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PLANNING - STUDY DOCUMENTATION OF HIGHWAY ON CORRIDOR Vc

LOT 1: SECTION SVILAJ – DOBOJ JUG (KARUŠE)

ENVIRONMENTAL IMPACT STUDY PHASE II

SUBPHASE – ENVIRONMENTAL IMPACT STUDY

IPSA Institute, Sarajevo

Sarajevo, May 2006

CLIENT:

**MINISTRY OF COMMUNICATION AND
TRANSPORT OF BOSNIA AND
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**LOT 1: SECTION SVILAJ - DOBOJ JUG
(KARUŠE)**

**ENVIRONMENTAL IMPACT STUDY -
PHASE II**

**SUBPHASE – ENVIRONMENTAL
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1. NON-TECHNICAL RESUME

Project purpose and aim

Corridor Vc has been integrated in the TEM network of Southeastern European transport infrastructure and will run from Budapest (Hungary), via Osijek (Croatia) and Sarajevo (B&H), to the port of Ploče (Croatia). The length of the B&H section of Corridor Vc will be 330 km and it will run in the direction north-south through the central part of the country utilizing the most favourable natural conditions, along the valleys of the Bosna and Neretva Rivers.

The B&H section of the transport Corridor Vc will include:

- E-73 Šamac - Doboj - Sarajevo - Mostar - Čapljina - Doljani, which will reach the Adriatic coast at the port Ploče, while Budapest will be its final junction in the north,
- Railway Šamac - Doboj - Sarajevo - Mostar - Čapljina - Metković,
- Airports in Sarajevo and Mostar,
- River waterways and ports along the Sava, Bosna and Neretva Rivers.

In 20th century, during 70s, UNDP Geneva started the initiative and proposed a plan to uplift the European motorway network. The project included the motorway connecting the Baltic and Adriatic Seas (Baltic-Adriatic) entitled TEM.

At the Third Pan-European Conference on Transport, which was held in Helsinki in 1997 and gathered EU member states and international organisations dealing with the issues of European infrastructure development, the 'Helsinki Declaration' was adopted, laying the framework to construct another ten pan-European corridors, including motorways.

The declaration also defined the routes of the ten trans-European corridors and their branches. It was specified under pan-European Corridor Vc that a motorway will pass through Bosnia and Herzegovina (Budimpešta-Osijek-Sarajevo-Ploče).

As previously said, Corridor Vc belongs to the pan-European network of corridors connecting the central Adriatic coastline, which has great tourist potential, but more importantly the port of Ploče with corridor X between Zagreb and Beograd, ending with the Budapest junction. Along with the plan to increase the capacity of the port Ploče, the corridor will help enhance trade between the countries in the region, and as for Bosnia and Herzegovina, it may improve its exchange of goods with the adjacent countries and Central Europe.

The study and project documents dealing with the motorway aim to provide a comprehensive analysis of the need to improve the quality, capacity and safety of transport in the corridor by building a full-profile motorway. The feedback and results of the study will be used in making investment decisions by those who ordered the study and by the funding institutions. This should particularly be kept in mind during the preparation of the prefeasibility study and the environmental protection study.

In accordance with pan-European transport initiatives and the Helsinki Declaration, which have been greeted as a great opportunity for Europe and particularly for B&H, recently there has been an increased level of activity to prepare for the construction of high-level communications,

i.e. motorways and fast roads, in order to meet the needs of the population and economy and boost development globally. Along with other roads (Banja Luka-Gradiška, Tuzla-Orašje and Adriatic-Ionic Corridor), preparatory activity has been undertaken for the construction of Corridor Vc motorway section. Therefore, the Ministry of Transport and Communications of B&H:

- adopted the document "Decision on existence of public interest to construct motorway on Corridor Vc through Bosnia and Herzegovina by granting concessions on the section and motorway to be defined by contract" (Official Gazette of B&H, no. 23, dated 7 August 2003),
- signed an agreement and agreed on the border crossing between the Republic of Croatia and B&H on the Sava River (Svilaj-Odžak) as part of the new motorway along with the route coordinates (3 September 2003),
- considered the proposal of the Republic of Croatia to specify Vc corridor motorway junction points in the south and reached the conclusion that due to the insufficiently elaborated project documentation and the difficulty to connect it to the Adriatic-Ionic Corridor, it is necessary to produce more detailed project documents prior to specifying the above-mentioned junction points,
- continuously exchanged information and views with representatives of the Republic of Croatia and the Republic of Hungary with regards to the preparations to construct the motorway along Corridor Vc,
- provided the necessary funds to prepare the plans and study, and undertake other activities before the construction of the motorway along Corridor Vc.

Taking into account the country's debts and its relation with the World Bank and the International Monetary Fund, i.e. its inability to obtain any bigger loans or subsidies, the Council of Ministers of B&H has decided that one adequate way to finance the construction of the new motorway would be through concessions. In that sense the Council of Ministers of B&H made the decision to prepare the study and project documentation, which would allow to define solutions and create conditions to find ways to fund the construction of the motorway.

Apart from B&H, both Hungary and Croatia have also expressed great interest in the project, and they intend to construct motorways along parts of this corridor on their territories by 2010. In conclusion, the motorway along Corridor Vc Budimpešta-Osijek-Sarajevo-Ploče through B&H is one of the most important, high-priority projects for B&H.

The aim of the study and project documentation is to determine the economic rationale to construct parts and/or all of the motorway, as well as the conditions to ensure the feasibility of the project; the prefeasibility study ought to evaluate the interest in getting concessions for the whole motorway in B&H through an international bid. Another aim is to attract foreign investors, start investment by beginning construction works at several sites and enable the growth of additional facilities along the completed parts of the motorway.

Complete plans and project documents in their final form will be used to submit the request to obtain the planning permission for individual parts of the motorway. There is readiness on the part of politicians to support the development of the country by approving the motorway project, its construction and exploitation in the most economical way and as soon as possible.

Following the political decisions to accelerate the preparations preceding the construction of the motorway, activities were undertaken to prepare a study and project documents for the whole motorway in line with contemporary standards of research and design and in accordance with the standards of the World Bank and other international funding institutions.

It is expected that upon its completion, the motorway will serve as a key generator of economic activity and enable B&H to become part of the main European transport communications network, as well as join the global European economic system. The motorway will represent a rational connection between Bosnia and Herzegovina and the adjacent countries and regions, and have stabilising and developmental effects on the country. Improved transport will result in a better quality of life, with these benefits:

- reduced travel distance and duration for goods and passengers,
- lower cost of transport of goods and passengers,
- increased employment,
- valorisation of B&H's geotransport position,
- increased economic competitiveness along the corridor,
- setting up of new projects and greater private investment in regional economy.

The aim of the study and project documents, which have been ordered, is to provide a comprehensive analysis of the need to improve the quality, capacity and safety of transport in the corridor by constructing a full-profile motorway. The findings of the study will be used by those who have ordered it as a basis for investing, as well as by other funding institutions.

General project description

Individual sections of the motorway have, so far, been considered in a number of studies, preliminary solutions and preliminary briefs. The motorway route may be found in both earlier and currently valid regional plans. Since a prefeasibility study is needed for the whole motorway running through B&H, two separate contracts (lots) are anticipated to be dealt with in the transport study and prefeasibility study for the section Svilaj - Sarajevo South and Sarajevo South – Border South. Each of these two lots represents a distinctive whole. Therefore, the study and project documents for the B&H motorway will consist of six functional wholes through six contracts (six lots), while the study and project documents for the whole motorway ought to be prepared with respect to contemporary standards of research and design, TEM standards and guidelines, as well as standards of the World Bank and other international funding institutions.

The future motorway has been divided into four lots, where LOT 1 covers the section Svilaj – Doboj South (Karuše) – and is approximately 63 km long. The lot Svilaj - Doboj South (Karuše) has been divided into six sections to ensure greater efficiency and functionality:

- Section 1: Svilaj – Odžak,..... approx. length 11 km
- Section 2: Odžak – Vukosavlje approx. length 6 km
- Section 3: Vukosavlje – Podnovlje..... approx. length 16 km
- Section 4: Podnovlje – Johovac..... approx. length 13 km
- Section 5: Johovac – Rudanka approx. length 6 km
- Section 6: Rudanka – Doboj Jug (Karuše)..... approx. length 10 km

Apart from the motorway along Corridor Vc, the studies cover the necessary access roads to all cities, towns and villages near the motorway, as well as the relief road which will be constructed around Doboj.

LOT1 begins with the bridge across the Sava River (the bridge is a joint enterprise with the Republic of Croatia) and in its initial part, it will run through the valley of the Bosna River passing the village of Vukosavlje, through the village of Modriča, to the village of Podnovlje. The motorway will be laid along the western end of the Posavina region, and then on the terraces on both banks of the Bosna River. In this part of the motorway the terrain is flat and suitable, and the road will mainly lie on fills. The soil consists of layers of alluvial sediments found in Posavina and the valley of the Bosna River, which means it is stable. The highest altitude of the motorway is 130 m. There will be five significantly long bridges, whose total length will be approximately 1700 m, two locations where service and catering shops will be constructed, and three junctions. The longest structure will be the interstate bridge across the Sava River (approx. 600 m). The Republic of Croatia has prepared a preliminary solution for the bridge, which ought to be inspected, after which follow-up activities will be proposed.

In its second part the motorway will begin in the valley of the Bosna River in Podnovlje and finish with a bridge in the vicinity of Karuše (km 62+600). The road will lie on the left bank of the Bosna River all the way to the village of Rudanka. After Rudanka, the motorway will reach hilly terrain and get into the valley of the Usora River, thus avoiding cutting across the urban infrastructure of the town of Doboј. The terrain is stable in this part. There is a plan to construct a site with service and catering shops, three junctions, five long bridges and two tunnels along this section. The total length of the bridges which will be constructed is 2750 m, while the tunnels will be approximately 1960 m long. The junctions will link the existent as well as new transport networks.

EIS impact area definition

The boundaries of the studied area with regards to the impact of the new motorway in Corridor Vc, LOT 1, comprise the broader area of the valley of the Bosna River between Svilaj and Doboј. In fact, the area stretches from the border with the Republic of Croatia to Doboј (Karuše). On the west side the boundary coincides with the road between Svilaj and Doboј, whereas on the east side it follows the railway.

As for the aspect of water resources, the studied area includes one-kilometre-long straps of land on both the left and right sides of the motorway contours, including the roadway itself. In cases where hydrogeological conditions require so, especially where ground water needs to be protected, the natural boundary between aquifers and aquifuges is respected as the contour, given that such soil frequently yields wells, springs or wet wells. A water resource map has been prepared with respect to the above said. The map shows the zones where wells will be protected as part of public water supply systems along LOT 1 (red hatching marked with the zone symbol), as well as areas sensitive due to existence of ground water (designated with orange slanted hatching). Protection zones are areas defined through and during research work, they are legally protected following the passing of necessary decisions, allowing to effectuate protective measures in agreement with the decisions or legislation in effect. Sensitive areas are aquifers through which the motorway may pass, but only provided all necessary preventive measures have been undertaken and negative impact on ground water has been minimized. Surface flows and their banks, along which the roadway is laid or across which it runs, are also treated as sensitive areas. The topographic info bases used as graphic documents in this study have been obtained from the joint-stock company IPSE, d.d. Sarajevo, in March 2006.

During the preparation of the technical study and preliminary solution, a broader area through which Vc motorway will pass was considered in order to select the most adequate routing. Following ample analysis and considerations during this stage, the final roadway was agreed

on. It is the subject of this study and is entitled 'Environmental impact assessment for preliminary brief preparatory stage'. The total roadway length is 62 634 m and it has been divided into six lots:

- Lot 1: Svilaj – Odžak, L = 10 891 m,
- Lot 2: Odžak – Vukosavlje, L = 6 398 m,
- Lot 3: Vukosavlje – Podnovlje, L = 16 178m,
- Lot 4: Podnovlje – Johovac, L = 13 157 m,
- Lot 5: Johovac – Rudanka, L = 6 192 m,
- Lot 6: Rudanka – Karuše, L = 9 818 m

The roadway width considered in the sense of motorway impact and protective measures is 500 m (250 m from the motorway centerline on both sides). However, a broader belt of 1000 m has been entered in maps (500 m from the motorway centerline) for the purpose of more careful examination of the surrounding soil and corresponding measures of protection, which is directly connected with their use value. The roadway will mainly run through plains and claim farmland. Besides, the sites where additional facilities will be constructed are still unknown (petrol stations, restaurants, motels, car parks, turnouts, motorway access and exit roads, and so on), which will certainly additionally pressurize the environment, including the surrounding ground. For these reasons it is important to research the broader area.

EIS preparation methodology

Regardless of the above-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 is a series of factors which require a deeper analysis of the methodology used in the research, where special attention should be paid to the steps which were taken respecting a certain hierarchy, their objectives and relation to the process of planning and design. This kind of analysis is necessary for the purpose of comparison with the applied methods used for the needs of this study and the methods considered valid by the general legislation regulating this area (Codebook for plants and facilities requiring environmental impact assessment and plants and facilities which may be constructed and operate provided they are granted environmental planning permission (Official Gazette of B&H Federation, no. 19/04)). Our principal goal is to try and adjust general methods to the specificities of this project and prepare plans and project documents using the right methods.

As part of preliminary activities and in line with Bosnian and Herzegovinian legislation, environmental impact assessment for projects of this kind is undertaken in two stages: the relevant ministry prepares the preliminary environmental impact assessment based on preliminary assessment documents, and the relevant ministry issues the environmental planning permission based on the project task of the ministry and the environmental impact study prepared using the project task.

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, Dvokut – Ecro, Zagreb. During its preparation, the preliminary environmental impact assessment was available to all interested parties and the public on the web page of the Federal Ministry of Physical Planning and Environment and submitted for opinion to all relevant individuals and parties. The preliminary environmental impact assessment document contains study results covering all of LOT1. The environmental impact study analysed the roadway selected based on various criteria.

General methods

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 and a previously defined manner of information and data exchange between those involved. Bearing in mind what has just been said, it is obvious that there has to exist a common methodological basis with clearly defined steps to be taken in the examination of environmental issues.

The need for common methodology to be used in the examination of environmental issues stems from the necessity to respect basic compatibility principles, establish harmony between the different levels of analysis, and ensure hierarchy as well as successive information exchange.

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

The need to harmonise different levels of analysis is equally important given the scope of approach, how detailed the existent and obtained information is, as well as the elements of the mechanism of analysis to be used. All analyses and conclusions must share the same seriousness of approach and be equally detailed, which will recommend them as valid in making the right decisions and continuing action.

Structured methodology is the prerequisite ensuring a valid methodological approach, which will primarily enable to respect the previously determined order of actions and form the basis to make decisions. The conclusions made during any previous stage will present conditions and the starting point for the subsequent stage of action.

The need to establish definite data exchange procedures between the two processes stems from the fact that the results of one process represent the entrance data for the other, and vice versa. We need to emphasise that this sequence is not arbitrary; it strictly adheres to the logic of both groups of analyses and their interrelatedness. Another important factor is the multidimensional harmonization of these data both for the needs of the processes and for the purpose of creation of the common info basis of greater significance.

Basic methodological steps are defined in a broader context if we are to stay aware of the global character of environmental issues. This context translates as the process of spatial planning integrating unique planning procedures that are distinct for roads, especially considering their requirements in terms of functionality and distinctive consequences. When it comes to the process of design, it has to be defined by means of standard methodology compounded by the preparation of investment documents.

In the light of what has been stated above, environmental impact studies represent the key step in the positive approach to environmental issues. With the selection of optimal design solutions as the essence of every individual design phase, it is clear that this stage only may provide real opportunity to preserve the environment. Here the preparation dynamics has to be in balance with the pace of preparation of other project documents. Part of the most extensive spatial analysis completed in the preliminary phase has to precede the actual design preparation. Since this issue deals with the spatial organization of potential pollutants, it is very important to

systemise and quantify all major factors using relevant indicators. The information basis of this study is a 1:25000 scale base map. The purpose of these documents is to use them as a means of extensive communication between all interested parties.

Population

As the Zenica – Doboj Canton is dealt with in LOT2, we will focus on the Doboj Region in the Republic of Srpska and the Posavina Canton in the B&H Federation. This area covers 3390,3 km².

As previously said, the Doboj Region covers the area of 3065,71 km², which makes 12,5% of the territory of the Republic of Srpska, holding 17,8% of the total population of the Republic of Srpska. The average population density in the region (85,5 st/km²) is above the average population density of the Republic of Srpska (60,1 st/km²).

The Posavina Canton covers the area of 324,6km², which makes 1,2% of the territory of the B&H Federation, holding 1,9% of the total population of FB&H. The average population density of 137,5 st/km² is above the average population density of the B&H Federation (89,1 st/km²). The birth rate in the Posavina Canton is 2,4% and the population density is rather high in comparison with the Doboj Region.

In the last five years, there has been a decline in the birth rate of the population in the Doboj Region, except in the municipalities of Teslić and Derventa. The death rate is on the increase in all parts of the region. The vitality index is below 1, indicating a bigger number of the deceased compared with the newly born.

The impact this motorway will have on the social environment may be examined only if we clearly determine the specific social groups which will use this space and facilities within it, and they only can be used as the basis to study this phenomenon. In this sense, we can single out two discrete interest groups in the concrete context related to the motorway. One group are motorway users, while the other are the inhabitants living along the motorway and real estate owners who will be affected by the motorway and its construction.

As a result of the motorway construction, the first social group consisting of motorway users will enjoy a series of benefits due to increased transport safety, reduced petrol consumption (which will have positive effect on a series of related global issues), reduced travel duration, better transport connection within the broader area (with all related positive effects) and improved conditions for the economic growth of the broader area.

A part of potential problems will be minimized in the areas which are scarcely inhabited, even though this may give rise to certain situations stemming from social contacts on a much higher level and related consequences (of practically international importance), which might cause acute problems in the communities living in their traditional setting.

A part of these problems will have to be resolved prior to the actual motorway construction, primarily through communicating with these communities and dealing with what will affect them during and after the construction of the motorway.

Certain social problems might arise during the construction of the motorway. Efforts should be made to place temporary construction facilities in such a manner as to avoid possible problems between construction workers and local inhabitants.

The issues related to land expropriation needed to construct the motorway and additional facilities important for the project implementation represent significant parameters in the sense of defining the relationship between the motorway and its surroundings. The examination of these issues became very important with the realisation that the soil occupied by the motorway will turn into a resource lost permanently, without a possibility to use it for any other purposes ever again.

The stated fact along with the fact that available farmland will be reduced has led to the need to examine this indicator. In defining potential impact, the need to occupy farmland has to be analysed from the environmental standpoint, where measures should be undertaken to minimise these impacts to their lowest. In order to minimise the undesired effects in the earliest design stages, it is necessary to determine the approximate number of estates, houses, shops and businesses along the motorway which might be expropriated. This will ensure objective indication of the scope of potential problems related to property expropriation and population displacement.

Soils and Agriculture

A responsible relationship toward agricultural land, as well as land in general, is a requirement for a stable agricultural development of any region. Roads fall into the category of immodest „consumers“ of agricultural land. Therefore, the selection of the optimal route for the Svilaj - Karuše section of the Vc highway corridor represents a delicate task. Marking the route of the highway should provide an utterly rational relationship and maximum protection of agricultural land from all types of damaging. This primarily refers to road pollution and minimum loss of agricultural land. Damages, of course, cannot be entirely avoided, however, they can be reduced to the lowest and acceptable level. Such solutions can be reached only based on scientific knowledge in the area of spatial distribution and significance of soils on this section route.

During the phase of development of a Technical Study and General Design, a broader area surrounding the route of the Vc highway was considered, in order to select the most suitable route option in total length of 62 634 m , LOT 1., divided in six sections.

In order to be able to accomplish the set goal, all available data were included in an overall analysis of major natural characteristics of the highway route area that make impact on the soil formation state and agri-hydrological conditions. The major characteristics include: climate in the area, parent material (geology - lithology) conditions, relief and soil properties.

The semi-humid climate is present in this entire area, and there is a tendency of developing brown soils. In the wider area of the Corridor Vc – LOT 1 route, parent material upon which the current soils have been formed are predominant: alluvial and colluvial depositions, tertiary clay, clay stone and loam material, sand, slates, sandstone, gravel, marl and solid limestones. Such structure of the parent materials upon which these soils were formed indicate its erodibility and potential mobility through erosion.

In the wider area of the corridor route, a total of 24 syb-systemic unit were identified, out of which 7 belong to Order of Automorphic soils and 17 to the Order of Hydromorphic soils. In Order of Automorphic soils, the predominant types belong to the class of Cambic and Humic accumulation soils, while in Order of Hydromorphic, they belong to the class of Fluvial and Fluvial gley soils, as well as to the class of Hypogley soils. All the above stated pedo-systemic units are divided into four usage value categories. The best usage value category is II (the second), and the worse is V (the fifth). This indicates that the highway route, in its major part,

passes through agricultural land which, depending on the shape of terrain, is being extensively or less extensively utilized. A review of physical, mechanical and chemical properties of the above listed pedo-systemic units is also provided.

The areas of agricultural and other types of land that will be exposed to the impact of the activities involved in construction of the highway can be divided in three levels:

- a) a narrow strip up to 60 m in width (30 m off the central axis of the road to the embracement or shoulder on the left and right side) will be fully «attacked», either by the highway route itself or by facilities and machinery during the construction. It means that 382.45 ha of land will be „attacked“ in this most direct way on the LOT 1 section of the highway,
- b) a broader strip up to 200 m in diameter (100 m off the road axis to each side). Along with the above stated, this is considered the area of direct impact of traffic, and most of it is owned by concessionaire or the state. Majority of protective measures also pertain to this strip. As for the area of this strip, it is being calculated to 1274.84 ha,
- c) a broad strip in diameter of 500 m (250 m off the road axis to each side, or 150 m as extension of the previous strip). This strip includes lands directly exposed to physical damaging and destruction, as well as the areas stretching along the highway directly suffering from traffic. If we take 500 m as the width of the strip, a total area of 3131.7 ha will be exposed to these drivers.

The shorter the route (more tunnels and viaducts), the lesser the loss of soil through change of use is. From the agricultural point of view, it is logical to request that deep arable land be avoided to the maximum extent possible.

Efficient proceeding of traffic is often in collision with the requirement to reduce fragmentation of production lots. This is feasible in the part of the sector situated in the slope foot by orienting the route along the margin, thus avoiding the traversing 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 road route is elevated relative to the land in the fields and valleys, where air circulation is more frequent, there is less fog and foggy days on the highway itself.

Any insertion of harmful matters into agricultural land jeopardizes its function. With regard to the basic meaning of the harmful emissions deriving from traffic activities, these matters can be divided in four groups: solid particle emission – dust, liquid matters emission, gas emissions, snow melting salt emission. As an example, average concentration of some heavy metals (Pb, Cd and Zn) was calculated for a 3 m strip along the road margins (shoulders or embankment), while traffic intensity factor was taken from the Study dubbed „Final Report on Pre-feasibility Study“ for 2015. The assessments were made for the accumulation of three major heavy metals in 3 m wide strip on each side of the road surface, by sections and for the total length of the lay-out. The total quantity of Pb, Cd and Zn in targeted area along the entire length of the lay-out is 9.27, 5.59 and 9.27 tons, respectively. This is surely a rough assessment, however, it indicates potential danger of contamination of the strip along the highway. Heavy metal accessibility for a plant depends on the soil condition, particularly on pH reaction. Therefore, intervention through changing the pH reactions of soil may prevent introduction of heavy metals into food chain.

All predictable impacts of the Svilaja – Karuša section of the Vc highway corridor near Dobo, on agricultural land and agro-ecosystems, particularly in view of change of type of land use, fragmentation of production lots and emission of harmful matters, were analyzed .

With regard to geo-morphological situation, type affiliation, depth, physical and chemical properties influencing the soil fertility, all soils in the area of 500 m in diameter (counting from the road axis), can be grouped in four categories. With regard to fertility and current, i.e. potential way of use, as well as protective role of soils, the soils are grouped in four categories (priority levels), that are related with the necessity of protecting them from various damages. There are appropriate soil protection measures recommended for each category. These measures are based on the concept of full protection of the most valuable soils, then on dispersion of pollutants on the very highway and collection of water from the highway through a closed drainage system.

- a) I category (1703 ha) – overall protection, includes fertile, deep, most valuable soils on the route, with favorable physical and chemical properties
- b) II category (509 ha) – High level of protection, includes soils with suitable physical and chemical properties, high fertility, but on limited, smaller areas, as well as soils with some disadvantages that could be removed by minor agro-meliorative actions.
- c) III category (868 ha) – selective protection, includes primarily soils with more or less dense bush, where deeper soils used for extensive growing of mainly fruit and vegetables appear only in sinkholes, valleys or cuts.
- d) IV category (52 ha) - protected (forest) soils, includes soils covered by reasonable forest cover. In case that highway route crosses such an area, it is necessary to take care that the damages inflicted on soils by road construction are carefully considered and reduced to a minimum, in order to avoid soil erosion by wind and water.

As a special action for mitigating negative impacts on environment, we recommend a concept of protection of agricultural production area – soil, i.e. agricultural ecosystem based on several basic principles:

- Efficient protection of all more valuable soil types from dust.
- Dispersion of fine dust and aerosols in the narrow strip possible, avoiding thus pollution of more valuable agrobiotope.

There are also some biological protective measures recommended. They are based on protective plantation and its major aspects: selection of plants (varieties), their spacing and size before and after the planting. Finally, the requirements are analyzed and recommendations concerning the monitoring systems are made, through previous consideration of zero-status, and monitoring of soil during and after the completion of the construction of highway.

Water resources

The research area from the water resources aspect encompasses the zone of one kilometer each from left and right side of the upper contour line of the motorway, including the route itself. In the situations where it was justified from the hydrogeological aspect, i.e. from the aspect of groundwater protection, in defining the spatial limitations the natural boundary of the aquifer has been adopted toward the water impermeable medium, as contour boundary, considering that in such environment the phenomenon of sources, exurgences or water supply pumping stations are very often. Respecting the previously said, the limitation map has been prepared in relation with water resources (Annex 12.3.5.). In this map, the sanitary protection zones of the sources in the public water supply systems are presented along the LOT 1 (marked with red hatch with the mark of zone), as well as all other sensitive areas in relation with groundwater (marked with orange oblique hatch). Surface watercourses and their coastal area, along which the motorway has been routed or has been crossing it, are also treated as sensitive areas. Topography layers which are used for graphic presentation in this Study were obtained from IPSA, stock company from Sarajevo in March 2006.

In the zone of motorway passage of this section, there is a dense watercourse network, among which the Bosna River is the most significant with its smaller and bigger tributaries. Besides the dense network of surface watercourses, the significant groundwater resources also exist, and most of it is still not enough explored.

During bedding of the route, it have been taken into consideration that the sources of public city and settlement water supply systems along the section LOT 1, as well as its accessory water protection zones are being avoided. The exception is the source of Odžak waterworks, which is located in the public watersupply system of Odžak, and is significantly remote from the motorway route. Considering that the route passes through the proposed third zone of sanitary protection of waterwork source in Odžak (according to the protection design developed in December 2005), when designing and constructing the motorway, it is necessary to comply with the limits prescribed for the III protection zone for sources in aquitards of intergranular porosity and to plan the structures that will satisfy the requirements prescribed by existing „Rulebook on conditions for determination of sanitary protection zones and protective measures for water sources that use or plan to use for drinking-October 2002“.

By analysis of hydrogeological characteristics of the concerned corridor, 11 sensitive areas for groundwaters has been determined by Study, i.e. the aquifers which represent the significant resource of quality drinking water for satisfying the increasing needs. In the sense of construction and usage, the sensitive areas mean the watercourse banks along which the motorway has been routed and where the motorway has been crossing it, as well as the sources within and outside of the watersupply system. One of the difficulties in the phase of preparation of this Study was inexistence of detailed hydrogeological map of closer zone around the motorway obtained on the basis of research works.

Respecting the concrete location conditions and existing available data, the potential adverse impact from construction and use of motorway has been evaluated on surface and ground waters and in accordance with that the proposed measures of prevention i.e. minimization of the same. In numerous cases the problem of lack of data has occurred, i.e. need for carrying out the detailed researches of certain water phenomenons in higher phases of conceptual design having in mind both its potential adverse impact on the motorway itself, and as well the potential adverse impact of the motorway on the same.

Facilities for motorway wastewater treatment principally may be located within the areas defined as sensitive in this Study, but before final selection of disposition of those structures the detailed hydrological layer of closer area around the motorway should be consulted in scale 1:5.000. It is necessary to pay attention not to locate the structures in aquifer areas in which the high levels of groundwater have been determined in order not to cause disturbances of groundwater flow hydraulic regime, disturbances of aquitard recharge and similar.

Having in mind all previously mentioned, it is necessary to carry out the control of assumed impacts on waters on the basis of data that will be obtained after the finalization of research works, that is hydrogeological maps and longitudinal profiles of closer zone of motorway in more detailed scale (1:5.000).

Sources that are located in public watersupply systems of Modriča, Vukosavlja, Doboј and Doboј-south, are rather far from the motorway route, and the negative impacts are not expected on the same.

Considering the hydrogeological picture and relations along the concerned section of LOT 1, as well as bedding of the motorway route in relation to the sources that are located in the watersupply system of Osječane, as well as sources of Ularica, Makljenovac and Alibegovci in

Usora Municipality, it can be said that the works on construction of concerned section can cause the significant impact. Sources that are located in the public watersupply system of Odžak, are significantly far from the motorway route. Considering that the route passes through the proposed third zone of sanitary protection of waterworks sources in Odžak, it can be said that works on the construction of concerned section can cause the significant impact. As the source Kraševo is located on the right bank of Usora River, the significant negative impacts are not expected on this source. The same applies for the local sources registered on the location of Doboj-south Municipality.

Both in the construction phase and in the exploitation phase of the motorway, the following sources will be exposed to the negative impacts the most: Odžak, Bare-Osječani, Ularice, Makljenovac and Alibegovci. This negative impact is evaluated as significant and in accordance with that the prevention measures i.e. measures of minimization have been proposed.

In all locations of crossings of planned motorway and watercourses, as well as in the locations where the route is located along the watercourse banks, the significant negative impacts are also possible during the construction and exploitation of motorway.

The sensitive areas in the form of aquifers can also be significantly endangered in the motorway construction and exploitation phase.

All foreseen negative impacts on the mentioned water phenomena in the motorway construction and exploitation phase can be avoided or reduced by proposed measures of prevention/minimization.

Considering that the motorway causes the numerous changes on the water phenomena along the route, which in the great extent depends on the way of construction and exploitation, in accordance with that and taking care of the best environment practices, the prevention, i.e. minimization measures have been proposed against the harmful impacts. The certain impacts on waters can be avoided in the designing phase, and in that sense the preparation of certain conceptual designs of external and internal drainage, watercourse regulation, horticultural regulation of protection zone have been recommended in the prevention measures, as well as the designing of vertical fences along the motorway in the locations marked as vulnerable and sensitive from the water resources aspect. By the appropriate organization of the construction sites and applying the proposed prevention measures during the construction, as well as in the exploitation phase, by maintenance of constructed structures for road wastewater treatment, the negative impacts on the groundwater and surface waters quality can be avoided.

With the aim of perception and valuation of changes incurred in the environment during the construction and exploitation phase, i.e. effects of proposed prevention/minimization measures, and introduction of necessary improvements and corrections, the plan for monitoring of surface and groundwaters has been proposed both during the construction and exploitation phase of motorway. Monitoring of zero status of water quality is the prerequisite for enforcement of adequate analysis, as well as taking the appropriate measures for both mentioned phases. The zero status of surface waters and groundwater quality in the research area has been presented in the study on the basis of available data from Republic Directorate for Waters of RS, waterworks and municipalities along the routes LOT 1.

The special problem, both in the construction and in the exploitation phase is pollution in the cases of accidental situations, especially of those where the heavy vehicles participate which transfer the dangerous loads (traffic accidents, damages), due to the weather and spatial unpredictability. In that sense, it is necessary to apply all available measures for reduction of

probability of occurrence of accidental situations. In the case if such situations still happens during the construction and exploitation, the preparation of plans is foreseen by study for the fast interventions and also organizing and equipping of appropriate intervention services, in order to ensure the restoration of damages caused by accidents in shortest period as possible, and to prevent the occurrence of accidents of larger scales.

Flora and fauna

This area contains a variety of hydrological, hydrogeological, pedological and geological entities with varying landscape, whereas on the other hand, its climate is homogeneous (it has the characteristics of moderate warm rainy climate), with minor deviations in the conditions of changed relief.

The natural conditions, landscape and climate directly influenced the appearance and condition of the vegetation in the studied area. The original vegetation has greatly changed due to anthropogenic factors, but the area still abounds in ecosystems and habitats.

According to their origin, the ecosystems can be grouped into primary and secondary. As for the primary ecosystems, there are forests, while as for the secondary (anthropogenic) ecosystems, there is farmland (meadows, ploughland), urban spaces (villages, towns), artificial water ecosystems (reservoirs, ponds), forested areas and others. In conclusion, the studied area contains the following ecosystems: forests, meadows and ploughland.

The current presence and density of wildlife is the historical outcome of all factors it has depended upon, and as such, it is neither constant nor permanent, as together with animals, they are all subject to continuous change. Therefore, the fauna in the area of Corridor Vc probably differs compared with the latest data we have if we take into account the war which took place in Croatia and Bosnia and Herzegovina at the end of the last century. We should not disregard the anthropogenic factor in the studied area in the aftermath of war, particularly in the areas with increased immigration.

In terms of zoogeography, the foremost part of Corridor Vc in the lowlands of Posavina belongs to the European Pannonian subregion, i.e. sub-Alpine Slavonia-Srem area, while the rest belongs to the central European Alpine area.

Reduction during construction stage

- To avoid unnecessary biotope loss, construction sites will be limited to the minimally needed area, especially at those spots which are very important for plants and animals. Construction material will be stored only within construction site perimeters. The areas of great importance in terms of their environmental value will be fenced off and protected during the construction stage. Construction machines ought not to move outside construction sites for danger of soil pressure. Layers of biotope removed at construction sites will be compensated for / renewed following the completion of construction works.
- Special attention will be paid to streams in order to avoid the cutting off or disturbance of surface and/or ground water. This measure will preserve the existent wetland and freshwater vegetation and ornithological populations.
- Trees and thicket will be removed in wintertime in order not to interfere with the time of brooding 1 March to 30 September. Removed biotope will be renewed following the completion of construction works.

- During the construction stage special attention will be paid not to diminish the quality and beauty of landscape, especially in lake areas. In other words, landscape degradation will be minimized following earth digging and filling works, and it will have to be easily corrigible.
- The contractor will be obliged to collect and dispose of any excess solid waste of any kind at the nearest dump immediately following the completion of works at any construction site. Solid waste produced in temporary worker housing zones, vehicle parks and vehicle maintenance grounds will be collected and disposed of.

Diminishing impact generated by road base

- Most impact generated by the road base is unavoidable (places are quoted in the study, where there may be great conflicts due to: bridges designed with detrimental effects to the environment, road junctions placed in valleys, small distance between the motorway and rivers, etc.) Special attention must be paid during the design stage to avoid the felling of wild trees such as poplar, tamarix and willow.
- Each lot must be studied to identify and preserve endangered species. If such species grow within construction area, they need to be uprooted and replanted in another area having similar conditions.

Measures to diminish impact caused by traffic

- Constant monitoring of the number and species of birds killed along the motorway, consultation and adequate preservation measures to diminish risks need to be undertaken along those motorway sections where wildlife is endangered.
- In case a great deal of amphibians is killed along certain sections of the motorway, relevant experts will have to be consulted in order to find adequate solutions.
- Bridges ought to be protected with high fence to prevent birds (individual animals as well as flocks) from colliding with vehicles, especially during migration periods.
- Greater value biotopes should not be planted in the vicinity of the motorway, which is a zone suffering various impacts and will have negative effects on the surrounding fauna. Birds will be attracted by the vegetation and use these biotopes along the motorway as their new habitats. Therefore, a minimum of trees and thicket should be planted to preserve the scenery and prevent erosion, without creating new biotopes. New plants should not represent an issue at cuts, since trees and thicket will be located above the road, so collision between vehicles and birds will be avoided.

Landscape

A general analysis of the landscape of this area and its traits, prevalent habitation types, their location and relation to the surroundings, farming techniques visible around habitations, spatial organization – habitation matrix, characteristics and manner of exploitation of the typical lot, structural, morphological and functional characteristics of residential and economic architecture – leads to the following conclusions:

A larger section of the studied area belongs to the northern, peripannonian region of the Republic of Srpska, characterized by hilly terrain gradually descending into the plains.

In terms of relief, the area consists of low-lying flatland, fertile river valleys and plains, mildly elevated terrain and mountainous ground. Valleys and hilly ground dominate the studied area (altitude up to 200 m), while there is considerably less lower mountainous terrain (200-600m). Low-lying lands comprise areas of up to 200 metres altitude and make a greater part of the

studied area. Mountainous terrain includes the hilly parts of the area. The height of this terrain ranges between 200 and 500 metres.

The mountainous part of the studied area consists of slopes descending into the valley of the Bosna River. Higher parts are covered in forest (beech, fir, mountain maple). The lowest-lying slopes are used as farmland, where vast meadows and forests alternate.

Valleys encompassed by hills dominate the broader studied area. The zone characteristic of the broader studied area combines these two types of landscape, with collimation lines containing elements of both. Forests and farmland alternate and dominate low-lying terrain. The valley is cut longitudinally by the Bosna River, which runs almost through its middle. The most elevated parts of the hilly terrain are covered in forests and pasture. There are suburban habitations with family housing and cultivated vegetable gardens in these hilly areas.

Four principal types of landscape are characteristic of the broader studied area:

- Natural landscape
- Cultivated landscape
- Constructed landscape
- Cultural and historic landscape

Following the identification and definition of these resources, we need to search for the measures to preserve them, reduce negative impact or compensate for their loss. At the same time, there has to be awareness that a road can never be constructed without disturbing the surrounding scenery.

In designing the road, efforts have to be made to diminish these factors, while taking into account the following:

- Elements of design geometry must meet the principle of homogeneity and match local morphological features.
- Cut and fill gradients need to be changeable and adapt to local morphological features.
- Bridges, viaducts and tunnels may be used when the motorway runs across steep slopes, which is an option more favorable than using cuts and fills. This will help preserve the visual and physical continuity of landscape.
- Various elements in the situational and leveling plan may be shaped purposefully to enhance the quality and attractiveness of views from the motorway.

Excellent effects may be achieved by planting vegetation across the areas where the motorway will pass, while taking into account the following:

- The motorway has to fit in the local vegetation (trees, bushes, tree-lines, hedge).
- Plants need to be replanted/relocated while ensuring they fit in the current scenery.
- The species selected need to match the road type and its function.
- New vegetation should not interfere with collimation lines or be planted simply to cover empty space.
- Planted vegetation should outline various types of scenery alternating along the motorway.
- Vegetation accentuates the various conditions in which transport takes place (changes to the situational plan).
- Care should be taken to use materials obtained locally to build motorway facilities.

Motorway upkeep may play a very important role in how it will affect the scenery and visual elements of the road. Visual pollution may be reduced by paying special attention to the shaping of different protective and supporting structures (various structures to reduce noise), introducing special fines and punishments, regulating advertising along the motorway, etc.

Negative effects on the landscape may be partly neutralized by means of forestation to compensate for the trees that had to be felled during the construction of the motorway and rehabilitation of the areas affected by various problems.

Protected environment

Determining the impact the motorway will have on the natural heritage requires an analysis of such natural complexes which are usually defined as national parks, nature preserves, nature reserves used in science and research, areas with special nature characteristics, unique landscape, special nature reserves and monuments of nature.

Spatial complexes defined as above are subject to a certain degree of public care and preservation measures following the passing of adequate legislation. By definition, these spatial complexes represent nature rarities, and the main principle that should be respected is to keep the motorway at sufficient distance from them to prevent detrimental impact.

There are no nature preserves within the zone of the studied lot, i.e. there is no requirement for additional preservation measures, so this issue is not elaborated on.

Cultural and historical heritage

After examining the area in its current state and analyzing possible impacts in the future, the existence of archeological sites was ascertained without locating them with greater precision, which might give rise to conflicts. Taking this into account, these potential sites may be protected during three stages, where one would follow another depending on the actual situation.

During phase one, archeological research by means of probing would be undertaken at identified sites to study their age and origin, determine archeological layers, chronology, degree of preservation of the findings and architectural remains, if any. As for this phase, research would have to be conducted prior to the actual commencement of motorway construction works.

During the second phase, following the findings of archeological research conducted during phase one, protective archeological excavation will be planned for those parts of sites that might suffer during construction works. Following the conclusion during phase one that no archeological items have been preserved at particular sites or that the motorway will take a detour, the research planned for phase two will not be undertaken.

The third phase would involve expert supervision, i.e. inspection during motorway earthworks. In case previously unknown archeological findings are uncovered, archeological excavation would be undertaken to protect the site and findings.

Noise

Possible reduction measures

One of the main goals of noise pollution assessment is to examine the effectiveness of noise neutralization measures to avoid the negative impact of noise on the structures / facilities along the motorway. Noise may be reduced by applying various measures:

- Hindering noise transmission by installing noise barriers.
- Reducing noise emission at source (vehicles, motorway surface).
- ☐ Reducing noise pollution in residential areas by fitting special soundproofing windows in each individual house.

These measures should be implemented in the following order: first, noise barriers are installed; second, noise is eliminated at source; elimination at receivers is the third step. The installation of noise barriers is one of the most important alleviation measures. Since the motorway along lot 1 will mainly be laid on fills, there is a good rationale to use thin walls for noise prevention (e.g. panels) rather than broad structures in the form of steep fills, which prevent sound diffusion.

In order to compare the effectiveness of walls of different heights to be used to prevent noise near residential areas along the new motorway, isophones were determined for relevant noise pollution. Based on this, dimensions were specified for walls to be used for noise prevention depending on locations (height and length) in order to meet the standard of 50 dB(A) at nighttime. A summary presentation of individual neutralisation measures is given in the table To calculate the level of noise, the average wall height was 3 m. The study used the bases of revised roadway solutions from the preliminary solution completed in 2D. The obtained wall height is satisfactory in most cases given the fact the motorway will mainly be laid on fills. In the case of residential buildings located at heights greater than the proposed wall height, especially for those immediately along the motorway, higher walls would be needed for effective protection (5 to 10 m). However, this would be absolutely cost-ineffective and therefore unacceptable, and they would additionally hinder the view. It would be best to install special soundproofing windows for noise prevention in such houses / buildings (passive measures).

Environmental impact assessment basis

All types of transport systems with their current characteristics represent great sources of environmental pollution. In that sense, the planning, design, construction and exploitation of motorways is a very important issue in terms of environmental preservation.

In the light of the above said, we may claim with great certainty that the planning and subsequent construction of high-capacity communications always brings about a series of conflicts between motorways and the environment. According to its character, the motorway Svilaj – Doboj definitely represents one such enterprise.

A global analysis of the impact the motorway will have on the environment shows the contributing factors may be grouped into three basic types. The first group comprises the effects resulting from construction works, which are temporary in their nature. They are a result of human and machine presence, as well as of the technology employed in and organization of construction works. As a rule, negative effects are caused by excavation/stockpiling works,

transport and use of huge quantities of construction material, as well as permanent or temporary occupation of land and other related activities.

Environmental impact resulting from the existence of the motorway in space and its exploitation in time will mainly be permanent in character and as such, it will surely represent the form of influence significant from the aspect of the relationship between the motorway and the environment. This kind of impact in most cases manifests the tendency to grow in space and time, which warns us of the need to pay due attention to its nature in good time.

All processes within the complex relationship between the motorway and the environment take place owing to the interdependence of a multitude of relations, which inseparably bring about many changes. These changes may range from those insignificant ones to the radical, where individual elements completely lose their basic characteristics. A systematic approach to these relations by means of analysis of individual factors produces satisfactory results in the majority of cases, provided their quantification is objective and the hierarchy of methods is consistently respected.

Given specific conditions, each factor may become dominant; however, practice to date has outlined the basic matrices of the relationship, which does not mean that in the future, with growing knowledge and environmental awareness, these matrices cannot undergo changes, on the basis of which we define the main body or types of potential impact.

With consideration to the specific features characterizing the motorway which will be constructed and local spatial relations, this research deals with the fundamental factors turned indicators by means of quantification, whose aim is to provide accurate quantification of future relations and define their true nature. In line with admissible values of certain types of impact and the projection of these values in the context of future relations, adequate measures to preserve the environment have also been proposed.

The analysis and assessment of the current state of the environment, as well as the assessment of possible impact resulting from the construction of the motorway show that unambiguous quantified data may be obtained only by carrying out a comprehensive analysis.

All experiences in this field testify that today we may speak with great certainty about the known impact matrix, but that we should always bear in mind the fact that this matrix represents a phenomenon susceptible to change in space and time; this means that both the relative impact of individual factors and their absolute limits must always be examined within concrete spatial relations. This primarily means that every individual factor needs to be quantified through verified procedures and its real impact may only be determined in the context of concrete local relations.

In order to assess the impact of each individual factor in an adequate way, it is necessary to add a series of indicators to each of them in concrete conditions, which by nature need to be exact values, simply usable 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 it is impossible to select exact indicators for certain factors whose impact is a matter of fact, which means that part or all of the impact takes place in the sphere of one subjective relationship.

The level of elaborateness in defining individual factors (criteria) and their indicators largely depends on the project phase for which the analyses are carried out. Since each phase in the preparation of plans and/or project documentation depends on the characteristics of the

information bases, which influences the scope and accuracy of the available information, consequently, this conditions the quantification and accuracy of exact indicators.

The basic factors (criteria) have been defined in this research based on previously defined facts and concrete conditions on sites.

The matrix of the analysed criteria results from the knowledge about problems appearing in the relationship between the motorway and the environment. The thing which seems clear at first sight is that not all criteria are equally important, especially if we take into account concrete spatial relations in the studied area.

Air pollution is a factor that requires quantification given the impact it might have along the motorway. It will primarily affect the flora, but also to a limited extent the human population and facilities.

The problem of noise in the studied area exists as a parameter of current and future relations along the motorway in relation to the population inhabiting the studied 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 factors in these given conditions, given the fact that the analysed corridors will cut across the land in the valley of the Bosna River, which is characteristically reproductive soil.

Spatial relations inside the zone of the analysed corridors and their specificities have impact on the flora and fauna; certain resources have been confirmed to inhabit the area, which was reconfirmed during the analysis of its current state.

The current relations in the researched area indicate that other criteria are of lesser importance. This inferiority is obvious primarily if we take into account the following two principal phenomena, which may be defined as: local presence or distribution, and low intensity along the researched corridors. Microclimatic factors and issues related to resources and power supply are local in character.

Social life will be affected, particularly in the context of the current situation along the valley of the Bosna River. The construction of the motorway in this area will bring with it significant economic changes.

What has been stated above proves that environmental issues may only be clarified and resolved if each individual factor is analysed in the context of concrete spatial relations and turned into a reliable indicator by means of quantification.

If we take into account concrete conditions on site, motorway characteristics, the intended use of areas inside the corridor, fundamental laws regulating the relationship between various factors in the interaction between the motorway and environment, while using quantified indicators, we will also be able to specify the requirements to undertake protective measures.

Crossborder impact

LOT 1: Svilaj – Dobož South (Karuše) will run through the Federation of B&H and the Republic of Srpska. Taking into account the dimensions of the lot, there is a risk and it is very possible

the project may affect the water resources of another country, i.e. it may have impact on water resources across the border, in the Republic of Croatia.

Lot 1 of the motorway will be laid in the valley of the Bosna River almost all its length, cutting across it at several spots, or running along its left or right banks. The Bosna River flows into the Sava River, which marks the border between the Republic of Croatia and B&H. In that sense, in case of accidents, crossborder impact is possible in the form of transfer of pollution into the Sava River into this adjacent country.

Accidents are frequently caused when vehicles transporting hazardous substances overturn near streams. In such cases, by leaking into streams, these hazardous substances may pollute water and be transported from one entity to the other (if pollutants enter the Bosna River), and depending on the factors involved, they may even reach the territory of another country (the Sava River).

It is possible to determine the risk of accidents involving hazardous substances if we are familiar with the structure of transport and have the basic information on traffic accidents along the researched lot. Based on these data, it is possible to determine chances that such accidents may happen and accordingly undertake special measures of protection. If we look at the available information on the number of accidents on the motorway planned for construction, we may conclude that chances are small that vehicles transporting hazardous substances may engage in an accident. However, this is possible, making it necessary to undertake protective measures along all streams in danger of receiving hazardous substances, which may in turn use waterways to be exported to the other entity (the Republic of Srpska) and another state (the Republic of Croatia).

Hazardous substances are those characterized as highly toxic, oxidizing, explosive, ecotoxic, inflammable, self-inflammable, or which possess other characteristics turning them into a threat to human life and the environment. Depending on its position in the communications network, each road has a certain role in the transport of hazardous substances. Special attention must be paid to the detrimental consequences in biologically valuable areas and high-concentration traffic communications, which will certainly characterize the motorway planned to be constructed. Given the type of transport which will take place on the motorway planned for construction, the following hazardous substances may be expected:

- Inflammable liquids – petrol and diesel oil, which are transported in tanks, and various other types of oil (machine, motor, reduction, hydraulic, emulsion), which are transported in different containers.
- Compressed gases – propane, butane, which are packed into special steel cylinders.
- Oxidising substances – chlorides, peroxides, which are transported in tanks.
- Corrosive substances – sulphuric, chlorosulphuric, hydrochloric and nitric acids, which are transported in tanks or cylinders.
- Poisonous and contagious substances – pesticides, herbicides, which are packed into sacks and small cardboard containers.

Bearing in mind the above said, it is necessary to employ all possible measures to reduce chances for these accidents to occur.

It is possible to prevent the movement of polluted water if water quality is monitored along the motorway and conditions are created to allow timely employment of all necessary measures of additional protection. In particular, it is necessary to introduce a system of urgent notification of water authorities in the Republic of Srpska, as well as farther in the Republic of Croatia. This

also refers to any possible accidents which may have negative impact on water resources during the construction of the motorway.

When it comes to impact on water resources across the border caused by natural floods, it is necessary to say that the motorway has been designed to be constructed in an area frequently exposed to the flooding of the Bosna and Sava Rivers. However, the design has raised the finished motorway above the high-water lines (VV 1/100 and 1/500), which guarantees safety from this disaster.

Monitoring system

The environmental action plan is an indispensable part of this document and its purpose is to ensure adequate implementation of the proposed measures of protection. Also, EAP enables to examine the effectiveness of protective measures as well as their improvement and correction, if necessary.

Design phase

The checklist during the design phase is necessary for the adequate consideration and examination of all environmental aspects and issues, i.e. for the preparation of suitable projects of protective measures. Special protection zones specified in the project must be respected and special protective measures have to be adopted with regards to them. The same applies to the construction phase and must be emphasized in the bidding documents.

Construction phase

In order to meet all environmental requirements specified in the project, it is necessary to hire an environmental engineer (expert in ecology), who would run frequent inspections and monitor the implementation of works, thereby protecting the interests of the investor.

The contractor is also obliged to appoint a person or persons responsible to monitor the implementation of environmental requirements in line with the bidding documents. This condition must be emphasized during negotiations and prior to signing the contract.

The parameters which will be monitored during construction works include the implementation of the adopted measures of protection, and all these parameters will be frequently monitored by the environmental engineer and the immediate 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 bidding documentation).

Conclusion

Environmental issues related to the construction of the motorway Svilaj – Doboj, LOT 1, were analyzed in a special study based on the contents of the preliminary environmental impact assessment. The study was prepared by these consultants: IPSA Sarajevo, the Institute for Urbanism of the Republic of Srpska Banja Luka, and the Institute for Hydrotechnics Sarajevo. The methods which were used in the analysis adhere with the contractual documents defined by the investor.

The above-mentioned issues were analysed in several chapters, which contain research basis, characteristics of the motorway which will be constructed, characteristics and evaluation of the current state, complex analysis of environmental impact, necessary protection measures, monitoring and the environmental preservation action plan.

Research basis defines the relevant factors which influenced the study, which primarily covered the starting program foundations, legislation and research methodology. The chapter dealing with the characteristics of the motorway defines the characteristics defined in the preliminary solution.

The research and evaluation of the current conditions in the area has served as a detailed analysis of the existent resources (soil, water, biotopes, climate, landscape, etc.) and the assessment of their state. This analysis has shown that this area possesses substantial resources, which means it is absolutely necessary to run all analyses of potential environmental impact.

The environmental impact study examines the issues of noise, vibration, air pollution, water, soil, land reclamation, flora and fauna, visual pollution, natural and cultural heritage, and other relevant effects. Each kind of impact has been defined through indicators characterizing local conditions, taking into account all spatial distinctions and specificities of generation and spatial distribution of impacts.

Having taken into account the admissible values of individual factors as well as typical spatial relations, it has analysed various measures of protection that may be undertaken. Based on all the analyses of significant factors, we may draw a general conclusion that impact will be particularly great in the immediate bank zone of the Bosna River and water protection area.

2. INTRODUCTION

2.1. Elements for environment impact assessment

Initiative to start with the preparation of planning-study documentation for the highway construction on Corridor Vc resulted from the necessity to light up the capital project and environment relations. Initial base for the preparation of Environment impact study is contract documentation which specified initial scope for the study preparation. Initial fundamentals defined within tender documentation had created the basic assumptions on the necessity of research scope as compositional part of Preliminary project.

In terms of environment impacts, as consequence of construction and service of the highway, this construction object belongs to the group of ones need to be especially assessed within the study. In regard with above mentioned facts, knowledge about concrete spatial relations and impacts as well as role of planned road direction, it acquired all terms for the preparation of research on the level of Environment impact study.

Since the Study is compositional part of the Preliminary project, analyses within this survey must find their right place in the process of decision about construction feasibility. Meeting of this requirement, on one side, presents the qualitative contribution to the issues of protection and improvement of environment, and on the other side the certain improvement related to the alignment of planned highway.

Foundations for preparation of Environment impact study came out the previous phase of project documentation, i.e. Preliminary Environment Impact assessment as well as support documentation done for the design purpose, that is, the level of Preliminary design. Within this documentation, specially useful data relevant for the most of possible impacts came out the purpose survey related to geotechnical survey and the survey done for the purpose of preparation of planning documentation for urban area within analysed area as well as purpose survey for the purpose of this study carried out in the field. All survey activities done in previous period for the purpose of preparation of project documentation presented as well the base for this study.

Relevant assumptions that were relevant for the preparation of Environmental impact study came out the valid planning documents for wider survey area from Svilaja to Karusa.

All mentioned assumptions created the base and initial study frame for the issues of protection and improvement of environment as well as initial points for the preparation of Environmental impact Study as the part of planning-study documentation of the highway on Corridor Vc section of LOT1 from Svilaja to Karusa.

Environmental impact study presents the relevant documentation that should serve for the insight of all relevant subjects into the environmental issues for the highway object on Corridor Vc as well as conduct of public hearing procedure, in accordance with valid laws, as well as making of decision of authorized Ministry for the environment protection of Federation of BiH and Republic of Srpska.

2.2 Legal regulations

Relevant base for every survey of environmental impact structure must be presented by valid legal provisions and appropriate regulations for this field of expertise. Special characteristic

presents the fact that legal foundations within the road domain in Federation of BiH and Republic of Srpska do not exist yet. For purpose of this survey, it was used a wider regulation range for the creation of some legal assumptions in wider domain of environment having a certain significant interpretation of relations which are made by construction and exploitation of planned highway. It has been used the legal regulations that are still in force in Federation of BiH and Republic of Srpska:

- 1.0 Law on environment protection, (`Off.Gaz. of RS" 53/02, Off.Gaz. of FBiH 33/03);
- 2.0 Law on air protection, (`Off.Gaz. of RS " 53/02, Off.Gaz. of FBiH 33/03);
- 3.0 Law on water protection, (`Off.Gaz. of RS " 53/02, Off.Gaz. of FBiH 33/03);
- 4.0 Law on waste management, (`Off.Gaz. of RS " 53/2, Off.Gaz. of FBiH 33/03);
- 5.0 Law on nature protection, (`Off.Gaz. of RS " 52/2, Off.Gaz. of FBiH 33/03);
- 6.0 Law on fund for environment protection, (`Off.Gaz. of RS " 52/02);
- 7.0 Law on meteorological and hydrological activity, (`Off.Gaz. of RS " 20/00);
- 8.0 Law on ionize radiation control, (`Off.Gaz. of RS " 52/01);
- 9.0 Law on agricultural land, (`Off.Gaz. of RS " 13/97);
- 10.0 Law on plant protection, (`Off.Gaz. of RS " 13/97);
- 11.0 Law on forests, (`Off.Gaz. of RS " 14/94, 8/96, 10/97, 23/98, 18/99);
- 12.0 Law on hunting (`Off.Gaz. of RS " 13/94, 3/97, 10/97);
- 13.0 Law on environment protection (`Off.Gaz of FBiH 19/04);
- 14.0 Law on plant protection (`Off.Gaz. of BiH 23/03);
- 15.0 Law on forests (`Off.Gaz. of BiH 20/02);
- 16.0 Law on spatial development (`Off.Gaz of FBiH`, no: 52/02)
- 17.0 Law on construction (Off.Gaz of FBiH, no: 55/02)
- 18.0 Law on communal activities (Off.Gaz of FR BiH 20/90);
- 19.0 Correction in text translation of Decision of High Representative no:147/03 that pronounced Law on construction land of BiH Federation (`Off.Gaz of FBiH, 25/03);
- 20.0 Law on agricultural land (`Off.Gaz of FBiH 2/98);
- 21.0 Law on waters (Bosnian language) (`Off.Gaz of FBiH 18/98-454);
- 22.0 Law on alterations and annexes of Law on property protection that are by Decision of Commission for protection of national monuments declared as national monuments of BiH (Off.Gaz. of BiH 27/02, Off.Gaz of FBiH 8/02)
- 23.0 Law on property protections that are by Decision of Commission for protection of national monuments declared as national monuments of BiH (Off.Gaz of FBiH, 29/03);
- 24.0 Law on alterations and annexes of law on forests (Off.Gaz. of FBiH, 29/03);
- 25.0 Law on alterations and annexes of law on economy annexes (Off.Gaz of FBiH, 29/03);
- 26.0 Law on alterations of law on forests (Off.Gaz of FBiH 37/04)
- 27.0 Law on nature protection (Off.Gaz. of FBiH 33/03);
- 28.0 Law on air protection (Off.Gaz. of FBiH 33/03);
- 29.0 Enactment about export prohibition of forest products for primary processing outside of RS borders, (`Off.Gaz. of RS`, 28/98);
- 30.0 Enactment about water classification of inter-republic watercourses, inter-state waters and waters of coastal sea of Yugoslavia (`Off. Gaz.of SFRJ 19/80);
- 31.0 Enactment about classification of waters and waters of coastal sea of Yugoslavia in the borders of FRBiH (Off.Gaz. of FRBiH 19/80);
- 32.0 Enactment about watercourses categorization (Off.Gaz. of FRBiH 42/67)
- 33.0 Enactment about control of air pollution (Off.Gaz of SFRJ 14/66);
- 34.0 Rule book about measures of forests and crops fire control, (Off.Gaz of RS, 16/96);
- 35.0 Rule book about forest and forest land cadastre (Off.Gaz. of RS, 30/94);
- 36.0 Rule book about dangerous substances that must not come in water (Off.Gaz of FNRJ 3/66, 7/66);

- 37.0 Rule book about types, the way and volume of measuring and survey of used and discharged polluted water ("Off.Gaz. of FRBiH" 39/85, 20/90);
- 38.0 Rule book about control of air pollution ("Off.Gaz. of FRBiH" 18/76);
- 39.0 Rule book about dangerous substances that must not come in water ("Off.Gaz. of FNRJ" 3/66, 7/66);
- 40.0 Rule book about maximal boundaries of radioactive contamination of environment and use of decontamination ("Off.Gaz. SFRJ" 8/87, 27/90);
- 41.0 Rule book about collection, recording, treatment, conservation, final disposal and discharge of radioactive waste substances in the environment ("Off.Gaz SFRJ" 40/86);
- 42.0 Rule book about special regime of the control of activity that endanger or may endanger environment ("Offic.Gaz. FRBiH" 2/76, 23/76, 23/82, 26/82).
- 43.0 Rule book about the annexes to the Rule book about work conditions, organizations and other conditions for the work of station for automobile inspection (Off.Gaz of FBiH, 16/04);
- 44.0 Rule book about type, methods and range of measuring and testing of used water, discharged waste water and extracted material from the watercourse (Bosnian language) (Off.Gaz of FBiH 48/98-2168, 36/00; correction 35/01; 20/03;56/04);
- 45.0 Rule book about conditions for determination of sanitary protection zone and protective measures for water sources used or planning to be used for drinking (Bosnian language) (Off.Gaz of FBiH, 51/02-2297);
- 46.0 Rule book on conditions that must meet authorized laboratories and the content and way of issuing the certificates (Off.Gaz of FBiH, no:54/99);
- 47.0 Rule book on drives and plants for which it is obligatory environment impact assessment and on the drives and plants that may be built or put into operation only if they have the environment license. (Off. Gaz of FBiH 33/03);
- 48.0 Rule book on hygienic control of drinking water (Off.Gaz of RBiH 2/92, 13/94); published in (Off.Gaz of SFRJ no:33/87; 23/91);
- 49.0 Decision on maximally allowed concentration of radionuclide and dangerous substances in inter-republic water courses, inter-state waters and waters of coastal sea (Off.Gaz of SFRJ 8/78);
- 50.0 Decision about the enforcement of Law on construction land of FBiH (Off.Gaz of FBiH no:25/03);
- 51.0 Decision on national monuments (Off.Gaz of BiH 15/03);
- 52.0 Decision on declaration of national monuments (Off.Gaz of BiH 23/03);
- 53.0 Commission for preservation of national monuments –Decision (Off.Gaz of BiH 43/03);
- 54.0 Decision on the criteria change for pronouncement of national monuments (Off.Gaz of BiH, 15/03);
- 55.0 Decision on borders of water area (Off.Gaz of FBiH 37/98);
- 56.0 Decision on the borders of main catchment area (Off.Gaz of FBiH 37/98);
- 57.0 Decision on maximally allowed concentration of radionuclide and dangerous substances in inter-republic water courses, inter-state waters and waters of coastal sea (Off.Gaz of SFRJ 8/78);
- 58.0 Instructions about determination of allowed amount of dangerous and harmful substances in soil and testing methods (Off.Gaz of FBiH 11/99);

International agreements and conventions that Bosnia and Herzegovina joined:

- 1.0 Convention about transboundary air pollution on large distance, Geneva, in 1979 year (came into force: 16.03.1986.) (Off.Gaz.R BH 13/94, Off.Gaz. SFRJ MU 11/86);
- 2.0 Protocol with Convention about transboundary air pollution on large distance from 1979 year, about long-term funding of the cooperation program for monitoring and evaluation of transboundary transmission of contamination substances in the air on large distance

- in Europe, Geneva, 1984. (Came into force: 28.01.1988.) (Off.Gaz.R BH 13/94, Offic.Gaz. SFRJ MU 2/87);
- 3.0 Vienna convention about protection of ozone shell, Vienna, 1985. (Came into force: 22.09.1988.) (Off.Gaz R BH 13/94, Off.Gaz SFRJ MU 1/90);
- 4.0 Framework convention of UN about climatic changes, Rio de Janeiro, 1992. (Came into force: 21.03.1994) (Off.Gaz BH 19/00).
- 5.0 Convention about transboundary effects of industrial accidents, Helsinki, 1992. (Came into force: 19.04. 2000.).
- 6.0 Co International convention about plant protection, Rome, 1951. (Came into force: 03.04.1952.);
- 7.0 Convention about biological diversity, Rio de Janeiro, 1992. (Came into force: 29. 12.1993.).
- 9.0 Convention about early informing about nuclear accidents, Vienna, 1986. (Came into force: 27.10.1986.) (Off.Gaz. R BH 13/94, Off.Gaz SFRJ MU 15/89).
- 10.0 Protocol about protection of Mediterranean from land pollution, Athens, 1980. (Came into force: 17.06.1983.). Modified in Syracuse (Italy) 1996. (Off.Gaz R BH 13/94, Off.Gaz SFRJ MU 1/90);
- 11.0 Protocol about specially protected area and biological diversity of Mediterranean, Monaco, 1996. (Old title: Protocol about specially protected area of Mediterranean sea, Geneva, 1982.) (Came into force: 23.3.1986.) (Off.Gaz. FR BH 13/94, Off.Gaz SFRJ MU 9/85);
- 12.0 International convention about prevention of sea pollution with oil, London, 1954. (came into force: 26.07.1958.) (Offic.Gaz. FR BH 13/94, Offic.Gaz SFRJ MU 60/73, 53/74);
- 13.0 International convention about pollution control from ships, London, 1973. (came into force: 02.10.1983.) (Offic.Gaz R BH 13/94, Offic.Gaz SFRJ MU 2/85).
- 14.0 Bazel convention about monitoring of transboundary turnover of dangerous waste and its disposal, Bazel, 22.03.1989. (came into force: 05.05.1992.) (Offic.Gaz. BH 31/00);
- 15.0 Supplement to the Bazel convention about supervision of transboundary dangerous waste and its disposal, Brussels, 1997.
- 16.0 Decision about ratification of Convention about the control of transboundary transfer of dangerous waste and its disposal (Off.Gaz of BiH 31/00);
- 17.0 Decision about ratification of Framework Convention of UN about climate changes (Off.Gaz of BiH, 19/00);
- 18.0 Decision about ratification of Convention about biological diversity, Rio de Janeiro, 5th June 1992 y. (Off.Gaz of BiH); no 13 dated on 31 12.2002.
- 19.0 Decision about giving the agreement for ratification of International convention about plant protection (Off.Gaz of BiH annex to International contracts 10/03, 21/07.2003);
- 20.0 Decision about giving the agreement for ratification of Framework agreement about Sava river catchment (Off.Gaz of BiH annex to International contracts 10/03, 21.07.2003);
- 21.0 Decision about ratification of International Convention about plant protection (Off.Gaz of BiH, 8/03, 30.06.2003 – annex)

Standards are as it follows:

- Standards of the environment protection management
- Standards of air issues
- Standards of water issues

EU Directive

- EU Habitat directive 92/43/EEC

Having in mind the fact that most of specific relationships within the environment domain related to the construction of one road direction, was not worked out within existing legislation for the purpose, so for the purpose of this work it was used the regulations and guidelines of other countries widely verified in international public.

There are especially used the guidelines that cover general problems, Merkblatt zur Umweltverträglichkeitsstudie in der Strassenplanung, and special noise problems, Richtlinien für den Lärmschutz an Strassen (RLS-90), aeropollution problems, Merkblatt über Luftverunreinigungen an Strassen (MLus-92), and water pollution problems, Richtlinien für Bautechnische Massnahmen an Strassen in Wassergrennungsgebieten.

Also, there were used the technical documents of World Bank, i.e.: "The World Bank technical paper No.376: Roads and the Environment, A Handbook", The World Bank Washington, D.C.

2.3. Methodology of EIA preparation

Regardless of the above-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 is a series of factors which require a deeper analysis of the methodology used in the research, where special attention should be paid to the steps which were taken respecting a certain hierarchy, their objectives and relation to the process of planning and design. This kind of analysis is necessary for the purpose of comparison with the applied methods used for the needs of this study and the methods considered valid by the general legislation regulating this area (Codebook for plants and facilities requiring environmental impact assessment and plants and facilities which may be constructed and operate provided they are granted environmental planning permission (Official Gazette of B&H Federation, no. 19/04)). Our principal goal is to try and adjust general methods to the specificities of this project and prepare plans and project documents using the right methods.

As part of preliminary activities and in line with Bosnia and Herzegovina legislation, environmental impact assessment for projects of this kind is undertaken in two stages: the relevant ministry prepares the preliminary environmental impact assessment based on preliminary assessment documents, and the relevant ministry issues the environmental planning permission based on the project task of the ministry and the environmental impact study prepared using the project task.

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, Dvokut – Ecro, Zagreb. During its preparation, the preliminary environmental impact assessment was available to all interested parties and the public on the web page of the Federal Ministry of Physical Planning and Environment and submitted for opinion to all relevant individuals and parties. The preliminary environmental impact assessment document contains study results covering all of LOT1. The environmental impact study analysed the roadway selected based on various criteria.

2.3.1 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 and a previously defined manner of information and data exchange between those involved. Bearing in mind what has just been said, it is obvious that there has to exist a common methodological basis with clearly defined steps to be taken in the examination of environmental issues.

The need for common methodology to be used in the examination of environmental issues stems from the necessity to respect basic compatibility principles, establish harmony between the different levels of analysis, and ensure hierarchy as well as successive information exchange.

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

The need to harmonise different levels of analysis is equally important given the scope of approach, how detailed the existent and obtained information is, as well as the elements of the mechanism of analysis to be used. All analyses and conclusions must share the same seriousness of approach and be equally detailed, which will recommend them as valid in making the right decisions and continuing action.

Structured methodology is the prerequisite ensuring a valid methodological approach, which will primarily enable to respect the previously determined order of actions and form the basis to make decisions. The conclusions made during any previous stage will present conditions and the starting point for the subsequent stage of action.

The need to establish definite data exchange procedures between the two processes stems from the fact that the results of one process represent the entrance data for the other, and vice versa. We need to emphasise that this sequence is not arbitrary; it strictly adheres to the logic of both groups of analyses and their interrelatedness. Another important factor is the multidimensional harmonization of these data both for the needs of the processes and for the purpose of creation of the common info basis of greater significance.

Basic methodological steps are defined in a broader context if we are to stay aware of the global character of environmental issues. This context translates as the process of spatial planning integrating unique planning procedures that are distinct for roads, especially considering their requirements in terms of functionality and distinctive consequences. When it comes to the process of design, it has to be defined by means of standard methodology compounded by the preparation of investment documents.

In the light of what has been stated above, environmental impact studies represent the key step in the positive approach to environmental issues. With the selection of optimal design solutions as the essence of every individual design phase, it is clear that this stage only may provide real opportunity to preserve the environment. Here the preparation dynamics has to be in balance with the pace of preparation of other project documents. Part of the most extensive spatial analysis completed in the preliminary phase has to precede the actual design preparation. Since this issue deals with the spatial organization of potential pollutants, it is very important to systemize and quantify all major factors using relevant indicators. The information basis of this study is a 1:25000 scale base map. The purpose of these documents is to use them as a means of extensive communication between all interested parties.

2.3.2 Applied 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 and a previously defined manner of information and data exchange between those involved. Bearing in mind what has just been said, it is obvious that there has to exist a common methodological basis with clearly defined steps to be taken in the examination of environmental issues.

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The need to establish definite data exchange procedures between the two processes stems from the fact that the results of one process represent the entrance data for the other, and vice versa. We need to emphasise that this sequence is not arbitrary; it strictly adheres to the logic of both groups of analyses and their interrelatedness. Another important factor is the multidimensional harmonization of these data both for the needs of the processes and for the purpose of creation of the common info basis of greater significance.

Basic methodological steps are defined in a broader context if we are to stay aware of the global character of environmental issues. This context translates as the process of spatial planning integrating unique planning procedures that are distinct for roads, especially considering their requirements in terms of functionality and distinctive consequences. When it comes to the process of design, it has to be defined by means of standard methodology compounded by the preparation of investment documents.

In the light of what has been stated above, environmental impact studies represent the key step in the positive approach to environmental issues. With the selection of optimal design solutions as the essence of every individual design phase, it is clear that this stage only may provide real opportunity to preserve the environment. Here the preparation dynamics has to be in balance with the pace of preparation of other project documents. Part of the most extensive spatial analysis completed in the preliminary phase has to precede the actual design preparation. Since this issue deals with the spatial organization of potential pollutants, it is very important to systemize and quantify all major factors using relevant indicators. The information basis of this

study is a 1:25000 scale base map. The purpose of these documents is to use them as a means of extensive communication between all interested parties.

2.3.3. Project assignment

Preparation of environment impact study is originally defined by legal regulations in the domain of environment protection and for the section of the highway on the corridor Vc, LOT 1 from Svilaja to Karusa, with the elements of Decision issued by the competent Ministry and as such it presents the obligation for consultant. Therefore, it is cited the complete Decision as the base for the preparation of documents as it follows:

Federal Ministry of spatial development and environment, upon the request of Ministry of communication and transport of Bosnia and Herzegovina, for Preliminary environment impact assessment, no: 03-29-1017/05 dated on 20.04.2005.y. and on the base of Article. 58 and 59. of Law on environment protection (Official Gazette of BiH, no: 33/03), Article. 3 and 4. of the Rule book on the operation and plant that can be constructed or put into operation only if they have the environment license (Official Gazette of Federation of BiH, no: 19/04) and the Article 200. of Law on administrative procedure (Official Gazette of Federation of BiH, no: 2/98), makes the following:

DECISION ABOUT PREPARATION OF ENVIRONMENTAL IMPACT STUDY

1. Ministry of communication and transport of Bosnia and Herzegovina is obliged that to this Federal Ministry deliver the Environment impact study of the highway on corridor Vc, section LOT 1: Svilaj - Doboju (Karuse), for the alignment selected on the base of multicriteria analysis, and for the conduct of further environment assessment procedure.
2. Environmental impact study should take into consideration the results of Preliminary environment impact assessment cited under the point 6 of this decision.
3. Environmental impact study about the construction and service of the Highway should contain the following:
 - 3.1. Description of proposed project
 - 3.2. Description of environment may be endangered by the project
 - 3.3. Description of possible environment impacts of the project
 - 3.4. Description of the measures for mitigation of negative impacts
 - 3.5. Draft of basic alternatives
 - 3.6. Non-technical resume
 - 3.7. Indicators of difficulties
- 3.1. Description of proposed project includes the following:
 - Description of physical properties of overall project and the conditions of land use during the construction and service of the highway;
 - Description of basic characteristics of production process, nature and quantity of used material;
 - Evaluation, per type and quantity of produced waste and emission (pollution of air, water and soil, noise, vibration, light, heat, radiation and similar) as result of planned construction and the use of the highway;

- 3.2. Description of the environment that might be endangered by the project should contain the following data:
- Data about population;
 - Data about flora, fauna, water, air, soil;
 - Climatic characteristics of the area;
 - Existing material property, including the cultural-historical and archaeological heritage;
 - Description of landscape;
 - Specific elements determined with preliminary environment impact assessment;
- 3.3. Description of possible project environment impacts, as consequence of given project existence, use of natural resources, emission of pollutant and waste production and disposal should contain the following:
- Impact on population;
 - Impact on flora, fauna, water, air, soil;
 - Impact on climatic factors;
 - Impact on material property, including the cultural-historical and archaeological heritage;
 - Impact on landscape;
 - Interrelation of above mentioned factors;
 - Specific environment impacts of the project determined with preliminary environment impact assessment;
 - Description of methods that consultants planned for environment impact assessment
- Description should contain the direct impacts and any indirect, secondary, cumulative, short and long term, permanent and temporary, positive and negative impacts of the project.
- 3.4. Description of the measures for negative impacts mitigation includes the measures for prevention, reduction or mitigation of any unfavorable environment impact.
- 3.5. Draft of basic alternatives and description of the reasons why proposed alternative route was selected, taking into consideration the environment impacts.
- 3.6. Non-technical resume contains the summary of information given within the Environment impact study, avoiding the technical terms, detailed data and scientific explanation.
- 3.7. Indication of difficulties that consultant had faced because of technical shortage, the lack of knowledge and material and financial funds during the preparation of Environment impact study.
4. Monitoring system with determination of methodology and frequency of measurement.
5. Measures related to the work conditions in the state of emergency.
6. Results of Preliminary environment impact study of the Highway on the corridor Vc, section LOT 1- part that is located in the territory of Federation of BiH, that should be taken into consideration during the preparation of Environment impact study are as it follows:
- 6.1. Remarks, proposals and suggestions of administrative authority, public enterprises, NGOs:

Federal Ministry of agriculture, water management and forestry:

- Additionally analyze of the impact on existing and planned drinking water springs, and in terms of that ask for the expert's opinion of the municipalities Odzak and Doboj jug;
- To prevent the problem of incidental situations and foresee the measures for elimination or minimization of harmful impact of such situations;
- For all objects on the highway, it is necessary to solve the issues of collection and treatment of waste waters, as well as their leading into receiving body of water after treatment;
- Storm waters from the area outside the highway belt, and which gravitate to the highway, should be collected and segregated with special objects (channels), not mixing them with polluted waters from the highway that firstly need the treatment;
- Determine the possible impacts of highway objects on the flowing regime of underground waters based on the hydro geological and other survey, and undertake the measures for prevention of such impacts;
- Provide the preventive measures for protection of surface water flows that may be endangered by the construction of the highway, and possible appearance of the floods can endanger the surrounding terrain;
- Bridges across the watercourses and culverts must have a required gauge that won't make the impact on the regime of flood flow;
- Anticipate and establish the monitoring of surface and underground waters for the monitoring of the highway impact on the ones and undertaking of preventive measures if necessary.

Municipality Doboj Jug

- Municipality Doboj Jug cited that this municipality as new-formed municipality, from two local communities Matuzici and Mravici, did not have the spatial – planning documentation for the lack of funds for its preparation, and they did not take over any spatial planning documentation from Doboj municipality, and they received the cadastre documentation very late in July 2000 by the support of OHR, so in terms of all these reasons they did not know about the alignment of the highway and they could not protect it. Municipal Council in 1998 year, adopted the Decision about the determination of land use and construction conditions in the territory of Doboj municipality that will be applied when the spatial i.e. urbanism plan is prepared.
- In terms of the highway alignment on the section LOT 1, they explained that the four alternative routes: green, violet, red and brown did not suit to their municipality, since in this area it was constructed the new settlement (marked on the map in annex). They found that the alternative route of grey color was acceptable one, and this alternative route could, in the direction of Doboj, and across the river Usora be directed on the alignments marked in green, violet, red and brown color.

Public Enterprise `Elektroprivreda` BiH

- They gave the collective comment on the documentation for preliminary environment impact assessment for all four LOT-s, and suggested that within the phase of Environment impact study preparation it should be defined the coordinated approach as well as they insisted on the appropriate level of relevant data processing for each section.
- They found very important the elaboration of possible conflict situation since the alignment passing through protected area, i.e. cultural-historical and natural heritage, or devastation of the ones.

- They thought that it should be emphasized the possible conflicts with the transmission lines and other infrastructural facility (base for more detailed consideration and coordination by the service of PE `Elektroprivreda` BiH)

PE `Bosanskohercegovačke sume`

- They informed that the activities within the environment impact assessment not fell within their enterprise competence, and they forwarded the received documents to Cantonal forest-economy association `Sarajevo sume`, j.s.c.

COOR

- They were of the opinion that the authors more detailed analyzed all relevant parameters in the domain of environment protection.
- They supported the suggestion of preliminary assessment author that in the phase of highway construction, it should be engaged the environment specialists that would supervise the monitoring of work execution.
- They thought that within the environment monitoring program in the phase of construction and exploitation of the highway it was necessary to form informatics center of environment protection that would perform the following tasks: merge all environment protection measures and monitoring programs, daily input of data received by measuring and analyses, regular reporting of the public and authorities about environment situation.

FONDEKO

- They said that promptly public involvement in such large-scale and responsible projects, has full justification and that will give the positive results for certain.
- They appreciated that all sections had an appropriate attention, but they distinguished the section LOT 3 as especially significant and rest of commentary was related to that section.

6.2. Remarks, suggestions and proposals from public hearing, that need to be taken into consideration within the Environmental impact study are the following:

Odzak / 06.06.05./

- From which reasons does the section Potocani – Odzak, Odzak – Srnava approach to the village and in that way crossing the most fertile land of local community Potocani and divide it on two parts? It is proposed the displacement of alignment for around 300m (from the side of channel) where the alignment would be passing the cadastral border of Potocani – Odzak, through the most fertile land.

Usora / 07.06.05./

- Has the State determined the basic assumptions how to compensate the land and private ownership?
- On the part of alignment where the highway crossing the river Usora, there are 5-6 springs that are in public use? How much will they be polluted and will the river Usora be environmentally controlled?
- What will be the aero pollution control? On which part of the alignment (selected one) will appear the highest pollution?
- Have you foreseen the noise control? How will you provide to meet and set up all environment control requirements?

- In terms of air and forest pollution, is it possible to ask from the investor to plant the trees around the highway? Will the devastated forest trees be compensated?
- Have the projects which implemented from other sources, for example landfills, coordinated with this project? Will the future landfill and the highway have the mutual impact?
- Where will the waste water be disposed?
- Some time ago, it was discussed about water supply project of this part of Northeast Bosnia with the common waterworks. Is that project still of current interest and is it in accordance to the highway project?

Doboj Jug / 07.06.05./

- What will be the decision about traffic noise control? Is it possible for the wind to demolish the protection?
- What is, according to the law, the allowed distance of residential objects from the highway? What will be the quality of life in the houses next to the highway that won't be demolished?
- What are the rising points on the highway and the falling points?
- Will be opened the gravel pit where and at what site?!
- Special attention should be paid to the protection of water supply springs. There are the water supply springs in the proximity of river Bosna for the settlement Matuzici, the spring that belongs to the municipality Tesanj in Krasevu and provide the water supply of Mravici, that belongs to the municipality Doboj-jug and two settlements of Luke.
- It is needed to solve the issue of flood control, in terms of the construction of the highway for this municipality.
- Take into consideration the Study of Usora river channel development, including three municipalities: Tesanj, Usora and Doboj-jug, and which is upon the initiative of PE for 'Water area of river Sava catchment', prepared by the Institute for water engineering of the School of civil engineering in Sarajevo.
- Take into consideration 'the idea' of bypass construction on Karusama along the river Usora, for the section of primary route M4 Doboj-Teslic, in the aim of traffic frequency reduction in this zone that is 'attacked' by construction.
- To have in mind, that the industrial zone is next to river Usora, and there is also the new settlement so population of this zone would prefer the alternative route with less number of objects.
- Is it prepared the study about the impact of dominant winds? Are there any dominant winds that are going to mitigate the aero pollution?
- Are there planned the quarantine for livestock?
- Will the highway construction lead to the job creation?
- Valley of the river Bosna has a very high mist appearance. Therefore, it is planned the road lightening on the highway, what will be the lightening impact on living world?

EXPLANATION

Ministry of communication and transport of BiH referred to this Federal Ministry with the request for the preparation of the preliminary environment impact assessment of the Highway on the corridor Vc, section LOT 1: Svilaj – Doboj Jug (Karuse). With the request, it was attached the documentation for preliminary environmental impact assessment, prepared by the consultants: IPSA - Sarajevo, Institute for Urbanism of RS – Banja Luka, Institute for water engineering – Sarajevo, Dvokut – Ecro, Zagreb. Documentation for preliminary environment impact assessment was related to the study area including all analyzed alternative routes. Environment impact study should focus on the alignment selected on the base of multi-criteria analysis.

Since this is about the highway construction, the project is on the base of the Articles 3 and 4 of the Rule book about sections and plants that may be constructed and put into operation only if

they have the environment license (Official Gazette of BiH Federation, no: 19/04) is placed on the list of the ones, that before the issuing of environment license, must obligatory prepare the environment impact assessment.

Within the preliminary environment impact assessment procedure, and in accordance with the Article 36. of Law on environment protection, the documentation for preliminary environment impact assessment was available to all interested parties on the web site of Federal Ministry of spatial development and environment (<http://www.fmpuio.gov.ba/>), and given upon the opinion to the following subjects:

Federal, cantonal and municipal administration bodies:

1. Ministry of agriculture, water management and forestry of Federation of BiH
2. Ministry of transport and communication of Federation of BiH
3. Federal road directorate
4. Ministry of industry, energetics and spatial development of Posavski canton
5. Ministry of agriculture, water management and forestry of Posavski canton
6. Ministry of transport and communication of Posavski canton
7. Municipality Odžak
8. Ministry of spatial development, transport, communication and environment protection of Zenicko – Dobojski canton
9. Ministry of agriculture, water management and forestry of Zenicko-Dobojski canton
10. Municipality Usora
11. Municipality Doboj Jug

Public enterprises:

1. PE `Elektroprivreda BiH`
2. PE `Elektroprivreda HZ Herceg Bosne
3. PE for «Water area of the river Sava catchment»
4. PE of BH Telecom
5. `Hrvatske telekomunikacije`, j.s.c. Mostar
6. PE of Bosanskohercegovačke sume
7. PE `Sume HZ Herceg-Bosne
8. Railway of Federation of BiH

Non-government organizations:

1. Regional center for the environment for central and east Europe – REC BiH
2. Center for environment sustainable development - COOR
3. FONDEKO
4. EKO MREZA BIH
5. Hunting society «Fazan, Odzak
6. Center for civil cooperation and activity, Odzak
7. Ecology movement “ZELENI” Zenica

Of above mentioned subjects, the following subjects gave their opinion: Federal Ministry of agriculture, water management and forestry, Municipality Doboj-jug, PE `Bosanskohercegovačke sume`,

PE `Elektroprivreda BiH`, COOR, Fondoko.

Federal Ministry of spatial development and environment, in cooperation with the Ministry of communication and transport of BiH, set up the public hearing about the preliminary

environment impact assessment of the Highway on the corridor Vc, section LOT 1: Svilaj – Doboj jug (Karuse) – the part located in the territory of Federation of BiH. Public hearings were held in the following municipalities:

1. in Odzak, on 06.06.2005 year, in the premises of the hall of Center for culture - Odzak.
2. in Usora, on 07.06.2005 year, in the premises of Municipality.
3. in Doboj jug, on 07.06.05 year, in the premises of Municipality.

Invitation on public hearing was announced in the daily newspapers of Dnevni avaz and Oslobodjenje on 26.05.2005, and presented on visible places in the mentioned municipalities. Documentation for preliminary environment assessment was submitted for perusal in the municipalities Odzak, Doboj jug and Usora, in the premises of Federal Ministry of spatial development and environment, on the web page of Ministry and in the premises of the Ministry of communication and transport of BiH.

Public hearings had the following schedule:

1. Presentation of legal framework for Environment impact assessment – representative of Federal Ministry of spatial development and environment
2. Presentation of documentation for Preliminary environment impact assessment – representative of investor and consultant
3. Discussion, replies, explanations

At public hearing, it was attended: in Odzak 46 participants, in Doboj jug 47 and in Usora 22 ones.

Results of received opinions, remarks and suggestions as well as results of public hearing, related to the environment protection, were summarized and made the compositional part of the contents of Decision about preparation of Environment impact study.

Having in mind the above mentioned facts, it was brought the decision as in the Decision.

Federal Ministry of spatial development and environment, upon the request of Ministry of communication and transport of BiH, for the Preliminary environment impact assessment, no: 03-29-1017/05 dated on 20.04.2005 year and on the base of Article.63. of the Law on environment protection ("Official Gazette of Federation of BiH", no. 33/03) and the Article 214. of Law on administrative procedure ("Official Gazette of Federation of BiH", no: 2/98), makes:

ADDITIONAL DECISION

ABOUT PREPARATION OF ENVIRONMENT IMPACT STUDY

Ministry of communication and transport of BiH undertakes the obligation, to this Federal Ministry within the Environment impact study of the Highway on corridor Vc, section LOT1: Svilaj - Doboj Jug (Karuse) deliver the special chapter with data about possible environment impact of the neighboring country – Republic of Croatia.

EXPLANATION

Federal Ministry of spatial development and environment, upon the request of Ministry of communication and transport of BiH, for Preliminary environment impact assessment was brought the Decision, no: UPI/03/02-23-4-46/05 dated on 20.07.2005 year, about the

preparation of Environment impact study of the Highway on corridor Vc, section LOT1: Svilaj - Doboj Jug (Karuse), for the alignment selected on the base of multi criteria analysis.

In the Decision, about the contents of Environment impact assessment, had not been included the above mentioned chapter with data about possible environment impact of the neighboring country, and in accordance to the Article 63. of the Law on environment protection.

On the basis of the Article 214. of Law on administrative procedure, the preparation of the one is bound by this Additional decision.

3. DESCRIPTION OF PROPOSED PROJECT

3.1 Project purpose and aim

Corridor Vc has been integrated in the TEM network of Southeastern European transport infrastructure and will run from Budapest (Hungary), via Osijek (Croatia) and Sarajevo (B&H), to the port of Ploče (Croatia). The length of the B&H section of Corridor Vc will be 330 km and it will run in the direction north-south through the central part of the country utilizing the most favourable natural conditions, along the valleys of the Bosna and Neretva Rivers.

The B&H section of the transport Corridor Vc will include:

- E-73 Šamac - Doboj - Sarajevo - Mostar - Čapljina - Doljani, which will reach the Adriatic coast at the port Ploče, while Budapest will be its final junction in the north,
- Railway Šamac - Doboj - Sarajevo - Mostar - Čapljina - Metković,
- Airports in Sarajevo and Mostar,
- River waterways and ports along the Sava, Bosna and Neretva Rivers.

In 20th century, during 70s, UNDP Geneva started the initiative and proposed a plan to uplift the European motorway network. The project included the motorway connecting the Baltic and Adriatic Seas (Baltic-Adriatic) entitled TEM.

At the Third Pan-European Conference on Transport, which was held in Helsinki in 1997 and gathered EU member states and international organisations dealing with the issues of European infrastructure development, the 'Helsinki Declaration' was adopted, laying the framework to construct another ten pan-European corridors, including motorways.

The declaration also defined the routes of the ten trans-European corridors and their branches. It was specified under pan-European Corridor Vc that a motorway will pass through Bosnia and Herzegovina (Budimpešta-Osijek-Sarajevo-Ploče).

As previously said, Corridor Vc belongs to the pan-European network of corridors connecting the central Adriatic coastline, which has great tourist potential, but more importantly the port of Ploče with corridor X between Zagreb and Beograd, ending with the Budapest junction. Along with the plan to increase the capacity of the port Ploče, the corridor will help enhance trade between the countries in the region, and as for Bosnia and Herzegovina, it may improve its exchange of goods with the adjacent countries and Central Europe.

The study and project documents dealing with the motorway aim to provide a comprehensive analysis of the need to improve the quality, capacity and safety of transport in the corridor by building a full-profile motorway. The feedback and results of the study will be used in making investment decisions by those who ordered the study and by the funding institutions. This should particularly be kept in mind during the preparation of the pre-feasibility study and the environmental protection study.

In accordance with pan-European transport initiatives and the Helsinki Declaration, which have been greeted as a great opportunity for Europe and particularly for B&H, recently there has been an increased level of activity to prepare for the construction of high-level communications, i.e. motorways and fast roads, in order to meet the needs of the population and economy and boost development globally. Along with other roads (Banja Luka-Gradiška, Tuzla-Orašje and Adriatic-Ionic Corridor), preparatory activity has been undertaken for the construction of Corridor Vc motorway section. Therefore, the Ministry of Transport and Communications of B&H:

- adopted the document “Decision on existence of public interest to construct motorway on Corridor Vc through Bosnia and Herzegovina by granting concessions on the section and motorway to be defined by contract” (Official Gazette of B&H, no. 23, dated 7 August 2003),
- signed an agreement and agreed on the border crossing between the Republic of Croatia and B&H on the Sava River (Svilaj-Odžak) as part of the new motorway along with the route coordinates (3 September 2003),
- considered the proposal of the Republic of Croatia to specify Vc corridor motorway junction points in the south and reached the conclusion that due to the insufficiently elaborated project documentation and the difficulty to connect it to the Adriatic-Ionic Corridor, it is necessary to produce more detailed project documents prior to specifying the above-mentioned junction points,
- continuously exchanged information and views with representatives of the Republic of Croatia and the Republic of Hungary with regards to the preparations to construct the motorway along Corridor Vc,
- provided the necessary funds to prepare the plans and study, and undertake other activities before the construction of the motorway along Corridor Vc.

Taking into account the country's debts and its relation with the World Bank and the International Monetary Fund, i.e. its inability to obtain any bigger loans or subsidies, the Council of Ministers of B&H has decided that one adequate way to finance the construction of the new motorway would be through concessions. In that sense the Council of Ministers of B&H made the decision to prepare the study and project documentation, which would allow to define solutions and create conditions to find ways to fund the construction of the motorway.

Apart from B&H, both Hungary and Croatia have also expressed great interest in the project, and they intend to construct motorways along parts of this corridor on their territories by 2010. In conclusion, the motorway along Corridor Vc Budimpešta-Osijek-Sarajevo-Ploče through B&H is one of the most important, high-priority projects for B&H.

The aim of the study and project documentation is to determine the economic rationale to construct parts and/or all of the motorway, as well as the conditions to ensure the feasibility of the project; the prefeasibility study ought to evaluate the interest in getting concessions for the whole motorway in B&H through an international bid. Another aim is to attract foreign investors, start investment by beginning construction works at several sites and enable the growth of additional facilities along the completed parts of the motorway.

Complete plans and project documents in their final form will be used to submit the request to obtain the planning permission for individual parts of the motorway. There is readiness on the part of politicians to support the development of the country by approving the motorway project, its construction and exploitation in the most economical way and as soon as possible.

Following the political decisions to accelerate the preparations preceding the construction of the motorway, activities were undertaken to prepare a study and project documents for the whole motorway in line with contemporary standards of research and design and in accordance with the standards of the World Bank and other international funding institutions.

It is expected that upon its completion, the motorway will serve as a key generator of economic activity and enable B&H to become part of the main European transport communications network, as well as join the global European economic system. The motorway will represent a rational connection between Bosnia and Herzegovina and the adjacent countries and regions,

and have stabilising and developmental effects on the country. Improved transport will result in a better quality of life, with these benefits:

- reduced travel distance and duration for goods and passengers,
- lower cost of transport of goods and passengers,
- increased employment,
- valorisation of B&H's geotransport position,
- increased economic competitiveness along the corridor,
- setting up of new projects and greater private investment in regional economy.

The aim of the study and project documents, which have been ordered, is to provide a comprehensive analysis of the need to improve the quality, capacity and safety of transport in the corridor by constructing a full-profile motorway. The findings of the study will be used by those who have ordered it as a basis for investing, as well as by other funding institutions.

3.2 General project description

Individual sections of the motorway have, so far, been considered in a number of studies, preliminary solutions and preliminary briefs. The motorway route may be found in both earlier and currently valid regional plans. Since a prefeasibility study is needed for the whole motorway running through B&H, two separate contracts (lots) are anticipated to be dealt with in the transport study and prefeasibility study for the section Svilaj - Sarajevo South and Sarajevo South – Border South. Each of these two lots represents a distinctive whole. Therefore, the study and project documents for the B&H motorway will consist of six functional wholes through six contracts (six lots), while the study and project documents for the whole motorway ought to be prepared with respect to contemporary standards of research and design, TEM standards and guidelines, as well as standards of the World Bank and other international funding institutions.

The future motorway has been divided into four lots, where LOT 1 covers the section Svilaj – Doboj South (Karuše) – and is approximately 63 km long. The lot Svilaj - Doboj South (Karuše) has been divided into six sections to ensure greater efficiency and functionality:

- Section 1: Svilaj – Odžak,..... approx. length 11 km
Section 2: Odžak – Vukosavlje approx. length 6 km
Section 3: Vukosavlje – Podnovlje..... approx. length 16 km
Section 4: Podnovlje – Johovac..... approx. length 13 km
Section 5: Johovac – Rudanka approx. length 6 km
Section 6: Rudanka – Doboj Jug (Karuše)..... approx. length 10 km

Apart from the motorway along Corridor Vc, the studies cover the necessary access roads to all cities, towns and villages near the motorway, as well as the relief road which will be constructed around Doboj.

LOT1 begins with the bridge across the Sava River (the bridge is a joint enterprise with the Republic of Croatia) and in its initial part, it will run through the valley of the Bosna River passing the village of Vukosavlje, through the village of Modriča, to the village of Podnovlje. The motorway will be laid along the western end of the Posavina region, and then on the terraces on both banks of the Bosna River. In this part of the motorway the terrain is flat and suitable, and the road will mainly lie on fills. The soil consists of layers of alluvial sediments found in Posavina

and the valley of the Bosna River, which means it is stable. The highest altitude of the motorway is 130 m. There will be five significantly long bridges, whose total length will be approximately 1700 m, two locations where service and catering shops will be constructed, and three junctions. The longest structure will be the interstate bridge across the Sava River (approx. 600 m). The Republic of Croatia has prepared a preliminary solution for the bridge, which ought to be inspected, after which follow-up activities will be proposed.

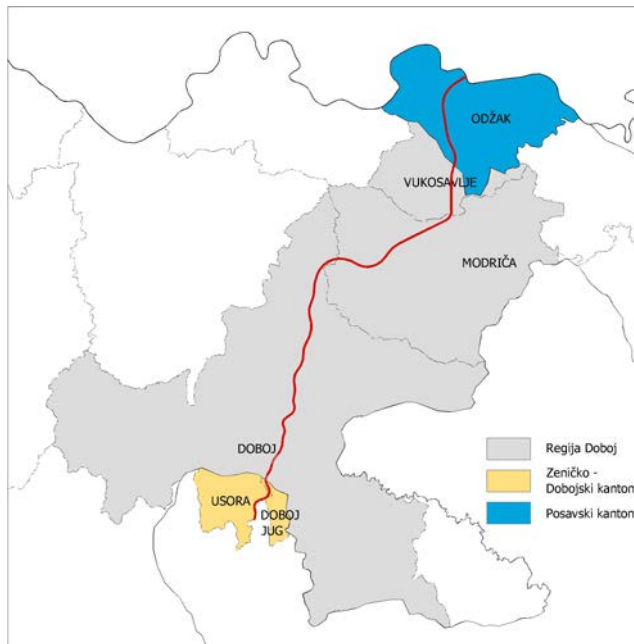
In its second part the motorway will begin in the valley of the Bosna River in Podnovlje and finish with a bridge in the vicinity of Karuše (km 62+600). The road will lie on the left bank of the Bosna River all the way to the village of Rudanka. After Rudanka, the motorway will reach hilly terrain and get into the valley of the Usora River, thus avoiding cutting across the urban infrastructure of the town of Doboj. The terrain is stable in this part. There is a plan to construct a site with service and catering shops, three junctions, five long bridges and two tunnels along this section. The total length of the bridges which will be constructed is 2750 m, while the tunnels will be approximately 1960 m long. The junctions will link the existent as well as new transport networks.

3.3 Spatial-planning documentation of impact area

The highway alignment on Corridor Vc, on the section of LOT1 passes through the following municipalities: Odzak, Vukosavlje, Modrica, Doboj, Usora and Doboj-jug. Spatial zone of wide impact area includes the Doboj region composed of eight municipalities¹. Narrow impact area includes the zone of six municipalities, of which three are located in the territory of Republic of Srpska (Vukosavlje, Modrica and Doboj), while the other three located in the territory of Federation of BiH (Odzak, Usora and Doboj – Jug). Up to 1992 year, this area was in the composition of the municipalities Odzak, Modrica and Doboj. In the last ten years, many significant changes occurred both in the total area, and in BiH and region in total; war conflicts, establishment of the new territory-political borders, changes in the geo-political environment etc. New-formed municipalities are Vukosavlje (formed by separation of the part from the municipalities Odzak and Modrica), Doboj – Jug (formed by separation of the settlements from the municipality Doboj) and Usora (formed by separation from the municipalities Doboj and Tesanj).

Federation of BiH was as well organized on the Cantonal level, in contrast to Republic of Srpska, so the municipalities Doboj – Jug and Usora located within the Zenicko – Dobojski canton, and the municipality Odzak within Posavski canton. The area of spatial zone of LOT1 is composed of 50 settlements listed below in the table T.3.3-01.

¹ Phase plan of RS from 1996 to 2001.y. Functional centres and regions (municipalities within the region are the following: Doboj, Bosanski Brod, Derventa, Teslic, Petrovo, Modriča, Šamac and Vukosavlje)



Picture 3.3-01.Territorial units where LOT1 alignment passing

Table 3.3-01: Settlements of spatial scope

ENTITY	Wide impact area – Cantons –	Narrow impact area – Municipalities –	Immediate impact area – Settlements –
REPUBLIC OF SRPSKA		VUKOSAVLJE	Srnava
			Jezero
			Jakes
			Gnionica
			Brezik
			Potocani
			Modricki Lug
			Koprivna
			Vranjak
			Tarevci
		MODRICA	Botajica
			Modrica
			Dugo Polje
			Kuznjaca
			Babesnica
			Podnovlje
			Glogovice
		DOBOJ	Bozinci Donji
			Trnjani
			Majevac
			Kozuhe
			Ritesic
			Bukovac
			Kotorsko
			Osjecani Gornji

			Osjecani Donji
			Johovac
			Kladari
			Busletic
			Civcije Bukovicke
			Grapska Donja
			Grapska Gornja
			Kostajnica
			Bukovica Velika
			Bukovica Mala
			Plocnik
			Prisade
			Cajre
			Miljkovac
			Doboj
	ZENICKO - - DOBOJSKI CANTON	USORA	Alibegovci
			Ularice
			Makljenovac
		DOBOJ - JUG	Matuzici
FEDERATION OF BIH			Vrbovac
			Odzak
	POSAVSKI CANTON	ODZAK	Potocani
			Novi Grad
			Donji Svilaj
			Posavska Mahala

3.3.1. Data and spatial-planning documentation of specific area where the highway on the corridor Vc will be passing

Summary from BiH Spatial Plan for period from 1981 to 2000 year - Final text (1988 year)

Spatial Plan of BiH determined the alignments of European roads (E 73, E 661, E 761 and E 762) and with special stress that on direction of transeuropean highway "North - South", which overlapping with the road E 73, and passing along the valleys of the rivers Bosna and Neretva, this area should be protected during the preparation of spatial plans of the municipalities and urbanism plans of the towns, in which area it was planned the alignment of European road E 73.

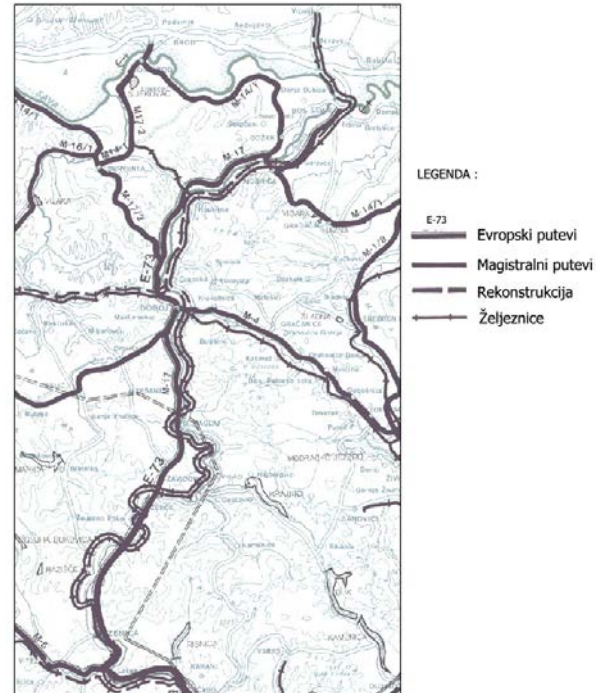
ABSTRACT FROM SPATIAL PLAN OF
BIH FOR PERIOD 1981 – 2000 YEAR
PLAN PHASE:DRAFT (1982.Y.)
FOR THE AREA OF LOT 1

ROAD AND RAILWAY TRAFFIC



ABSTRACT FROM SPATIAL PLAN OF
BIH FOR PERIOD 1981 – 2000 YEAR
FINAL TEXT (1988.Y.)
FOR THE AREA OF LOT 1

ROAD AND RAILWAY TRAFFIC



Picture 3.3-02. Abstract from spatial plan of BiH for the area of LOT1

Spatial Plan of BiH, for the period 1981.-2000. – Final text (“Off.Gaz of FRBiH “, no. 33/88), brought a certain difference regarding the position of the highway alignment determined in the Draft of same Plan (from 1982.y.).

Within the Draft of the plan from 1982 year, it was determined the highway alignment going from Modrica on north towards Odzak and bordered with the Republic of Croatia. Contact point was on the river Sava at place called Svilaj.

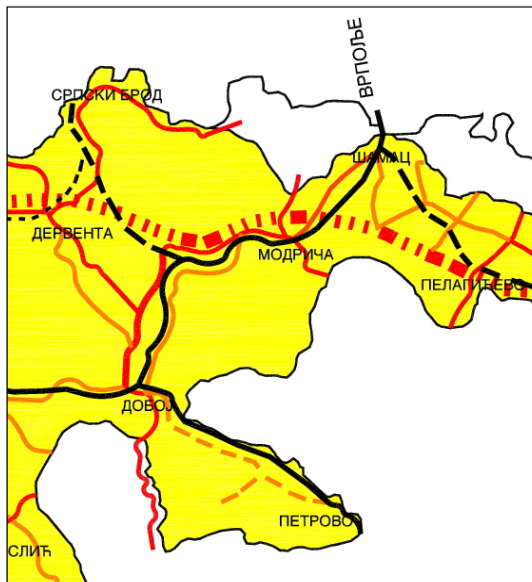
In the Spatial plan of BiH for the period 1981-2000. – the final text, the highway alignment from Modrica town passed along the valley of river Bosna towards Bosanski Samac.

Abstract from Spatial Plan of RS for period 2001-2015.y. Draft 2005.

Spatial Plan of Republic of Srpska 1996-2015.y. – Phase plan 1996-2001.y. was not treated the traffic Corridor Vc. The emphasis was placed on the planned highway Bijeljina – Novi Grad (direction east-west) found on the primary base of the development of Republic of Srpska.

ABSTRACT FROM SPATIAL PLAN OF RS FOR
PERIOD FROM 1996 – 2015
PHASE PLAN 1996 – 2001 YEAR
FOR THE AREA OF LOT 1

Basic traffic infrastructure



LEGENDA:

- AUTOPUT
- MAGISTRALNI PUT
- ŽELJEZNIČKA PRUGA

ABSTRACT FROM SPATIAL PLAN OF RS
FOR PERIOD FROM 2001 – 2015 YEAR
PHASE PLAN: DRAFT
FOR THE AREA OF LOT 1

Traffic and traffic infrastructure
Road network plan



Изградња заобилазнице									
Активности	Период			Период			Период		
	аутопут	брај пут	маг. пут	аутопут	брај пут	маг. пут	аутопут	брај пут	маг. пут
Реконструкција									
Изградња пута	■	■		■	■		■	■	
Изградња студијске/ просторно-планске/ техничке документације за изградњу путева	■	■		■	■		■	■	

Picture 3.3-03. Abstract from spatial plan of RS for the area of LOT1

On this development direction, there are 13 economic centers among them, Banja Luka town as the largest center in the Republic of Srpska. Here, it is the highest population number (75% of RS population settle this area according to the data from 1996 year).

At the beginning of 2002 year, it was initiated the preparation of Spatial plan for the period 2001-2015.y.

Within the Draft of the Plan (2005.y.) it was as well planned and treated the corridor of the highway in direction «North-South», through the municipalities Vukosavlje, Modrica and Doboj. With this plan, it was foreseen the expressway Banjaluka – Doboj with intersection on the highway on Corridor Vc at place called and fast communication Bijeljina – Modrica with intersection on the highway Vc at Modrica.

By Decision of FRBiH Parliament dated on January 28th in 1975 year, it started the preparation of Spatial Plan of Bosnia and Herzegovina. Plan was prepared on the basis of Law on spatial development, and with the methodology use adopted by the Committee for spatial development,

protection and environment improvement in 1976 year. Preparation of municipal spatial plans in BiH was initiated by the preparation and passing of the Spatial plan of Bosnia and Herzegovina for period 1981- 2000 year.

By passing of Guidelines about obligatory and unique methodology for preparation and enactment of spatial plans in 1974 year, it started the preparation process of the spatial plans of municipalities, where the Corridor Vc passing. The majority of the municipalities has the prepared and brought the spatial-planning and town planning documentation, except of the municipalities Vukosavlje, Usora and Doboj Jug that are the new-formed municipalities in the area of Republic of Srpska and Federation of BiH. Vukosavlje was in the composition of the municipality Modrica and Usora and Doboj-Jug in the composition of the Doboj municipality.

Municipality Odzak

- Municipality Odzak has not the Spatial plan but it uses the Spatial plan of BiH 1981-2000.y.

Municipality Vukosavlje

- Municipality Vukosavlje has not the Spatial Plan but it uses the Spatial Plan of Republic of Srpska.
- Municipality Vukosavlje is newly created municipality in the area of Republic of Srpska. Jakes settlement as municipal center was before the war in the composition of Modrica municipality.
- Within the spatial plan of Modrica, it was given the highway alignment through the urban area of Jakes settlement.

Municipality Modrica

- Within the spatial plan of Modrica, it was planned the highway corridor of the width of 250 m,
- Preparation of urbanism plan `Modrica 2020` - proposal phase, is in progress.

Municipality Doboj

- Spatial plan of Doboj municipality (1987) protected the highway corridor as section of Trans - European primary route, planned with the Spatial plan.

Municipality Usora

- Usora is newly created municipality and has not its own spatial-planning documentation, but it uses Spatial plan of BiH for period 1981-2000 year.

Municipality Doboj-Jug

- Doboj-Jug is newly created municipality and has not spatial-planning documentation but it uses the Spatial plan of BiH for the period 1981-2000 year.

3.4 Social-economic significance of the Project

Aspect of social-economic project significance was recognized as global phenomenon related to the area along the project of the highway on corridor Vc, i.e. both the parts of (LOT-s) that

involved in the planning (designing) process and the parts that are in the construction phase or already constructed from Svilaja to south border. Such approach has completely founded principle since it is not possible to analyze the processes on the relation: capital investments-social economic effects except as the projects of national significance.

Preparation of the planning-study documentation for the highway on Corridor Vc through Bosnia and Herzegovina is carried out in the environment where it is very difficult achievement of general national, political, regional, and economic and any other consensus to any other issue, as the consequence of war disturbed relations. The rare positive exception is general consensus regarding the construction of the highway that in current situation has a special significance. Project of the highway construction was declared as priority development project of the national interest and treated as "development project of the century". Such treatment came out its general social-economic and political significance for Bosnia and Herzegovina. The following facts as well pointed to a wider social-economic significance.

a) On Third Pan European Transport Conference (Helsinki 1997), traffic corridor of Budapest – Osijek – Sarajevo – Ploče was assigned to Pan European transport network as Corridor Vc, confirming its wide international significance. Through Bosnia and Herzegovina, the Corridor Vc passes through the middle area in the direction of north-south, along the valleys of rivers Bosna and Neretva, i.e. the area with the highest involvement of population, natural and anthropogenic resources;

b) In the Corridor belt of around 40 km (on less of 20% territory) there is over 50% of population, achieve over 60% of total GDP of Bosnia and Herzegovina. Within this area, there is administrative-cultural, sport and economic centre and capital city of BiH-Sarajevo, cultural-sport and tourist-economic centre and the biggest town of Herzegovina-Mostar, mining-steel producing center of BiH-Zenica, the largest traffic and railroad junction - Doboj, as well as number of other significant industrial-energy, tourist-catering, sport-recreation, cultural-historical and religious centres, such as the Park of Nature - Hutovo Blato, religious tourism center – Medjugorje, winter tourism centres around Sarajevo on Olympic mountains of Jahorina, Bjelasnica and Igman, as well as on the mountain Vlasica at Travnik, water power plants system on Neretva with artificial impounding reservoirs, spa-health facilities of Ilidza, Fojnica, Teslic, Steam power plant and Mine Kakanj, lumber industry Zavidovici, Cellulose of Maglaj, Oil Refinery Modrica and others.

c) Main existing double lane communication of width 7,00 m that passing along the Corridor (road M17), for a long time does not meet the traffic requirements in terms of service level and traffic security. Road M17 passing through all large towns, so some sections of this road are turned into urban and suburban communications where mixing trunk road, remote authentic-goal and local urban-suburban traffic, with all negative consequences, both for environment and for the traffic (creation of other lanes, congested traffic with longer traffic holdup, traffic accidents, air pollution, excessive noise and similar). Such situation resulted in very high costs of transport beneficiaries, big time losses, productivity reduction, reduction of competitive ability, diminution of market, dissuade of foreign investors and others. By elimination of traffic obstacles that result from the current unsatisfactory traffic infrastructure, and that will be achieved by the construction of high rank communication, i.e. the highway, it will be created the conditions for the reduction of transport costs share in production costs, reduction of non productive in favor of productive time and increase of total work productivity, it will facilitate the accessibility to productive and consumers centres leading to the more balanced market conditions as well as the processes of cooperation, spatial and productive-technological prestructuring in production, it will be increased the mobility of work force, and all these will effect on faster and more comprehensive development of BiH and strengthening of its economy competition.

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 the special privilege to this economy sector. Construction of the structure, which estimated cost is 6,20 billion of KM, certainly will lead to the job creation, intensification and production increase in current plants, as well as to the opening of new productive facilities, especially in the civil engineering sector, the production of construction material and equipment, agricultural-processing industry and services. After the construction of the highway, it will come to the direct additional employment on the works of management and maintenance of the highway, as well as on many service works.

e) Impact of the highway construction on employment and increase of production is in line transmitted on wide range of indirect producers and suppliers of consumer goods, materials and equipment, where effects multiplied. Involvement of domestic construction operative on such large and complex works will provide the staff, technical and technological strengthening and upgrading for the access to world wide markets and the return of the pre-war reputation and position. Engagement of domestic high skilled staff on the rendering the consulting services in the phase of preparation, execution of works and project management in the exploitation, will create the staff structure, capable for the own creation of development strategy and the policy and management of other development projects.

f) It is common that in such projects the attention of environment and other specialists deal with environment protection is focused on negative environment impact of the project. That is in every case positive, since it results in the measures that will those negative impacts eliminate or reduce on acceptable level. In concrete case, the construction of planned highway with the bypass around larger towns, will in great measure unload the network of urban roads, mitigate the congested traffic, and in that way postpone the necessity of investment interventions; mitigate the noise effects, reduce the emission of harmful substances, and consequently improve general living conditions in the towns. Having in mind that the mentioned negative impacts in density settled and constructed urban zones, where the control of these impacts is practically impossible or very difficult, transmitted in the unsettled zones with application of protection measures, it is easy to conclude that total highway construction environment impact will be very positive.

g) Dislocation of transit traffic outside the narrow urban zones will provide more appropriate land use, more favorable position of different urban facilities, i.e. it will help their more rational and functional development. Although it may be expected that in certain limited zones along the highway, it occurs the dropping of the real property value (land and facilities) because of the proximity of highway and the effect of `obstacle`, it is certain that in large scale and in the wide area will come to the increase of real property value. Increase of investment activity, increase of production and trade exchange, the growth of GDP, will as well lead to the increase of fiscal revenue of social-political community. As reverse positive effect that may effect on reduction of tax rate and other fiscal burthen that is additional incentive to economic progress.

Mentioned positive highway impact on total economic development, is impossible to quantify and express in cash. Some of them are found in the effects of transport beneficiaries in the cost-benefit analysis (operative vehicle costs, travel time of goods and passengers), but it will certainly appear some indirect effects. There were some attempts to evaluate indirect impact of the highway construction on general economic development of Bosnia and Herzegovina. As illustration, there are given the results of expertise impact assessment.

According to the analyses and assessments² conducted by Assistant professor. Ph.D. Faruk Jasarevic, Prof. Ph.D. Branko Beros and Velibor Peulic, during the construction and after the highway construction, it will occur the significant indirect development effects within the narrow and wide gravity area.

Starting from the preliminary assessment, that construction costs would be around 6 billion of KM, the authors carried out the assessment of direct benefits that 42 economic activities would accomplish during the construction phase (Table T.3.4-01). Authors as well evaluated that the use of this highway will initiate the new economic activities and encourage total economic activities, especially within narrow gravity area, but as well in total BiH. They evaluated that average growth of GDP in the municipalities of narrow gravity area in the following period of anticipated 5, 5% annually, in the case of highway construction could reach the rate of 6, 2%, the authors came to the effect in the amount from 323, 7 millions of KM in 2013 year up to 857, 2 millions in 2020 year, i.e. 1495, 5 millions in 2025 year.

Tabela 3.4-01. Development economic performance during the highway construction

Economic activity	Value of the direct benefit of the economic activities during the highway construction on Corridor Vc (mil. KM)
Electrical industry	141.18
Coal production	48.06
Coal processing	30.06
Production of the oil and gas	50.04
Oil derivates	201.18
Iron ore	14.12
Ferrous metallurgy	398.12
Ore of ferrous materials	19.41
Ferrous metals	48.30
Nonmetal	117.18
Processing of nonmetals	25.46
Metalworking	254.12
Production of machinery	74.12
Means of transportation	80.54
Electro machine and apparatus	138.32
Chemical products	45.60
Processing of chemical products	46.92
Stone and sand	197.70
Construction material	636.00
Timber and lamella	53.82
Final lumber products	24.42
Paper processing	47.04
Fabrics	22.62
Processing textile industry	9.78
Production of leather shoes	6.24
Rubber	8.12
Food production	25.41
Beverage production	0.24
Cattle feed	0.84
Tobacco processing	0.00

² "Economic benefits and other effects of Corridor Vc before, during and after construction phase" Sarajevo 2005.

Different products	2.33
Agriculture and fishery	20.12
Forestry	34.70
Water management	43.41
Building construction	26.12
Installation works and final works	211.41
Traffic and communications	554.12
Trade	374.12
Catering and tourism	0.74
Specialist's services	314.12
Public services and utilities	37.41
Other productive services	164.12

Acceleration of the economic growth because of the highway construction will lead to the job creation. By the evaluation of the authors, besides the high engagement of the workers during the construction phase, on the service and maintenance of the highway in use will be permanently employed around 1.000 workers, the involvement of the facilities in different economic sectors, from the industry, trade to the tourism will result in about 10.000 additional work posts.

3.5. Technical description of adopted alignment of LOT 1

After the completion of the preparation of preliminary parts of planning-study documentation for the corridor of the highway Vc, it started the preparation of preliminary designs individually for each section within the contracted LOT-s.

The highway Svilaj – Doboj Jug (Karuse) LOT 1, in the preliminary design, goes from the bank of the river Sava and in the direction north-south passing through the flat area in the first and second section, while in the third, fourth and fifth section with the longest part passing along the valley of the river Bosna and ends up in the hilly terrain above Doboj (sixth section), where with smaller tunnels take the difference of level in that zone. Total alignment length on LOT 1 is 62,634209 km.

Contact point between two countries on the river Sava was previously agreed on the meetings of investor (Ministry of communication and transport) and representative of Republic of Croatia and on the basis of the analyses within the preparation of planning-study documentation that preceded to the preparation of Preliminary design.

Also, it was agreed about two issues: first, that mutual checkpoint should be located on the side of Republic of Croatia and the second that bridge across the river Sava was not treated by the preliminary design.

The highway is designed with two, verge separated road surfaces that will have two lanes and one stopping lane. All technical elements of the highway were defined according to the project assignment and the rules book for the category and significance of the highway, for the design velocity of $V_p=120\text{km/h}$.

Limiting elements of the plan and section

Limiting elements imply the estimate of minimum and maximum values for the layout, vertical alignment, cross-section and visibility in the function of design speed of the section.

Layout:

- Maximum length of the direction max L $20 \cdot V_p$ 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:

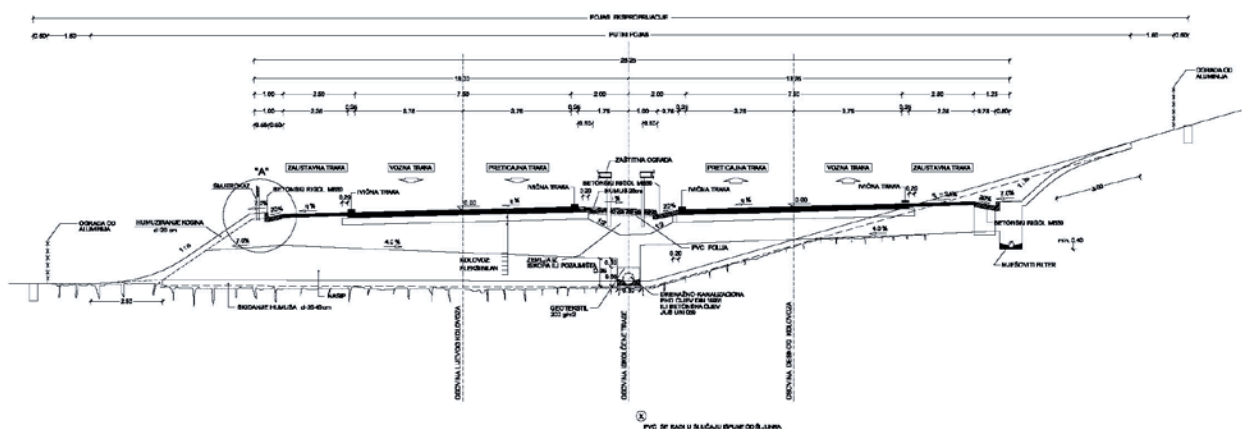
- Maximum vertical alignment grade max i_N 4,00 %
- Minimum vertical grade min i_N 0,30 %
- Maximum grade of road surface twisting barrier max i_{IV} 0,50 %
- Minimum grade of road surface twisting barrier min i_{IV} 0,20 %
- Minimum radius of convex rounded min R_{konv} 12000m
- Minimum radius of concave rounded min R_{konk} 12000m

Cross-section:

- Width of lane for continuous ride t_v 3,75m
- Width of stopping lane t_z 2,25m
- Width of marginal strip t_i 0,25m
- Width of flank b 2,00m
- Minimum cross fall of the road surface min i_p 2,50 (%)
- Maximum cross fall of the road surface in curve max i_{pk} 7,00 (%)

Visibility:

- Minimum length of visibility on the gradient min Pz 250m
- Minimum length of visibility on the gradient min Pz 310m



Picture 3.5.1. Normal cross - section of the highway

3.5.1. Section 1: Svilaj - Odzak from km 0+000,00 to km 10+890,79

Section Svilaj – Odzak is the first section both of LOT – 1 and total project of the highway on Corridor Vc through Bosnia and Herzegovina with the length of 10890, 79 m, which chainage starting from the centre of the river Sava which is bridged with the structure of the length of 600m.

Geometry of alignment

Geometry of alignment is defined with directions, curves and transition curves in the form of clothoids. There were applied three horizontal curves: two right ones ($R=2750$ m and $R=3500$ m) and one left $R=1750$ m, with appropriate transition curves.

Alignment is going through the centre line of highway (within the central island), because of relatively simple terrain configuration there were no necessity for separation of road surface.

Routes were located on the following sections, i.e. on the beginning of bridge across the river Sava with the length of 979,033 m, and then it was set up between I and II curve of the length 1999,35 m and between II and III curve of length 610,464m. Section is ended with transition curve.

Twisting of road surface was carried out around the centre line of the road surface (5.75 m from the centre line of highway in the central island). With leading of finished road level in this way, it was as well carried out the twisting of central island providing drainage without central canal, except when the alignment is set up in the direction. Because of these reasons, grade line is completely same for both tracks, and vertical alignment is related to the centre line of left and right road surface, while cross-section of the terrain in vertical alignment is related to the centre line in the central island.

Elements of leveling plan

Alignment is going through the embankment of variable height and i.e. from 12m behind the abutment of Sava bridge to the shallow embankment of 1-1, 5m in the part where there is no necessity for ascending of alignment because of underbridge or culvert.

In this way, there were provided the conditions for efficient runoff from grade without special measures of the introduction of additional drainage system. Water runoff from tracks is solved with special water treatment.

Line of finished road level is set up with very slight grade because it passes through extremely flat area. Because of the fact that maximum grade is 1,14 % and that is in the contact with section 2 and the minimum grade is 0.25 %, the road crossing and bridges are set up in the most rational way to avoid the embankment . Finished road level has 7 vertical curves observing from the river Sava of the following dimensions: 50000m, 75000m, 65000m, 35000m, 60000m, 80000m, 28000m.

Drainage

For controlled drainage from the tracks, it was set up the special drainage system, i.e. special water treatment, as closed drainage system, which is the subject of special project.

Water from bedding is mostly drained directly through the embankment, in the parts where it is not possible by drainage channels. It is planned that water from drainage channel is not released in the water gully, because the water from water gully going in the central main drain and further on in the treatment unit, which it is not needed for the water collected in drainage channels. Since the alignment is found in the proximity of drainage channel (surrounded by the embankment of the height up to 1,5 m) collecting the storm waters from surrounding hills, which further discharging into Sava river, there is fear that water from the right side of channel which by now run down in underground and surface ways, because of natural slope could be flowing towards the road base of the highway and in that way endanger the toe of embankment. In terms of that, from the right side of highway next to the toe of embankment, it was set up the channel of depth around 1 meter, for controlled drainage of water to the nearest receiving body of water.

On the left side of the highway, it was planned the channel for controlled drainage. Reason for such decision is found in the terrain character (satisfactory permeability) that is gradient of terrain although minimum although it is still opposite from the highway base.

Somewhat faster ingress of water in `micro surface storage` won't significantly change the current situation where the atmosphere water overflowing the terrain (by existing channels, the old river bed that are ceased with mentioned channel, but are still the function of runoff to the larger channels and even further in the river Sava) dives and evaporates.

Structures and other facilities

On the chainage of about 7100 m, there are opposite associate structure (type C) for each direction individually, with the parking lot for freight (17) and passenger vehicles (42), petrol station, auto repair shop, motel, restaurant and telephone booth.

On the chainage of about 9500 m, it was located the delevelled junction of `trumpet` type where double – tracked connection towards the regional road is located under the highway. On the same point in the zone of direction it was set up the toll check point. Positions of the road structures were showed in the following table:

Bridges and under bridges	Chainage	length (m)
Under bridge 1	1+496,37	32,50
Over bridge 1	3+712,37	32,50
Under bridge 2	5+957.92	32,50
Over bridge 2	7+604,85	52,00
Under bridge 3	9+411.24	32,50
Under bridge 4	9+819.46	32,50

Besides the bridges on the alignment, as well there were planned the road passage (mostly for agricultural purpose), objects of frame construction and that is 6 passages of 5x3, 5 m and one passage of 5x4,5.

Parts of road on the contact with abutments were shown in the special projects of the structures, but it is as well the obligation of the ones who marking out that in the graphical parts prepare the parts of bridge construction on the contact with road such as slope round head, flank walls and crossing slabs. Slope round heads were planned as through-put embankments on under

bridges and over bridges of the grade 1:1,5 which is different from the grade of slope on the embankments of highway which is on total section 1:2.

Protective safety fence was set up from inner side (within the central island) along total section while from outer side planned only on the parts where the embankments higher than 3 m.

From the position where ends up the road base (toe of embankment on the right side or the end of channel on left side of highway) on the distance of 3 m it was set up safety fence of highway serving to disable any crossing over the highway, and first of all as dam for passing of animals and protection for both traffic participants and animals. Placing of safety fence can deviate from proposed 3 m because of esthetical criteria. The area between fence and road was left as option for communication of construction equipment or common vehicle for eventual intervention on the highway from that side. One meter behind the fence of highway, there is property line, which in some case may deviate from proposed rule.

3.5.2. Section 2: Odžak - Vukosavlje from km10+289,79 to km17+289,01

Section 2 starts with extension on the section 1 with chainage of 10+890, 79 and ends up on the bridge across the river Bosna on km 17+289, 01. Total length of section is 6, 40 km and it extends along flat area up to the river Bosna. The start and end of section was identified with the selected alternative route from Conceptual design. With additional selection of bridge construction across the river Bosna, taking account about the high waters and adjusted to the finished road level, the end of the section is on the bridge.

Geometry of alignment

Because of favorable terrain conditions, there were designed two horizontal curves with appropriate transition curve. There were changed the curves of radius $R=3500\text{m}$ and $R=1100\text{m}$. Because of relatively simple terrain configuration, the alignment was laid out the centre line of highway (within central island). It was no necessity for separation of the road surface. On the section 2 it was adopted the twisting of road surface like on the section 1 and 3 for better fitting and continued lay out of the highway on LOT 1.

Therefore, the twisting of road surface was done round the centre line of track (5,75 m from central line in the median island). With such twisting, the finish grade is the same for both tracks, and longitudinal profile is related to the center line of left and right track, and the cross-section of terrain in vertical alignment to the central line (in central island).

Elements of leveling plan

Alignment is located with entire length on embankment; with the height from 2 to 10 m. Gradient of embankment slope on total section is 1:2. In terms of water management, runoff from track is solved with special treatment of these waters (more detailed in the project of drainage). With lay out of the alignment on the embankment it is solved the drainage from the grade without additional drainage systems.

Because of extremely flat terrain, the finish grade has very slight gradient. Maximum gradient is 1,14%, and minimum gradient is 0,30%. With such finish grade, in the best way there are set up the road passages and bridges and avoided the high embankments. Applied radius of vertical curves ranges from 35000m to 100000m.

Structures and other facilities

All crossings with existing traffic network were solved as delevelled, their connection with the highway are only possible in the junctions. On this section, it was planned the junction Vukosavlje km 16+540, 79 (connection on regional road for Odzak). Junction is of type 'trumpet'. Two-track connection towards regional road is found under the highway. On the same point it was set up the toll check point. On the bridges and under bridges, basic width of track is the same as on other part of alignment. Positions of road objects were shown in the following table.

Bridges and under bridges	Chainage	Length (m)
Under bridge 1	11+313,23	32,50
Under bridge 2	13+275,64	32,50
Under bridge 3	13+538,95	32,50
Bridge (r. Gnionica)	13+820,39	52,00
Under bridge 4	15+212,63	32,50
Under bridge 5	16+085,67	32,50
Under bridge 6	16+206,47	32,50
Under bridge 7 (junction Vukosavlje)	16+340,79	32,50
Bridge 2 (M 17 and river Jakesnica)	16+634,40	92,00
Bridge 3 (river Bosna)	17+054,60	542,40

On the alignment, there were planned the road passage (for local and footpath). There were designed the objects of frame construction type and that is 5 (five) passages 5x4m.

3.5.3. Section 3: Vukosavlje - Podnovlje from km 17+289,01 to km 33+466,59

With bridging over of the river Bosna, it ends up the section Odzaci - Vukosavlje, closing with the chainage km17+289,01 and it starts the section Vukosavlje - Podnovlje. Total length of section of 16, 20 km was settled in flat area of Corridor Vc.

Alignment passing through the municipality Modrica and is located in mutual corridor with railway Sarajevo - Vpolje, it touches the urban zone of Modrica town, i.e. passing the narrow belt between the Botojanicka strana and railway, from south east side of the settlement Dobor. Alignment is in the corridor of railway, on the distance of about 100,00m from first objects in the settlement Dobor.

Basic concept of the designer on this section was rationalization of the area in terms of setting up of infrastructural systems of the road and railway into the common corridor. Existing railway was planned for reconstruction and introduction of second track that won't significantly impact on the distance of all corridor from the objects in the settlement Dobor.

Geometry of alignment

First element of alignment on the target section is the route of length $L = 4.826, 12\text{m}$. Such too long route is unfavorable in terms of optical, psychological and form criteria and it does not meet the boundary condition. Very long route is the consequence of the alignment integration in the unique corridor with railway, which presents the priority in relation to fulfillment of boundary elements.

On this section, there were applied the circular arc of following radius: $R=3000, 00\text{m}$, $R=2200, 00\text{m}$, $R=2670, 00\text{m}$. Applied transition curves meet the boundary elements as well as the esthetical criteria.

Elements of location plan fulfilled the task related to the compatible composing of geometric elements and perspective and traffic psychological effects. Degree of neighboring curves is in very good area in terms of adjustment so it was created the right speed change and with that created an adequate degree of security.

Elements of leveling plan

Gradients of finish grade, were adjusted to functional type of communication and objective conditions of the site.

On this section, there were applied the gradients meeting the boundary conditions.

Every break of finish grade, regardless the width was subject to warping from $R_v=12000\text{m}$ to $R_v=147000\text{m}$. Course of finish grade depends on the requirements for meeting of hydrologic conditions of high tide level, the limitations related to the height of bridge construction objects with boundary elements coming from individual criteria in relation to drainage, visibility, drive dynamics and exploitation effects.

High level of underground waters, a number of objects as well as geological and geotechnical conditions, defined the position of finish grade in the area, so an average height of embankment is $4,50\text{ m}$.

Drainage

Highway on Corridor Vc on the section 3 LOT-a 1, with all length of alignment is located on high embankment. This means that surface waters were captured with closed, controlled drainage system. Drainage was performed with closed channel system.

Seepage water from the slope does not present the problem. Drainage of formation is simple – with central drainage system. Abandoned natural water runoff is captured with system of protective channels for leading of water to appropriate receiving body of water. Drainage system of the highway presents the highest level of system implying complete underground water channeling from the road surface and storm waters.

Water collection from carriageway will be done with marginal drain channel within inner marginal strip of road surface, where on certain distance will be set up the surface water gully. Associate system also implies inspection chamber to provide complete control of runoff to the receiving body of water. From outer side of the track, water collection from carriageway as well will be

done with marginal drain channel with surface water gully and inspection chamber. Water is led in common central sewage in the median.

Structure and other facility

Connection between the settlements Dobor and Modrica was provided with rebuilt system of local communications as well as communication of higher range:

- From north-east side, the settlement Dobor makes the direct communication with central zone of Modrica with communication of length 1080,89m, that was designed as the extension of existing communication through the settlement.
- From south west side, settlement Dobor as well creates the connection with the regional road R-465, the road that is parallel with highway on Corridor Vc of length 1798, 19m.
- Within the system of higher rank communication, in the zone of Modrica town, it was performed the rebuilding of the railway crossing in the level of regional road R-465, by design of over bridge as common crossing over the railway the highway on Corridor Vc and new-designed local road.
- Within the system of higher rank communication, in the zone of Modrica town it was performed the rebuilding of regional road R-465 that imply dislocation of regional road out of the highway and railway zone and harmonization of project elements.

System of agricultural roads was saved by the opening of road passages of the width 7,00 m. Road passages fulfill the vertical clearance of profile of 4,80 m. Road passages were set up on the following chainage km 26+049,13; km 28+502,48; km 29+878,22; km 31+389,01.

On km 21+939,01 the alignments of highway and railway separate the individual corridors. The alignment overbridges the river Bosna, under oblique angle on km 23+639,01 – km 24+186.69, aiming to establish the contact with the slope of Mađarevica where it was laid out the course of the primary route M-17 and release the valley of river Bosna.

Winding of the course of river Bosna Krivudavost required on very short distance two objects of bridges, one from km 27+069.74 – km 27+364,64 and the other from km 27+689,01 – 28+039,01.

On km 30+389, 01 it was set up the associate structure for the needs of beneficiary „Podnovlje”. Connection with primary route M-17 was created with delevelled junction of type indirect `trumpet` in Podnovlje on km 32+589,01.

3.5.4. Section: 4 Podnovlje - Johovac from km 33+466,59 to km 46+624,14

Closing with the chainage on km 33+466.591 it ends up the section Vukosavlje – Podnovlje and starts the section Podnovlje – Johovac. Section 4 is located in relatively narrow corridor between the primary road M-17 and left bank of the river course of Bosna which minimum width on chainage km 47+424,14.

With bridge construction, the alignment passes over the river Bosna aiming to create unique corridor with railway and regional road Modrica - Maglaj.

Upon the request of investor, in relation to previous phases of project documentation, the alignment was dislocated and removed from the mentioned corridor and laid out the middle of plain between the river Bosna and railway.

Consequence of alignment dislocation in relation to previous phases is bypass of water intake in the zone of Osjecana that is in previous phase of the preparation of documents absolutely limitation defined with narrow protection zone of radius $R=372,50\text{m}$ and the zone of supervision of radius $R=622,50\text{m}$.

Although this area has not been surveyed more detailed, and not explicitly identified neither the protection zones nor the possibilities of the water intake protection within the alignment determined in previous phases, the alignment was moved to the west from the water intake. With its all course the alignment passes exclusively through agricultural land of the valley of river Bosna.

Geometry of alignment

Minimum elements of the base line in the location plan $\min R=1500,00\text{m}$. On this section, there were applied the circular curves of radius $\min R=1500,00$. Elements of the location plan fulfilled the task related to the balanced composition of geometric elements and perspective and traffic-psychological effects. Radiuses of adjacent curves are in very good area in terms of the adjustment, so it is accomplished the balance of the speed change and with that created adequate safety degree.

Elements of leveling plan

Gradients of finish grade were adjusted to functional rank of communication and the site situation. On this section, there were applied the gradients meeting the boundary conditions.

Every break of finish grade, regardless the sharpness was subject to the warping from $R_v=13000\text{m}$ to $R_v=100000\text{m}$. Course of finished grade should meet the hydrological conditions of the high tide level, then limitations related to the height of the objects of bridge constructions with respect of boundary elements come out of the individual criteria related to the drainage, visibility, drive dynamics and exploitation effects.

High level of underground waters, a lot of objects, as well as geological and geotechnical conditions, were defined the position of finish grade in the zone, so the average height of the embankment is $4,25\text{m}$.

Drainage

Highway on Corridor Vc on section 4 LOT-1, with total length of alignment is set up on the high embankment. This means that surface waters were captured with closed, controlled drainage system. Drainage was performed with closed channel system.

Seepage water from the slope does not present the problem. Drainage of formation is simple – with central drainage system. Abandoned natural water runoff is captured with system of protective channels for leading of water to appropriate receiving body of water. Drainage system of the highway presents the highest level of system implying complete underground water channeling from the road surface and storm waters.

Water collection from carriageway will be done with marginal drain channel within inner marginal strip of road surface, where on certain distance will be set up the surface water gully. Associate system also implies inspection chamber to provide complete control of runoff to the receiving body of water. From outer side of the track, water collection from carriageway as well will be

done with marginal drain channel with surface water gully and inspection chamber. Water is led in common central sewage in the median.

Structure and other facility

For the alignment, it is characteristic the dissection with the water courses of the river basin of river Bosna:

- Km 33+589.97 Mrki potok,
- Km 35+386.78 Potok Ljuteš,
- Km 37+143.53 Potok Lovnica,
- Km 41+286.59 Potok Struica,
- Km 45+032.06 Vasiljevića Potok,
- Km 45+362.2 Potok Riječica,
- Km 45+730.63 Potok Riječica

Also, there is a lot of agricultural roads which continuence was created with opening of the road passages, totally 12 of width 7,00m and 3 of width 12,00m.

On km 36+116,59 it was set up the associate structure for the needs of beneficiary „Seslije”.

3.5.5. Section 5: Johovac - Rudanka from km 46+624,14 to km 52+816,02

Section Johovac – Rudanka is the fifth section of LOT—a 1, with length of 6191.88 m. Contact point wwith section 4 (Podnovlje - Johovac) is located on chainage 46624.139 m and ends up on the contact with sixth section (Rudanka - Karuše) on the chainage 52816.019 m.

Geometry of alignment

Geometry of alignment was defined with the directions, curves and transition curves in the form of clothoid. It was applied 5 horizontal curves and that is mostly S curves : three right (R= 1341.392 m , R=700.00 m and R=2411.636 m) and two left (R=762.574 m and R=700.00m), with appropriate transition curves. Alignment was laid out the centre line of highway (wthin the central island) because of relatively simple terrain configuration it was not required the separation of tracks. Alignment was set up on only one location of length 599.927 m. Section starts and ends up with transition curve.

Twisting of road surface was done around the centre line of road surface (5.75 m from the centre line of the highway in central island). With lay out of finish grade in this way, it was done as well twisting of central island which provide the drainage without central channel. Because of above mentioned, the line of finish grade is completely same for both tracks, and longitudinal profile is exactly related to center lines of left and right track while the section of terrain in longitudinal profile is related to centre line of central island.

Drainage

For controlled drainage from the tracks, it was set up the special drainage system, i.e. special water treatment, as closed drainage system, which is the subject of special project.

Water from bedding is mostly drained directly through the embankment, in the parts where it is not possible by drainage channels. It is planned that water from drainage channel is not

released in the water gully, because the water from water gully going in the central main drain and further on in the treatment unit, which it is not needed for the water collected in drainage channels. Because of necessity for the drainage of riparian waters (which in short time intervals are of torrent character) from east side of the highway and railway, it was planned 9 pipe culvert Φ 200, 2 pipe culvert Φ 150, and two box culvert 3x3 m. In the periods of very high tide on the river Bosna, the same channel can serve for equalization of water level from both sides of the highway for purpose of increase of flood zone.

Elements of leveling plan

Alignment is laid out the embankment variable height and that is of 12 m in the proximity of bridge for overbridge of the railway up to the shallow embankment of 1.5 meters in the part where there is no need for ascending of alignment because of under bridges or culverts. In this way, there were provided the conditions for efficient drainage from grade without special measures of introduction of drainage systems. Drainage from the tracks is solved with special treatment system that is especially worked out in the Project of outer and inner drainage.

From the end of large bridge construction (about chainage 52500) the alignment starts dapping, and all up to the entrance in the tunnel (6 sections) is located in the cutting. Levelling line was set up with very slight gradient because of the lay out in the flat area except of the zone before enter in the tunnel (crossing of the river Bosna and entry in hilly terrain) where alignment was laid out in the grade of 4 %. Minimum grade is 0.3 % and that is in the contact with fourth section. Finish grade has 5 vertical curves and viewing in the direction of chainage, having the following sizes: 50000m, 45000m, 45000m, 50000m, 12000m.

Structure and other facility

On chainage about 48000 m, there were set up the opposite associate service structure (type A) for each direction individually, with parking for freight (14) and passenger vehicles (20), petrol station, restaurant and telephone booth. On the chainage about 52000 m it was located delevelled junction of the type `trumpet` where two-track connection towards primary route is located under the highway. On the same point in the zone of direction, it was set up the toll check point. Delevelled junction will be shown in the project as separate ensemble in the scale 1:2500.

In the zone of loop, on the exit from the check point it was located the center for maintenance and control of traffic that presents the complex of objects allocated on the plateau of dimension approx. 150x80 m.

Center for traffic control and management / COKP / is composed of the following objects:

- OBJEKT A – management, system of distance conduct and management of traffic and workshop
- OBJEKT B – garage of freight vehicles, garage of fireman vehicles
- OBJEKT C – garage for personal vehicles and storage
- OBJEKT D – Storage bin for salt
- OBJEKT D1 – storage CaCl_2
- OBJEKT F – laundry room of vehicles
- OBJEKT H – auxiliary objects

Technological process that needs to be fulfilled within COKP is composed of service of vehicles if necessary in each of the COKP objects. Because of that, gyratory traffic is the most economical and from this it came out layout of the objects. Management of vehicles and definition of necessary tasks was planned and analyzed in the administration building, where there is the center for gathering of all relevant data from the section of the highway maintained by COKP. As basic part of COKP of the highway, it was planned the construction of integral system for control and conduct of traffic (traffic – informative system, system of distance conduct and management of traffic). Positions of road objects were shown in the table below:

Bridges and under bridges	Chainage	Length (m)
Bridge across the river Lukavice	46+852,69	32,50
Over bridge	49+084,22	100,00
Bridge across the railway, the river Bosna and the road in the loop zone	52+025,00	950,00

Besides the bridges on the alignment, there were as well planned the road passages (for agricultural purpose), the objects of the type of frame construction and that is 2 passages of 5x4.5 m and 5x4m.

Parts of road on the contact with abutments of bridges were shown in special projects of the objects, but it is also the obligation of the ones who mark out that in the graphical annexes prepare the parts of bridge construction on the contact with road such as slope round head, flank wall and crossing slabs. Slope round heads were planned as culvert embankments on the undewr bridges and over bridges of gradient 1:1.5 which is different from the gradient of slopes on the embankments of the highway which is on all section 1:2.

Protective safety fence was set up from the inner side (within the central island) along the total section while from outer side it was only planned on the parts where the embankments are higher than 3 meters.

From the position where the road base ends up (toe of embankment on right side or next to the channel on left side of the highway) on the distance of 3 meters, it was set up the safety fence of the highway serving to disable any passage across the highway and first of all as dam for animal passage and certainly as protection of both traffic participants and animals itself. Setting of safety fence can deviate from proposed 3 meters for purpose of esthetical criteria. The space between the fence and road was left for possible communication of construction equipment or common vehicle for eventual intervention on the highway from that side. One meter behind the fence of highway, there is property line, which in some cases (dealing with property-legal issues...) may deviate from proposed rule.

3.5.6. Section 6: Rudanka-Karuse from km 52+816,02 to km 62+634,21

Commence of the alignment of section 6, is after the crossing of the river Bosna, the primary route M17, Doboј – Modrica and railway Doboј – Banaj Luka in the place Rudanka, and on the end of section 5 Johovac – Rudanka.

Geometry of alignment

Geometry of alignment was defined with the routes, curves and transition curves in the form of clothoid. It was applied seven horizontal curves: four right (R-1500, R-1600, R-800 m and R-1000 m) and three left (R-2000m, R-850 and R-750m), with appropriate transition curves.

The alignment was laid out the centre line of highway (within the central island) because of relatively simple terrain configuration it was not needed to separate the tracks.

Elements of leveling plan

Alignment is immediately on the start in the gradient of 4%, set up the valley of stream and regulates it until the entrance in the first tunnel. Before the entrance in the tunnel, centre lines of rolling tracks move apart from 11,50 m on the necessary 25,0m, as it is going to be all to the exit from other tunnel, where again the gap of center line returns to the 11,5m. Longitudinal gradient is one-sided and that is on entrance 2, 25%, and then up to the end 0,36%.

After the crossing of these two valleys, alignment again enters in the tunnel of length 660,0m. All tunnel is in vertical curve Rv-20000m with average longitudinal grade of 2,0%.

After the exit from tunnel, alignment lowers from 4,0% into the valley of river Usora, and centre line of lanes again approach with 25,0m to 11,5m. Alignment was laid out in such way, that minimum works needed.

Before the descent in the valley of river Usora, there is longer object of 315,00m. Finish grade of the road after descent in the valley of river Usora was adjusted to the level VV of river Usora, Q1/100, controlled channel. Such finish grade is significantly lower than for non controlled channel and for approx. 3.0m.

At the end of section, alignment was located along the river Usora, cutting into the slope that steeply lowers in the river channel. To reduce the works on that section, and that the dapping is smaller on this section, it was planned the finish grade.

After this section, the alignment lowers again adjusted to the VV of river Usora for controlled channel. On the part along the village wells, it was planned the setting of impermeable foil under total embankment and boundary ditch, to prevent the penetration of polluted waters in the underground in accidental cases. The closest well is removed approx. 50m from the motorway. Because of the passage of the river Usora and the primary route of M4 outside the level, at the end of section it was planned longer bridge. Bridge would be of 560m length. Course of alignment shows that on the first part of the alignment it is in ascent from 4% to the contraflexure, and then up to the descent in the river of Usora it is of 4%.

Drainage

On its immediate start, the alignment is laid out the valley of stream and controlled it, so the hydrological situation within this part is very favorable. On the contraflexure, the alignment is set up over crest and it can be said that the hydrological conditions are favorable.

Finish grade of the motorway directly depends on VV river. There were prepared two alternatives of finish grade depending on the VV of river, and if it will be controlled or not. Difference in the levels is approx. 3,5 m, which means that for non controlled channel the embankment would be higher for approx. 3,5 m. After the proposals of alternatives to the

investor, the investor decided that the finish grade on this section should be determined according to the controlled channel of the river Usora. Smaller watercourses were passed through with the culverts through the road base.

Structure and other facility

On the section 6, there are 2 tunnels, 4 bridges and one junction. First tunnel is from chainage km 54+206,07 to km 55+506,01 length of 1300m. After the exit from the first tunnel, alignment immediately passes over two valleys with the objects of length 245,0 and 420,0m. Between these two objects, there is shorter cutting over which it was planned the construction of over bridge for the purpose of existing local road.

Second tunnel starts on chainage km 56+786.04 to the chainage km 57+445.96 of length 660m. On chainage km 59+008.17 the alignment passes the watercourse Duboki potok with bridge of length 315m. Because of the crossing of the river Usora and primary road M4 outside the level,, at the end of section it was planned the longer bridge. Bridge would be of length 560m.

Selected site of junction Karuse was chosen after long analyze of terrain situation and the wishes of municipality inhabitants gravitate within the junction, and it differs from the site proposed in the Preliminary design. New site provides the siting of all ramps, toll ramp and connection with primary route M4, Karuse – Banja Luka.

3.6. Spatial limits of survey within EIA

The widest spatial limits of the area interested for the survey of the planning highway impact on corridor Vc, LOT 1, include a wider spatial entity in the Valley of Bosna River from Svilaja to Doboj, and from the border with Republic Croatia all up to Doboj (Karuše). On west side, the survey border was set up approximately along existing road from Svilaja to Doboj and on east side along the existing railroad. Outline of survey area was given on graphical part no. 01-1 to 01-4 in scale of 1:25000.

Survey area for the aspect of water resources includes the belt of one kilometer on both sides of contour line of the highway, including the alignment itself. In the situations where it was feasible in terms of hydro geological, i.e. aspect of underground waters protection and during the definition of spatial limitations it was adopted the natural border of water bearers towards impervious environment as contour border, since in such environment it can be found very often the springs, well or pumps for water supply.

According to the above mentioned, it was prepared the map of limitations related to the water resources (annex 12.3.5.). Within this map, there were presented the zones of sanitary protection of the source area in the systems for water supply along LOT-1 (marked with red hatchs with mark of zone), as well as sensitive area in relation to the underground waters (marked with orange acute hatchs). Zones of sanitary protection are the area determined by survey works, they are legally protected with appropriate decision and within them enforce the protective measures according to the valid Decision, i.e. legal act. Sensitive areas are water-bearers where the highway can pass with undertaking of all necessary prevention measures and minimizing of negative impact on underground waters. Surface watercourses and their shore where the highway set up or intersects them were as well treated as sensitive area.

During the phase of developing a Technical Study and General Design, a broader area surrounding the route of the Vc highway was considered, in order to select the most suitable route. Following a thorough review of arguments, the final route option, being the subject of this

study ("Assessed impact on environment for the phase of General Design development"), was adopted. Its total length is 62 634 m, LOT 1. and it is divided in six sections:

- First section, Svilaj – Odžak, L = 10 891 m,
- Second section, Odžak – Vukosavlje, L = 6 398 m,
- Third section, Vukosavlje – Podnovlje, L = 16 178,
- Fourth section, Podnovlje – Johovac, L = 13 157 m,
- Fifth section, Johovac – Rudanka, L = 6 192 m,
- Sixth section, Rudanka – Karuše, L = 9 818 m

This chapter will provide general characteristics of the highway route in its entire length, while description of actions aimed at mitigating the negative impact on the environment, both for each section and entire length of the highway; will be provided in a separate chapter. In addition to the narrative data, there will be attached a set of maps showing soil types on the route as well as protection category (use-value) for both entire length and specific sections. The width of the route that is being considered in terms of impacts and protection measures is 500 m in diameter (250 m on each side of the highway axis). Additionally, the maps provide a wider strip of 1,000 m in diameter (500 m on each side of the highway axis) to provide a better insight into spreading and representation of certain soil types and inherent protection categories, that are in close connection with use-value. Since the most of the route goes through the lowlands, it occupies the land being used in agricultural production. The sites where infrastructural facilities (gas stations, restaurants, motels, turns, highway exit/entry points, etc.) will be built have not been determined yet. This will surely make additional pressure on environment, to include soil. All the above stated facts make better understanding of the wider strip equally important.

3.7. Waste materials and emissions

During the use of highway, it will come to the waste waters from the communication, and which collected and treated with specific system of inner drainage with associate facility. Limiting values of emissions in these waste waters should be satisfactory and harmless for overall environment. For limiting values it is necessary to respect the values defined in the `Rule book about conditions of waste water discharge into surface waters` Official Gazette of RS, no: 44/01 or in the `Rule book about discharge of waste waters in public sewage systems` Official Gazette of RS, no: 44/01. This is as well recommendation for the parts of alignment that passing through the area of Federation of BiH, since there is no relevant sub legal act that regulate this matter in FBiH.

4. DESCRIPTION OF ENVIRONMENT ENDANGERED BY THE PROJECT

4.1. Demographic and economic features

4.1.1. Municipality Odzak

4.1.1.1. Settlement and settlement systems

Table 4.1.1.1 Surface of municipality, number of inhabitants and population density

Surface (km ²)	Number of inhabitants (2004.)	Population density inh/km ²
171,4	17.074	99,6

Before the war conflicts, municipality Odzak had 14 settlements with 30.056 inhabitants. The following table gives the outline of the settlement and population structure assessed in 1991 year.

Before the war conflicts, municipality Odzak had 14 settlements with 30.056 inhabitants. The following table gives the outline of the settlement and population structure assessed in 1991 year.

Table 4.1.1-02 Structure of settlement and population with situation from 1991 year

Ordinal 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%

With Dayton Agreement, it was changed the pre-war territory structure of municipality Odzak, as change of surface and settlement system. Surface of municipality in 1991 year was 205 km².

In the area of Odzak municipality, the most numerous groups are the settlements between 1000 – 2000 inhabitants with the highest population in overall structure, which is favorable in terms of further development. Municipal center is the settlement from 5000 to 10.000 inhabitants.

4.1.1.2. Demographic features

Municipality Odzak occupies 52, 8% of Posavski canton area, where live 38, 2% of population. Population density is below average population density of the canton. Population number in

2004 year was considerably lower as consequence of the size change of territory and change of population trends.

Table 4.1.1-03. Demographic features

Surface of municipality (in km ²)		171,4
Indicators		za 2004.
1.	Number of inhabitants	17.074
2.	Population density (inh/km ²)	99,6
3.	Rate of population growth (1991 – 2004.)	-4,3

4.1.1.3. Macroeconomic characteristics

Economic situation of narrow impact area composed of six municipalities, such as Odzak, Modrica, Vukosavlje, Doboj, Doboj-Jug and Usora, will be recognized through the following indicators: income, employment, capital³ and number of business subjects.

Table 4.1.1.- 04: Economic indicators of municipality development

1.	Employment	
	Number of employees	1.465
	Employment rate	9,2
2.	GDP per inhabitant in KM	2.110
3.	Unemployment	
	Number of unemployed	2.207
	Labor force	3.672
	Unemployment rate of labor force	60,1
4.	Development level of municipality in relation to FBiH	
	GDP/accommodation	62
	Employment rate of population	61
	Unemployment rate of labor force	130

According to basic development indicators, municipality Odzak is considerably below the development level of Federation of BiH for 38% and according to GDP per inhabitant for 39% below employment rate of FBiH. Unemployment rate of labor force is higher for 30% in relation to the one in FBiH.

4.1.1.4. Economic structure

Table 4.1.1. -05: Economic structure of municipality according to the activities in 2003 year.

Activity	Business subjects	
	Number	%
Agriculture and forestry	10	3,8
Industry, mining and power supply	44	16,9
Civil engineering	16	6,2
Trade, catering, handicrafts and tourism	90	34,6
Traffic and telecommunications	12	4,6

³ These indicators were related to the legal entity which submitted the annual balance sheet in 2003 year in the municipalities of Republic of Srpska while the same not possessed for the municipalities of Federation of BiH

Other activity	88	33,8
Total	260	100

Table 4.1.-06: Economic structure of municipality according to the activity sectors

Structure of subjects %	
I sector	4,2
II sector	22,7
III sector	43,5
IV sector	29,6

Sectorial structure of registered business subjects shows the domination of tertiary and quarterly sector with 43, 5% and 29, 6%. Such structure of economy suits to the developed areas, but on this development level it is unsuitable because the tertiary and quarterly sector have a small employment potential.

4.1.2. Municipality Vukosavlje

4.1.2.1. Settlement and settlement systems

Table 4.1.2.-01. Surface of municipality, number of inhabitants and population density

Surface (km ²)	Number of inhabitants (2004.)	Population density inh/km ²
86.83	5454	62,8

Vukosavlje municipality is new-established municipality in the territory of Republic of Srpska, established after the signing of Dayton Agreement from the parts of the municipalities Modrica and Odzak. It is characterized by a small number of settlements and with mostly population in municipal center. In the territory of municipality, there are 13 settlements⁴, of which three are without population.

Current title of municipality is Vukosavlje, instead of previous title Odzak (settlements Gnionica, Josavica, Srnava, Ada, part of settlements Potocani, Vrbovac, and Odzak). Municipality surface was enlarged with the joining of the settlements Jakes, Pecnik and the part of settlement Modricki lug from the municipality Modrica.

In the area of Vukosavlje municipality, the most numerous group of settlements includes the settlements between 500 – 1000 inhabitants, then the settlements from 1000 – 2000 inhabitants.

4.1.2.2. Demographic features

Table 4.1.2-02: Demographic features of Vukosavlje municipality

Surface of municipality (in km ²)	86.83
Indicators	for 2004
1. Population number	5454
2. Population density (inh/km ²)	62,8
3. Population growth rate (1996 – 2004.)	15,1
4. Rate of vital statistics in ‰ (2003.)	

⁴ Data received from Republic office for survey and property-legal affairs

Birth rate	8,06 ‰
Death rate	9,90 ‰
Population growth	-1,84 ‰

Municipality Vukosavlje with its surface occupies 2, 8% of Dobož region area where live 2, 1% of population. Population density is below an average population density of the region. Population number in 2004 year was considerably increased in relation to 1996. (1765 inhabitants) occurred as consequence of population movement. Birth rate is an averagely high as in region; while population growth is considerably lower than average of the region.

4.1.2.3. Macroeconomic characteristics

Table 4.1.2 -03: Economic indicators of municipality development

1.	Employment	
	Number of employees	104
	Employment rate	1,9
2.	Income per inhabitant in KM	-
3.	Unemployment	
	Number of unemployed	-
	Labor force	-
	Unemployment rate of labor force	-
4.	Development level of the municipality in relation to RS	
	Income/inhab.	-
	Employment rate of population	12
	Unemployment rate of labor force	-

Municipality Vukosavlje is according to the employment rate of population considerably below an average level of Republic of Srpska for 88%. In the area of municipality, there are no registered unemployed persons.

4.1.2.4. Economic structure

Table 4.1.2-04: Economic structure of the municipality ⁵ according to the activities in 2003 year.

Activity	Number of employees	Business subjects		Total income (%)	Capital (%)
		Number	%		
Civil Engineering	11	-	-	-	-
Trade, catering, handicrafts and tourism	5	-	-	-	-
Traffic and telecommunications	2	-	-	-	-
Other activities	86	-	-	-	-
Total	104	-	-	-	-

⁵ Within the municipality Vukosavlje, only one enterprise from the sector of civil engineering industry submitted the annual balance sheet so it was not processed the structure of income and capital.

Table 4.1.2-05: Economic structure according to the activity sectors

1.	Structure of employees %	
	II sector	10,6
	III sector	6,7
	IV sector	82,7

Structure of employees according to the activity sectors shows a considerably share of quarterly social sector in total employment of municipality. Such economic structure suits to the developed area, while it is inappropriate on this development level, because the tertiary and quarterly sector have a small employment potential.

4.1.3. Municipality Modrica

4.1.3.1. Settlement and settlement system

Table 4.1.3-01: Surface of municipality, number of inhabitants and population density

Surface (km ²)	Number of inhabitants (2004.)	Population density inh/km ²
314,22	28.581	91,0

Before the war, Modrica municipality had 21 settlements with total of 35.613 inhabitants. The following table gives the outline of majority structure of settlements and the population with situation from 1991 year.

Table 4.1.3-02: Structure of settlement and population with situation from 1991 year

Ordinal No.	Size structure	Number of settlements	Total inhabitants	Structure
1.	Up to 199 inhabitants	2	236	0,66%
2.	200-499	4	1462	4,11%
3.	500-999	1	835	2,34%
4.	1.000-1.999	8	10375	29,13%
5.	2.000-4.999	5	12251	34,40%
6.	5.000-10.000	–	–	–
7.	More than 10.000	1	10454	29,36%
TOTAL		21	35.613	100%

With Dayton Agreement, it was carried out the change of pre-war territory of Modrica municipality, the change of surface and settlement system. Surface of the municipality in 1991 year was 297 km².

Seven settlements from the municipality Pelagicevo was joined to Modrica municipality, while 3 settlements were separated and joined to the new-established municipality Vukosavlje (Modrički lug, Jakes and Pecnik). Today, municipality Modrica includes 23 settlements. In the area of Modrica municipality, the most numerous group makes the settlement between 1000 – 2000 inhabitants, which is favorable in terms of further development of settlement system. Considerable share also have the settlements with 2000 – 5000 inhabitants (34,40%).

Municipal center is the settlement larger than 10.000 inhabitants. In the settlements over 1.000 inhabitants lives 60% of municipal population.

4.1.3.2. Demographic features

Table 4.1.3-03: Demographic features of municipality Modrica

Surface of municipality (in km ²)		314,22
Indicators		For 2004.
1.	Number of inhabitants	28.581
2.	Population density (inh/km ²)	91,0
3.	Growth rate of population (1996 – 2004.)	0,6
4.	Rate of vital statistics in ‰ (2003.)	
	Birth rate	10,67 ‰
	Death rate	10,46 ‰
	Population growth	0,21 ‰

Municipality Modrica occupies 10, 2% of Dobož region area, where live 10, 9% of population. Population density is above average population density of the region. Number of inhabitants in 2004 year was insignificantly increased in relation to 1996. Birth and death rate is above average values created in the region, while the population growth is within the average regional borders.

4.1.3.3. Macroeconomic characteristics

Table 4.1.3-04: Economic indicators of municipality development

1.	Employment	
	Number of employed persons	3.975
	Employment rate	14,0
2.	Income per inhabitant in KM	4.323
3.	Unemployment	
	Number of unemployed	3.007
	Labor force ⁶	6.982
	Unemployment rate of labor force	43,1
4.	Development level of the municipality in relation to RS	
	Income/inhab.	75
	Employment rate of population	80
	Unemployment rate of labor force	117

According to the basic indicators of development, municipality Modrica is below the development level of RS for 25% according to the income per inhabitant and for 20% below the employment rate of RS. Unemployment rate of labor force is higher for 17% in relation to the one in RS.

⁶ Sum of employed and unemployed

4.1.3.4. Economic structure

Table 4.1.3-05: Economic structure of the municipality according to the activity in 2003 year.

Activity	Number of employees	Business subjects		Total income (%)	Capital (%)
		Number	%		
Agriculture and forestry	46	7	2,7	0,3	3,9
Industry, mining and power supply	1.353	33	12,8	46,9	87,0
Civil engineering	145	16	6,2	4,5	1,4
Trade, catering, handicrafts and tourism	988	132	51,2	40,0	3,4
Traffic and telecommunications	225	13	5,0	2,9	1,8
Other activity	1.218	57	22,1	5,5	2,5
Total	3.975	258	100	100	100

Table 4.1.3-06: Economic structure of the municipality according to the activity sectors

1.	Structure of employees %	
	I sector	1,2
	II sector	37,6
	III sector	32,7
	IV sector	28,5
2.	Income Structure %	
	I sector	0,3
	II sector	51,3
	III sector	43,4
	IV sector	5,0
3.	Financial indicators in 000 KM	
	Income	122.778
	Profit	3.436
	Loss	3.888
	Number of employees ⁷	2.719

Economic structure of municipality according to the activity sector shows the domination of secondary and tertiary sector which is especially obvious in terms of income structure. Structure of employees according to the activity sector shows a significant share of social quarterly sector in total employment of municipality.

In the area of Modrica municipality, it was 258 legal entities in 2003 year (book keeping according to the chart of accounts of the enterprise) which submitted the annual balance sheet, or 18, 4% of total number in Doboj region. Created financial results of the municipal legal entity participate with 13, 7% in the incomes of region, with 12, 9% in the profit and 3, 7% in created loss of Doboj region. These results created 2.719 employees, which makes 11, 6% of employees in the legal entity of region.

⁷ In the business subjects run the book keeping per the enterprise chart of accounts

4.1.4. Municipality Doboj

4.1.4.1. Settlement and settlement system

Table 4.1.4-01: Surface of municipality, number of inhabitants and population density

Surface (km ²)	Number of inhabitants (2004.)	Population density inh/km ²
808,84	80.464	99,5

Before the war conflicts, municipality Doboj had 73 settlements with total of 102.549 inhabitants. The following table gives the outline of majority settlement structure and population with situation from 1991 year.

Table 4.1.4-02: Structure of settlements and population with situation from 1991 year

Ordinal no.	Size structure	Settlement number	Total of population	Structure
1.	Up to 199 inhabitants	1	199	0,19%
2.	200-499	13	5140	5,01%
3.	500-999	27	20299	19,79%
4.	1.000-1.999	27	37668	36,73%
5.	2.000-4.999	4	11745	11,45%
6.	5.000-10.000	–	–	–
7.	More than 10.000	1	27498	26,81%
TOTAL		73	102.549	100%

With Dayton agreement, it was carried out the change of pre-war territory of Doboj municipality, the change of surface and settlement system. Surface of municipality in 1991 year was 684 km².

The area of Doboj municipality was reduced with the territory separation and establishment of the municipality Doboj – Jug, Doboj – Istok, Usora, while with joining of three settlements from municipality Petrovo (previously called Gracanica), the parts of municipality Maglaj and settlement from municipality Pelagicevo (previously called Gradacac) increased the territory of municipality. Today, municipality Doboj is composed of 82 settlements.

By functional organization⁸, Doboj belongs to the category of regional centers of first order (range of central function, the role of center in settlement system, spatial characteristics related to communication and development bases).

In the territory of Doboj municipality, the most numerous groups are the settlements between 500 – 1000 and 1000 – 2000 inhabitants. Municipality Doboj is featured with a lot of settlements of different size structure. Municipal center is the settlement with more than 10.000 inhabitants. In the settlements over 1.000 inhabitants lives 70% of the municipal population.

⁸ Phase Plan of Republic of Srpska 1996-2001 year.

4.1.4.2. Demographic characteristics

Table 4.1.4-03: Demographic characteristics of the municipality Doboj

Surface of municipality (in km ²)		808,84
Indicators		za 2004.
1.	Number of inhabitants	80.464
2.	Population density (inh/km ²)	99,5
3.	Growth rate of population (1996 – 2004.)	0,9
4.	Rate of vital statistics in ‰ (2003.)	
	Birth rate	8,36 ‰
	Death rate	9,29 ‰
	Population growth	- 0,93 ‰

Municipality Doboj occupies 26, 4% surface of Doboj region, where live 30, 7% population. Population density is above average density of region. Population number in 2004 year has been increased in relation to 1996 year. Birth rate is within the average of region, while the death rate is above average values created in the region, so it is the trend of negative population growth.

4.1.4.3. Macroeconomic characteristics

Table 4.1.4-04: Economic indicators of municipality development

1.	Employment	
	Number of employees	12.869
	Rate of employment	16,1
2.	Income per inhabitant in KM	4.301
3.	Unemployment	
	Number of unemployed	8.887
	Labor force	21.756
	Unemployment rate of labor force	40,9
4.	Development level of municipality in relation to RS	
	Income/inhab.	75
	Employment rate of population	99
	Unemployment rate of labor force	111

According to basic development indicators, income per inhabitant of Doboj municipality is for 25% less in relation to the average of RS, while employment rate is on the level of average rate in Republic of Srpska (for 1% lower than RS). Unemployment rate of labor force is higher for 11% in relation to the one in RS.

4.1.4.4. Economic structure

Table 4.1.4-05: Economic structure of municipality according to the activity in 2003 year.

Activity	Number of employed	Business subjects		Total income (%)	Capital (%)
		Number	%		
Agriculture and forestry	156	16	3,1	1,8	1,1
Industry, mining and power supply	2.989	84	16,5	25,1	39,7
Civil engineering	898	30	5,9	9,4	1,0

Trade, catering, handicrafts and tourism	2.455	178	34,9	39,9	3,4
Traffic and telecommunications	2.065	28	5,5	15,8	52,1
Other activity	4.306	174	34,1	8,1	2,7
Total	12.869	510	100	100	100

Table 5.2.4.6. Economic structure of municipality according to sector activity

1.	Structure of employees %	
	I sector	3,7
	II sector	27,7
	III sector	38,1
	IV sector	30,5
2.	Income structure %	
	I sector	3,5
	II sector	32,8
	III sector	57,0
	IV sector	6,7
3.	Financial indicators in 000 KM	
	Income	343.998
	Profit	10.051
	Loss	24.567
	Number of employees	10.494

Economic structure of municipality according to the sectors of activity shows the domination of tertiary and secondary sector, which is especially obvious on the basis of income structure. Structure of employees according to the activity sector, besides the secondary and tertiary sector shows a significant participation of quarterly sector in total employment of municipality.

In the area of Dobož municipality in 2003 year, 510 of legal entity (book keeping according to the enterprise chart of accounts) submitted the annual balance sheet, showing 35, 7% of the total number in Dobož region. Accomplished financial results of municipal legal entity participate with 38, 3% in the total income of region, and with a 37, 9% in profit, and 23, 3% in loss of Dobož region. These results accomplished 10.494 employees, which is 44, 7% of employees in legal entity of region.

4.1.5. Municipality Usora

4.1.5.1. Settlement and settlement systems

Table 4.1.5-01: Surface of municipality, number of inhabitants and population density

Surface (km ²)	Population number (2004.)	Population density inh/km ²
49,8	7100	143

Municipality Usora is new-established municipality in the Federation of BiH established after signing of Dayton Agreement, from the municipalities Tesanj and Dobož. Municipality Usora includes less number of settlements, and the municipal center is located in the settlement Sivsa.

The most of settlements are in the category from 1000 – 2000 population, where live around 60% of total population. According to data from 1991 year, it lived around 9100 population in this area.

4.1.5.2. Demographic characteristics

Table 4.1.5-02: Demographic characteristics

Surface of municipality (in km ²)		498
Indicators		za 2004.
1.	Population number	7100
2.	Population density (inh/km ²)	143
3.	Growth rate of population (1991 – 2004.)	-1,9

Municipality Usora occupies 1, 5% of the territory of Zenicko-Dobojski Canton with 1, 8% of population. Population number has been lower in 2004 year than in 1991 year. Population density of the municipality is above an average in the canton.

4.1.5.3. Macroeconomic characteristics

Tabela 4.1.5-03: Economic indicators of municipality development

1.	Employment	
	Number of employees	504
	Employment rate	7,1
2.	GDP per inhabitant in KM	1.146
3.	Unemployment	
	Number of unemployed	1.143
	Labor force	1.647
	Unemployment rate of labor force	69,4
4.	Level of municipality development in relation to FBiH	
	GDP/inhabitant	34
	Employment rate of population	47
	Unemployment rate of labor force	150

According to basic development indicators, municipality Usora is quite below development level of Federation of BiH for 66% according to GDP per inhabitant and for 53% below employment rate of FBiH. Unemployment rate of labor force is higher for 50% in relation to the one in FBiH.

4.1.5.4. Economic structure

Table 4.1.5-04: Economic structure of municipality according to activity in 2003 year.

Activity	Business subjects	
	Number	%
Agriculture and forestry	0	0
Industry, mining and power supply	11	16,2
Traffic and telecommunications	4	5,9
Civil Engineering	19	27,9
Trade, catering, handicrafts and tourism	5	7,4
Other economic activities	29	42,6
Total	68	100

Table 5.2.5.5. Economic structure of municipality according to activity sectors

Structure of subjects %	
I sector	0
II sector	22,1
III sector	36,8
IV sector	41,2

Sectorial structure of registered business subjects shows the domination of tertiary and quarterly sector with 36, 8% and 41, 2%.

4.1.6. Municipality Doboj-Jug

4.1.6.1. Settlement and settlement systems

Table 4.1.6-01: Surface of municipality, number of inhabitants and population density

Surface (km ²)	Number of inhabitants (2004.)	Population density inh/km ²
10,2	4852	473

Municipality Doboj – Jug is new-established municipality in the territory of Federation of BiH, established after signing of Dayton Agreement from one part of territory of municipality Doboj. In the territory of municipality, there are two settlements Matuzici and Mravici. The center of municipality Doboj – Jug is in the settlement Matuzici.

Both settlements belong to the group of settlements from 1000 – 2000 inhabitants (Matuzici – 1783; Mravici – 1476 inhabitants). In 1991 year, in the territory of municipality lived 3259 inhabitants.

4.1.6.2. Demographic characteristics

Table 4.1.6-02: Demographic characteristics

Surface of municipality (in km ²)		10,2
Indicators		for 2004.
1.	Number of inhabitants	4852
2.	Population density (inh/km ²)	473
3.	Growth rate of population (1991 – 2004.)	3,1

Municipality Doboj – Jug occupies 0, 3% surface of Zenicko – dobojski Canton, where live 1, 2% of population. Population density is higher than the average of Canton. Population number is higher in 2004 year than in 1991 year, as consequence of the change of territory size and population trends.

4.1.6.3. Macroeconomic characteristics

Table 4.1.6-03: Economic indicators of municipality development

1.	Employment	
	Number of employees	576
	Employment rate	12,1
2.	GDP per inhabitant in KM	2.369
3.	Unemployment	
	Number of unemployed	1.252

	Labor force	1.828
	Unemployment rate of labor force	68,5
4.	Level of municipality development in relation to FBiH	
	GDP/inhabitant	69
	Employment rate of population	81
	Unemployment rate of labor force	148

According to basic development indicators, municipality Doboju-Jug is quite below the development level of Federation of BiH for 31% according to GDP per inhabitant and for 19% below employment rate of FBiH. Unemployment rate of labor force is higher for 48% in relation to the one in FBiH.

4.1.6.4. Economic structure

Table 4.1.6-04: Economic structure of municipality according to activity in 2003 year.

Activity	Business subjects	
	Number	%
Agriculture and forestry	2	2,7
Industry, mining and power supply	14	18,7
Traffic and telecommunications	8	10,7
Civil Engineering	22	29,3
Trade, catering, handicrafts and tourism	4	5,3
Other economic activities	25	33,3
Total	75	100

Table 4.1.6-05: Economic structure of municipality according to activity sectors

Structure of subjects %	
I sector	4,0
II sector	28,0
III sector	38,7
IV sector	29,3

Sectorial structure of registered business subjects shows the domination of tertiary and quarterly sectors with 38, 7% and 29, 3%.

4.2. Climatic and meteorological characteristics

Surveyed wider area of the highway on corridor Vc – the section Svilaj-Doboj, includes the valley of Bosna river in its lower course from Doboj to the confluence in the river Sava, covering hilly terrain, and wide alluvial planes on the right bank of Sava. Vučak mountain (367m) and Krnin mountain (265m) west from the river Bosna, then mountains Trebovac (644m) and Ozren (917m) east from the river Bosna, Crni vrh (687m) in the south, present a special morphological entities in this area. Although the height of mentioned mountains does not exceed 1500m, these mountains rich with forest resources make an impact on climate of surveyed area. Besides the mentioned topographical factors, the local climatic conditions and especially characteristic of ruling air flows and regime of precipitation above surveyed area in great measure are effected by the sea distance and distribution of the fields of high and low air pressure, i.e. position of anticyclone and cyclone above Europe and Atlantic ocean.

The area around lower Bosna and Posavina has a moderate-continental climate with middle annual air temperature of 11°C and annual precipitation amount of 745-907 mm. Because the survey area is open towards west, northwest and west break of humid Atlantic air which brings considerable amount of precipitation especially during the period May-June. Amount of precipitation for warmer period of year it makes 56% that confirms continental precipitation regime in this area.

In aim of detailed investigation of climatic conditions of wide section area of the highway Svilaj-Doboj, there were analyzed available data of meteorological measuring and observation for period 1951-2004 year for the following meteorological stations:

Slavonski Brod	$\varphi = 45^{\circ} 10' N$,	$\lambda = 18^{\circ} 00' E$,	H = 88 m
Derventa	$\varphi = 45^{\circ} 00' N$,	$\lambda = 17^{\circ} 55' E$,	H = 105 m
Modriča	$\varphi = 44^{\circ} 59' N$,	$\lambda = 18^{\circ} 18' E$,	H = 115 m
Brčko	$\varphi = 44^{\circ} 53' N$,	$\lambda = 18^{\circ} 50' E$,	H = 96 m
Gračanica	$\varphi = 44^{\circ} 43' N$,	$\lambda = 18^{\circ} 16' E$,	H = 160 m
Doboj	$\varphi = 44^{\circ} 44' N$,	$\lambda = 18^{\circ} 06' E$,	H = 165 m

It is needed to be mentioned that for purpose of spatial analysis and interpolation of basic climatically elements were used the data of mentioned meteorological stations and the results of climate survey of this area within Spatial Plan of RS.

4.2.1 Air temperature

Local conditions of relief and low altitude of surveyed area cause moderate continental climate with very equalized thermal conditions (Picture. 3.1-01). During most part of year (April – October), middle monthly air temperatures are higher than 10°C, while other months are cold with considerable lower temperatures. Here, winters are often strong while summers are moderate. Average annual air temperature in lower course of the river Bosna, northeast from Modrica ranges around 12°C,, and on the part of the highway section Modrica-Doboj ranges around 10.8°C (Picture 4.2-01, Table. T.4.2-01).

Analysis of middle monthly air temperature (Table T.4.2-01, Picture 4.2-02) shows that it is the lowest temperature in January and varies from -0.9°C in Modrica, up to -0.4°C in Doboj, while the warmest month is July with average air temperature in range from 20.6°C in Doboj to 20.7°C in Modrica.

It should emphasize that because of global climatic changes during last decade of XX century, it has been registered the highest increase of air temperature both on global and local level. During the last decade of XX century, average annual air temperature in analyzed area is averagely higher for 0.3°C in relation to standard 30-yearly average 1961-1990 year, which is confirmed by the monitoring results on meteorological stations Modrica and Doboj (Table T.4.2-01).

Pronounced annual fluctuation of air temperature (from 21°C in Doboj and 21.6°C in Modrica, as well as high amplitude of absolutely extreme air temperatures (68.5°C for Modrica area and even 72.5°C for Doboj), shows a dominant impact of physical-geographical and local conditions of relief on forming of moderate-continental climate regime in analyzed area. Middle annual maximum air temperature in analyzed area ranges from 16.2 °C in Modrica to 16.3°C in Doboj (Table T.4.2-01), while middle minimum annual temperature ranges from 5.4°C Modriča, to 5.7°C in Doboj. As data indicate (Table T.4.2-01), absolute maximum of air temperature appears only in Modrica in July (41.5°C), while on other meteorological stations registered in

August (Doboj, 40.3°C, Brčko 42.0°C). Absolute minimum of air temperature (Table T.4. 2.-01) appears in January (Doboj, -32.2°C, Modriča, -27.0°C).

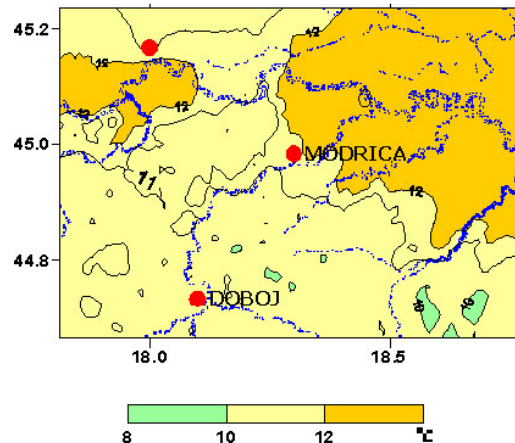
It is noticed that the temperature extremes are more pronounced in depressions (Doboj) in relation to slopes and hilly area of higher altitude, because of temperature inversion.

Winters are in surveyed are quite cold with average temperature ranges from 0.7°C in Marcia to 0.7°C in the Doboj area (Table T.4.2-01). Middle summer temperature ranges from 19.9, in Doboj, to 21.2°C in Modrica, with mild growth tendency towards Brcko and Bijeljina, i.e. dropping with altitude growth south from Doboj.

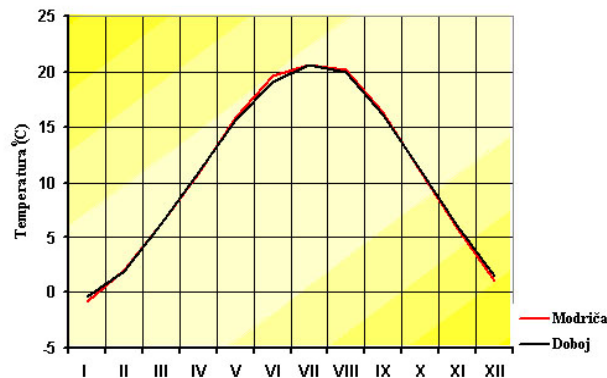
Autumns are some warmer than spring (on profile Doboj-Modriča, middle temperature of autumn months ranges around 11.1°C, and during spring from 11.0°C) pointing to the fact that analyzed area is located in the zone of poor pronounced maritime impact on thermal regime (Table T.4.2-01).

Table T.4.2-01: Air temperature (°C), period 1951-2004 year

METEOROLOGICAL STATION	MONTH												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	God.
a) Middle monthly temperature													
Modriča	-0.9	2.0	6.3	10.9	15.9	19.6	20.7	20.2	16.4	11.1	5.9	1.1	10.8
Doboj	-0.4	1.9	6.3	11.0	15.7	19.1	20.6	20.0	16.1	11.2	6.0	1.5	10.7
b) Middle maximum air temperature													
Modriča	2.6	6.2	12.0	16.9	22.1	25.6	26.9	27.0	23.1	17.3	10.7	4.5	16.2
Doboj	3.3	6.7	12.1	17.0	22.0	25.0	27.1	26.9	23.4	17.7	10.7	5.2	16.4
c) Middle minimum air temperature													
Modriča	-4.6	-2.3	0.9	5.0	9.3	13.1	14.2	13.8	10.4	5.6	1.7	-2.5	5.4
Doboj	-4.3	-2.5	1.0	5.2	9.6	13.1	14.4	13.9	10.8	6.4	2.3	-1.7	5.7
d) Absolute maximum air temperature													
Modriča	19.7	22.4	26.8	30.8	34.8	37.5	41.5	41.2	35.5	30.4	28.0	19.8	41.5
Doboj	20.7	23.0	29.0	31.7	36.0	37.8	40.0	40.3	35.0	31.0	26.4	22.0	40.3
e) Absolute minimum air temperature													
Modriča	-27.0	-21.0	-19.0	-3.0	-0.4	3.0	6.5	5.5	-1.0	-5.2	-14.6	-21.0	-27.0
Doboj	-32.2	-26.8	-18.2	-6.0	-2.1	1.6	6.7	5.3	-0.2	-5.6	-15.4	-20.8	-32.2



Picture 4.2-01: Spatial allocation of middle annual air temperature in wide area of the section of highway Svilaj-Doboj, period 1951-2004 year



Picture 4.2-02: Middle month air temperature (°C), period 1951-2004 year

4.2.1.1 Frost

High frequency of frost appearance (days with minimum air temperature T_n below 0 °C) and mist appearance also present a significant climatic characteristic of the wide area of highway section Svilaj-Doboj. Annually, in the valley of river Bosna, there is from 79 to 92 frost days in average, and mostly from October to April, with rare occurrence during May and September month (Table T.4.2-02).

Number of the days with strong frost appearance (days with minimum daily air temperature T_n lower than minus 10 °C) range annually in average from 11.2 days in Doboj to 9.6 days in Modrica (Table T.4.2-02). The most days with strong frost appear in Derventa (around 12 days), and the least in Brcko (around 8 days). Winter period is characteristic per high frequency of ice days (days with maximum air temperature T_x below 0 °C). Middle annual number of ice days range from 20 in Doboj, Modrica and Brcko to 21 in Derventa (Table T.4.2-02).

4.2.1.2 Summer and tropics days

During the summer, bottom of valley and ravine is warming up, so with decrease of altitude increase the number of summer days (days with maximum air temperature T_x above 25 °C) and number of tropic days (days with maximum air temperature above 30 °C). Tropic days appear in the period from April to October in Doboj, and from May to October in Derventa (Table T.4.2-

02), but the most of them appear during the summer, and in average from 23 days in the valley of Bosna, while going towards Brčko this number increases and it is annually around 30 days. Number of summer days is in relation to tropic ones, proportionally higher and in Doboj is 87 days annually.

Table T.4.2-02: Air temperature (°C), period 1951-2004. year

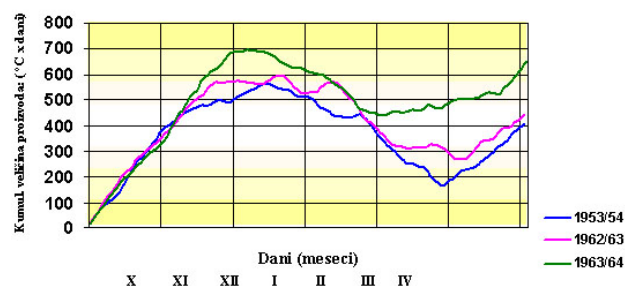
METEOROLOGICAL STATION	MONTH												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
a) Tn ≤ -10 °C (days with strong frost)													
Derventa	5.6	3.6	0.5								0.3	1.9	12.0
Modriča	4.9	2.0	0.4								0.3	2.0	9.6
Brčko	4.4	2.2	0.3								0.1	1.3	8.3
Doboj	5.2	3.4	0.5								0.2	1.9	11.2
b) Tx < 0 °C (ice days)													
Derventa	9.7	4.3	0.7								0.5	5.5	20.7
Modriča	10.1	2.8	0.5								0.4	5.8	19.6
Brčko	9.7	4.5	0.5								0.2	4.9	19.9
Doboj	9.2	3.9	0.8								0.4	5.1	19.5
c) Tn < 0 °C (frost days)													
Derventa	25.8	19.5	12.0	2.2	0.1				0.1	2.5	9.1	20.6	91.8
Modriča	25.7	19.2	10.6	0.9	0.0				0.1	1.9	9.0	20.9	88.3
Brčko	24.4	16.9	8.8	0.8					0.0	1.6	7.9	18.5	78.8
Doboj	23.5	18.2	10.9	1.9	0.1				0.0	1.5	8.4	18.6	83.2
d) Tx ≥ 30 °C (tropic days)													
Derventa					1.1	3.6	7.5	7.2	1.9	0.1			21.5
Modriča				0.0	1.2	4.7	7.6	7.0	1.8	0.1			22.3
Brčko				0.0	1.3	5.7	9.2	8.7	2.7	0.1			27.6
Doboj				0.0	1.3	4.0	8.0	7.6	2.9	0.1			23.9

4.2.2 Frost index

Based on the middle daily air temperature for Modrica, it was determined the frost index of environment for three coldest winters 1953/1954, 1962/1964 year with average winter air temperature from -3.7 °C, -3.8 °C and -2.8 °C, respectively and received results were shown on the picture 4.2-03.

As it is noticed, the value of frost index of environment for Modrica for mentioned winters (calculated according to JUS U.C4.016, as absolute value of difference between maximum and minimum value of cumulative sum of temperature for the coldest weather period) is 394.7 °C, 301.9 °C and 255.8 °C, and number of days between extreme values of cumulative sum is 74, 54 and 56 days. On the base of received data, it can be determined the authoritative frost index for 20 years period, necessary for dimensioning of pavement structure and undertaking of protective measures from bad impact of freezing and defrosting. Depth of frost penetration in

soil, determined according to the formula $dm = K\sqrt{Im}$, in which: dm is –depth of frost penetration in soil in cm; K – coefficient that has the value of 5.3 for the area below 800 m of altitude; and Im –frost index in °C, is in average 94 cm for the above mentioned three coldest winters. If for determination of the depth of frost penetration in soil it is applied the Makovnikov`s method, using the formula $dm = K\sqrt{2\alpha T}$, in which: α – coefficient of frost penetration which depend on the exposure of the place to the wind (in our country it is used the value $\alpha = 25.5$ for the sites below 800 m of altitude) and T – number of days with negative middle daily air temperature, then for above mentioned three the coldest winters for Modrica, are gained the values of frost penetration from 61.4 cm, 52.4 cm and 53.4 cm.



Picture 4.2-03: Frost index of environment for Modrica

4.2.3 Sunny days and cloudiness

The data about real lasting of sun shining with average annual sums below 2000 hours indicate to the continental climatic features of surveyed area (from 1645h in Doboj, to 1813h in Derventa, Table T.4.2-03). Namely, average annual sun shining in surveyed area is 1729 hours; it is much lower in relation to the potential annual lasting of Sun emission, which is for analyzed geographical width around 4400 hours. The longest average lasting of Sun shining appears in July (Doboj, 237.3 hours, Derventa, 262.1 hours) while in November (Derventa, 42.2 hours), and in December (Doboj, 49.1) appears minimum of sun shining.

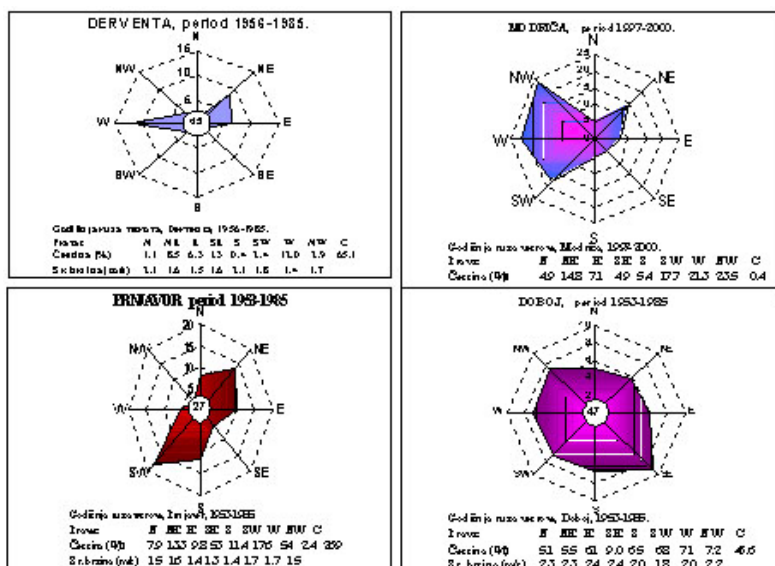
Middle annual cloudiness ranges around 5.7 tens of cloudiness above analyzed area (Table T.4.2-03). In period from May to October, monthly amount of cloudiness is less than annual average, and in period from June to September it is mostly below 50%. In cold half of year (from November to April), middle monthly cloudiness ranges from 54 to 76%, so the number of somber days (with average daily cloudiness above 80%) is in this period very high (in average every second day). During a year, their number reaches around 120 days (Table T.4.2-03). Average annual number of clear days (with middle daily cloudiness below 20%) ranges around 73 days (Table T.4.2-03), and the most often appearance of clear days is in July, August and September (in average every third day).

Table T.4.2-03: Cloudiness and Sunny days

METEOROLOGICAL STATION	MONTH												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	God.
a) Middle monthly amount of cloudiness (1/10)													
Derventa	7.4	6.8	6.2	5.9	5.5	5.3	4.1	4.1	4.5	5.7	7.3	7.7	5.9
Modriča	7.3	6.8	5.7	5.6	5.0	4.7	3.9	3.9	4.4	5.1	6.8	7.4	5.6
Brčko	7.0	6.3	5.6	5.4	4.9	4.6	3.6	3.6	3.8	4.9	6.7	7.2	5.3
Doboj	7.4	7.0	6.4	6.0	5.7	5.2	4.3	4.4	4.9	6.0	7.1	7.6	6.0
b) Middle monthly amount of Sun shining period (hour)													
Derventa	48.3	73.9	126.0	154.0	204.5	225.2	262.1	255.3	208.6	131.7	42.2	45.4	1777.2
Doboj	50.6	71.8	116.4	147.2	182.6	198.4	237.3	223.1	177.4	124.9	66.4	49.1	1645.1
c) Number of clear days (N < 2 /10)													
Derventa	2.9	3.4	5.3	5.6	6.3	6.2	11.1	10.6	10.0	6.0	3.3	2.4	73.1
Modriča	2.7	3.2	5.8	5.5	6.9	7.7	11.1	11.1	9.9	8.0	3.5	2.6	77.9
Brčko	2.7	4.7	6.1	6.2	7.6	7.7	12.2	12.5	11.9	8.4	3.6	2.8	86.4
Doboj	2.0	2.5	3.9	4.3	4.7	5.6	8.8	9.1	6.3	3.4	2.4	1.6	54.8
d) Number of somber days (N > 8 /10)													
Derventa	18.1	13.2	12.6	10.6	9.0	7.6	5.4	5.1	6.6	10.4	16.6	18.9	134.1
Modriča	16.7	12.9	10.3	9.0	6.6	5.3	4.7	4.4	6.0	8.3	14.3	17.0	115.6
Brčko	15.4	11.6	9.6	8.9	6.5	5.8	4.2	4.2	4.8	8.0	14.1	16.7	109.8
Doboj	16.4	13.0	12.3	10.1	7.9	6.7	4.8	4.8	6.3	9.8	15.1	17.8	125.0

4.2.4 Wind

Regarding the wind regime, there is a dominant impact of local geographical obstacles both on the direction and on the wind intensity. During a year, there are mostly the winds from west and north quadrant (Picture 4.2-04). There are mostly west and northeast winds in Derventa , and southeast and northeast winds in Prnjavor, northwest-west-southwest and northeast winds in Modrica, while in Doboj there are equally included winds from all directions with small flows from the direction of northwest and southeast because of canalized air flow in the direction of Doboj`s depression. Proportionally high frequency of silence indicates that there is around 40% of days without wind in this area, and mostly in Derventa, even 65%. The highest average wind does not always follow the frequency of wind directions and it ranges around 2.4 m/s in Doboj, 2.1 m/s in Derventa, 1.7 m/s in Prnjavor, and 1.6 m/s in Modrica (Picture 4.2-04). Middle annual number of days with strong wind intensity above 6 Beaufort) ranges from 8 in Doboj, to 12 in Modriča. The appearance of days with storm wind (the intensity above Beaufort), it is much rarer and in average it is two days.



Picture 4.2-04: Annual wind rose for Derventa, Modriča, Prnjavor and Doboј

4.2.5 Air moisture

Relative air moisture is a high and annually in average ranges from 79% in Modriča to 82% in Derventa (Table T.4.2-04). From September to March, the relative air moisture is high and it is over 80%. The highest value of air moisture appears in November, December, January and February and it is in average over 85%, while the lowest value appears from April to August and it is in average around in analyzed area.

Middle monthly values of water vapor pressure (Table T.4.2-04) follow annual pace of air temperature, where the lowest values appear in January (around 5.0mb), while maximum appears in July and ranges around 18 mb.

Table T.4.2-04: Air moisture

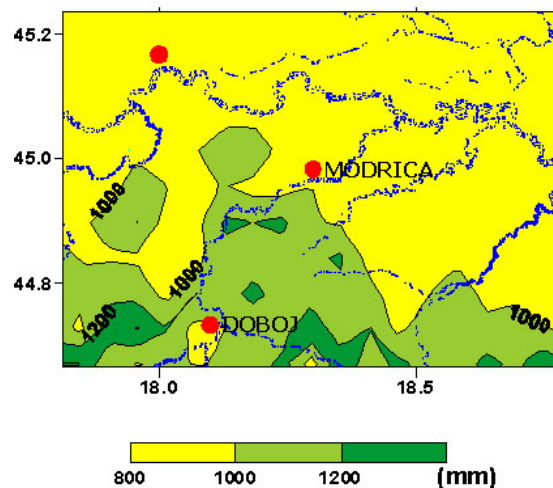
METEOROLOGICAL STATION	MONTH												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
a) Middle pressure of water vapor (mb)													
Derventa	5.2	5.9	7.4	9.9	13.8	17.2	18.5	18.0	15.0	11.2	8.4	6.1	11.4
Modriča	5.2	6.0	7.4	9.6	13.4	16.8	17.8	17.8	14.6	10.9	8.0	5.9	11.1
Brčko	5.5	6.3	7.8	10.2	13.9	17.5	19.0	18.4	15.3	11.4	8.3	6.3	11.7
Doboj	5.3	6.0	7.4	9.5	13.3	16.8	18.0	17.7	15.0	11.4	8.3	6.3	11.3
b) Relative air moisture (%)													
Derventa	87.8	86.2	80.2	76.6	77.4	77.2	76.2	77.9	81.6	84.4	88.1	89.1	81.9
Modriča	85.5	84.5	77.6	74.1	74.4	73.1	73.1	75.3	79.1	82.0	85.0	87.7	79.3
Brčko	86.8	82.4	77.9	74.6	73.6	71.2	73.1	74.3	77.9	80.2	83.5	85.8	78.5
Doboj	87.6	83.9	78.7	74.6	76.2	77.1	76.0	78.0	81.6	84.3	86.4	88.5	81.1

4.2.6 Precipitation

Precipitation regime certainly presents one of the most significant climatic elements in terms of road traffic security aspects. Spatial distribution of annual precipitation amounts (Table T.4.2-05 and Picture 4.2-05) indicates that there is in average about 900 mm of water settling in the area of Dobož and around 836mm in the area of Modrića. In the higher hilly area in the surrounding area of Dobož, there is bigger amount of water settling, in average from 1000mm to 1200mm a year (Picture 4.2-05). In terms of the precipitation regime characteristic, the surveyed area is located in the zone having the features of continental pluviometer regime. Namely, precipitation distribution during a year (Table T.4.2-05 and Pictures 4.2-06 and 4.2-07) indicates that maximum amount of precipitation appears during a second half of spring and first half of summer, i.e. in period May-July. During that period, it is extracted in the area of lower course of the river Bosna around one third of annual sum of precipitation, and there are the least monthly amounts in February and March (around 55mm).

Spatial distribution of average annual amounts of precipitation in wider area of the highway section Svilaj-Dobož (Picture 4.2-5.) indicates that this area intakes a significant and pretty equal amount of water settling during a year, from 745mm (Bijeljina) to 900mm (Dobož). In terms of that, Bijeljina and Brčko have less sums of precipitation than the surveyed area (838mm), and Modrića, Derventa and Dobož have even larger (Picture 4.2-05).

Values of absolute maximum daily precipitation amounts (Table T.4.2-05) are in the interval from 74mm in Brčko to 101mm at site of Bijeljina, and they exceeded at least in one month monthly amount of rainfalls (Dobož -July; Modrića - August) on each location.

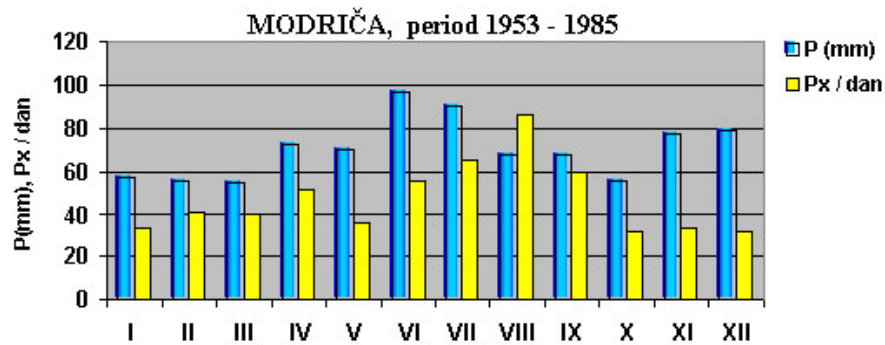


Picture 4.2-05: Spatial distribution of middle annual amounts of rainfall amounts for wider area of the highway section Svilaj-Dobož, period 1961-1990 year

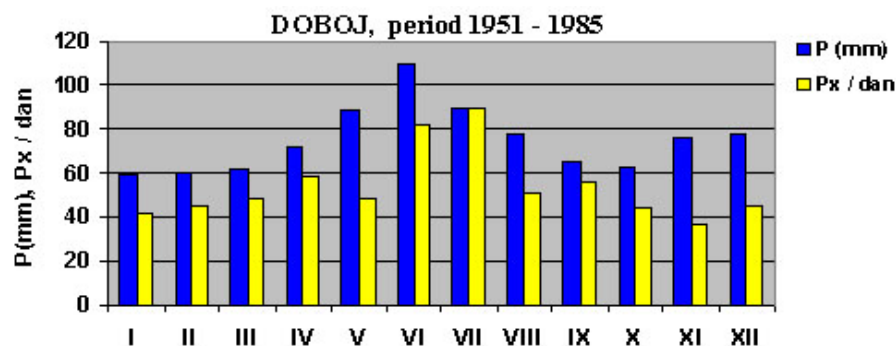
Table T.4.2-05: Precipitation and number of precipitation days

METEOROLOGICAL STATION	MONTH												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
a) Middle monthly precipitation amounts (mm)													
Derventa	54.8	59.0	58.3	73.4	81.5	106.0	92.3	79.7	67.5	65.9	79.4	79.9	897.8
Modriča	57.9	56.1	55.3	72.5	70.4	96.9	90.0	67.7	68.2	55.9	77.8	78.9	847.6
Brčko	52.4	52.7	52.7	68.0	74.7	95.7	77.2	70.9	55.8	49.9	72.1	72.7	794.9
Doboj	58.9	59.7	61.4	72.1	89.0	109.8	89.4	77.8	65.9	62.4	75.9	78.0	900.3
b) Maximum of daily precipitation days (mm)													
Derventa	34.7	47.7	43.8	78.5	63.7	85.3	73.5	74.5	71.0	79.1	46	39.0	85.3
Modriča	33.8	41.3	40.1	52.2	36.0	56.2	65.8	86.5	60.0	31.4	34	31.0	86.5
Brčko	42.7	39.0	66.4	50.6	56.6	73.5	72.8	61.0	55.2	53.0	48.2	47.7	73.5
Doboj	41.6	45.2	48.0	58.2	48.0	81.8	89.7	51.4	55.8	44.3	37.2	45.1	89.7
c) Number of precipitation days ≥ 0.1 mm													
Derventa	10.0	10.3	10.2	11.0	12.0	11.6	9.2	8.6	7.7	8.6	10.6	11.9	121.7
Modriča	10.1	11.0	11.3	12.5	12.6	12.9	9.6	8.9	8.9	9.2	11.6	12.3	130.8
Brčko	9.4	9.2	9.5	10.6	10.8	10.5	8.5	7.8	7.5	7.2	10.0	10.5	111.6
Doboj	13.8	13.2	14.1	14.1	14.3	14.1	11.4	10.5	9.3	10.2	13.1	14.7	152.8
d) Number of days with snow cover													
Derventa	13.8	9.0	2.2	0.1						0.0	2.5	9.5	37.1
Modriča	16.4	10.0	2.5	0.1							2.3	10.4	41.6
Brčko	12.3	8.8	2.3	0.1							1.0	6.2	30.8
Doboj	18.5	13.2	4.9	0.4							2.8	11.5	51.3
e) Number of days with snow cover													
Doboj	50	82	48	17						1	30	49	82
f) Number of days with silver thaw													
Sl. Brod	0.6	0.1	0.1	0.1							0.2	0.8	1.7
Derventa	0.2											0.1	0.4
Modriča	0.0		0.0									0.2	0.3
Doboj	0.1	0.1	0.1		0.0						0.0	0.2	0.4

For need of dimensioning of hydraulic structures and risk assessment of water erosion and landslide, it is necessary to be aware of the probability of maximum rains of short lasting for certain reversible period.

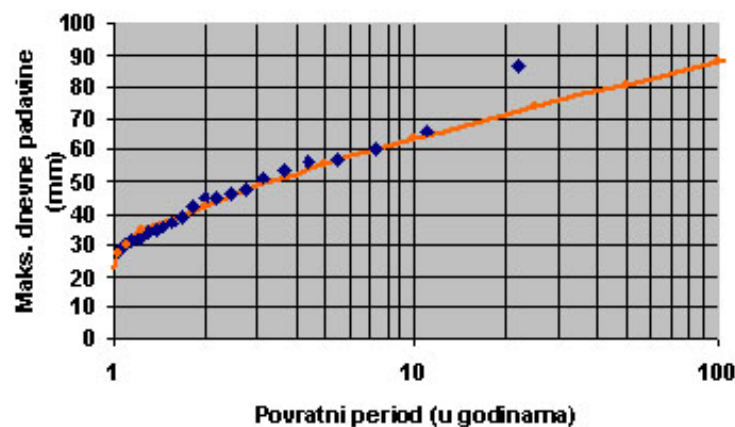


Picture 4.2-06: Middle monthly and maximum daily precipitation amount for Modrica, period 1953-1985 year



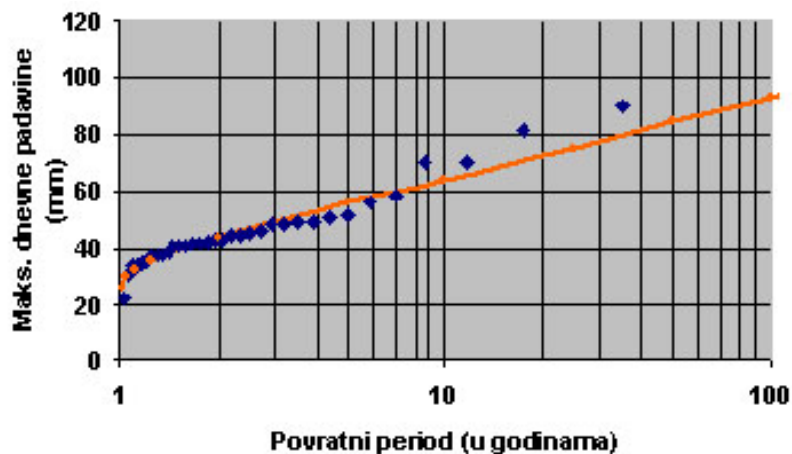
Picture 4.2-07: Middle monthly and maximum daily precipitation amount for Doboj, period 1951-1985 year

On the pictures 4.2-08 and 4.2-09 it was shown the probability of maximum daily precipitation amount determined based on 35-years line of maximum daily annual precipitation amounts for the stations Modrica and Doboj. As it can be noticed, value of maximum daily rain amount appear only once in ten years in Modrica and it is 63.7mm, while maximum amount of precipitation which appears once in 50 years is 80.6mm. As it can be noticed on graphical outline, absolute maximum daily rain amount of 86.5mm registered in 1951 year exceeds a maximum theory value of precipitation for reversible period of 50 years.



Picture 4.2-08: Probability of maximum daily precipitation Modrica, period 1951-1985 year

Similar results were also gained for Doboj station (Picture 4.2-09). The value of maximum daily rain amount which appears only once in ten years in Doboj is 64 mm, while maximum daily amount of precipitation which appears once in 50 years is 84 mm. It should emphasize that absolute maximum daily rain amount of 89.7mm registered on July 24th 1976 year in Doboj, exceeds a theory value of maximum daily precipitation (gained with application of Log Pearson III method) for reversible period of 50 years and it is very close to theory value for reversible period of 100 years (93mm).



Picture 4.2-09: Probability of maximum daily precipitation for Doboj, period 1951-1985 year

Precipitation regime is characteristic by relatively large number of precipitation during a year (Doboj, 153; Bijeljina, 138; Modriča 131; Derventa, 122, Brčko, 112 days). On mentioned meteorological stations, the largest number of precipitation days is in May and December, in average every second day. Number of precipitation days with stronger intensity (≥ 10 mm) is the largest during summer, and it is a 30 days a year in the zone of the highway section Svilaj-Doboj.

In this area, snow appears mostly from November to April, and very rarely in May, June and October. Middle annual number of snow days for Doboj is 42 days and for Modrica 28 days.

Middle number of days with snow cover larger than 1cm in surveyed area ranges from 31 (Brcko) to 52 days (Doboj, Table T.3.3-05). Real number of days with snow and snow cover is less than the period with appearance of snow and snow cover between middle limiting data

Average maximum height of snow cover in shore of Sava ranges around 30-40cm, with maximum of 60cm, while in the area of Doboj average maximum height of snow cover is 50cm and absolute maximum reaches 82cm (Table T.3.3-05). Since surveyed area belongs to low peri -Pannonia area, snow cover is unstable, and after short period of lasting it is melting and then forming again.

According to the data given in table T.4.2-05, it has been identified that silver thaw on surveyed area appears in period from November to May, but the most often in December and January. In average it appears one day with silver thaw in the surrounding area of Doboj, while in shore area of Sava, this is an average of two days a year.

Large frequency of humidity of road surface because of precipitation belongs to significant risk factors of traffic in all seasons. Hazards are especially pronounced in the coincidence of wet road surface and other unfavorable meteorological factors such as snow cover, strong wind,

silver thaw or at least reduced visibility because of frequent mist and haze, as well as land slip and rock fall during the precipitation of strong intensity.

4.2.7 Mist appearance

Besides the impact on wind regime, local topographical conditions also contribute to appearance of mist. Therefore, there are a relatively large number of mist days, in average 78 days a year. At site of Modrica, average annual number of mist days is 37 days a year (Table T.4.2-06). Besides the relief, the rivers also have an impact on education and keeping of mist by increase of air humidity in river valleys and depression.

Table T.4.2-06: Number of mist days

METEOROLOGICAL STATION	MONTH												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Number of mist days													
Derventa	4.6	3.6	1.9	0.8	0.8	0.4	0.3	2.4	5.2	7.1	6.7	6.3	40.1
Modriča	5.8	3.9	1.6	1.0	0.3	0.3	0.2	1.1	4.1	6.2	6.9	5.6	36.9
Brčko	6.1	3.9	2.2	0.5	0.4	0.2	0.0	0.5	1.9	5.9	6.0	6.5	34.1
Doboj	7.0	5.4	4.0	2.3	3.3	2.8	3.8	8.1	12.6	13.5	8.0	7.5	78.2

4.2.8 Conclusion

According to survey results of local climate within the project of Republic of Srpska spatial plan preparation and assessment of possible regional climatic changes as reflection of global climatic changes in the following period, it can be expected a further growth of air temperature with average speed of 0.3°C per decade, reduction of annual amount of precipitation for about 15%, and larger growth of frequency and intensity of climate extremes, and especially maximum values of climatic elements in the surveyed area. In case of thermal regime and precipitation regime more detailed which is being analyzed within this impact assessment, it means that maximum air temperature will more often exceed current absolute extremes, with increased frequency of warm weather wave in summer period, while in terms of precipitation it can be expected more frequent storms with larger short-term rain intensity or even larger frequency of glaze, silver thaw, mist and other inclement weather characteristic for this region.

4.3. Geomorphologic characteristics

Designed lot of Corridor Vc from Svilaja towards south is the flat area up to Modrica (17 km) which altitude increases from around 90 m on Sava to 100 m in Odzak. Altitude gradually rises towards south-west from 105 m and on the slopes up to the site Cerik in the direction of Koliba (14 km of section) and further in the direction of Vukosavlje place it rises up to 182 m.

From Modrica (up to around 38 km) this Lot is laid out the narrow canyon of river Bosna which makes between surrounding elevated relief from Vukosavlje, Botajica, Betnje, Podnovlja and Ritesica from the left side and Brijestova, Donje Babesnice, Koprivne and Kozuhe from right bank of river Bosna. On some places, the canyon shrinks on few hundred meters. Uplifted terrain parts have corrugated and shattered forms of relief with steep slope subject to water erosion. Altitude of these surrounding terrains outside the area is in average from 200 to 350 m, with exception of individual uplifted relief parts that can be higher. Altitude in the riverbed of

Bosna it rises unstream (from lower towards upper course) and that is from 100,2 m on the bridge in Modrica to 125 m in Civcijama.

From Civcija (38 km) to the confluence of Rudanka into Bosna (between 51 and 52 m), alignment of highway passes through extended alluvial terrace of river Bosna, while surrounding part of relief is partially light merges with mentioned alluvial terrace. Slight rolling relief is characteristic for left side of the course of river Bosna in the area of Johovac, Kladara and Velke Bukovice, but as well in the area of Osjecani and Grapska from the right side. The most important water courses on the right side of this section are Lukavica and Grapska rijeka that flows into this water course, and on the left side Foca, Zarjece and Rudanka.

Further towards Dobož, river Bosna comes from the direction south-east, where makes through the narrow canyon between Kostajnica and Susnjara. The survey area is much wider and includes the hilly-mountain curve across Mala Bukovica, prisada, Ogladenovca and Omanjske. Altitude of this hilly area ranges even up to 350 m where relief is quite shattered and rolling, but relatively well covered with vegetation.

The end of highway (LOT 1 from 62 634 m) ends up in alluvial-delluvial plateau of river Usora which is tributary of Bosna. Alluvial terrace of Usora (Polje, Lug, Struke) were surrounded from the north-west plateau called Alibegovci and Debelo Brdo and from south-east Brezik.

4.4. Geological, engineering-geological and geotechnical characteristic

4.4.1. Geological terrain characteristic

Geological structure of terrain along the corridor Vc on the lot: Svilaj-Dobož, is made of Mesozoic sediments of Jurassic and cretaceous, Cenozoic, and palaeogene, Neogene's and quarter.

- **Mesozoic (Mz)**

- **Jurassic (J)**

These sediments cover the area from river Rudanka and place Mala Bukovica (on the north) to Alibegovac (at the end of corridor Vc section).

The oldest Mesozoic sediments on the subject terrain belong to the Jurassic period (J), i.e. photolytic mélangé built from sediment rocks (sandstone, shale, chert) with olistolites silicified calcium carbonate and magmatic rocks (spilits, diabase and serpentine). Spilits usually appear as pillion-lava or breccias pillion-lava. They are made of submarine effluents. Diabases appear as individualized shape. Relations of these magmatic rock masses with sediment creations of ophiolitic zone are usually tectonic where serpentine lie above or besides sediment rocks.

- **Upper cretaceous (K₂)**

These sediments form a smaller part of terrain in the surrounding area of Dobož. Upper cretaceous sediments are composed of: plate marl limestone, breccias limestone and plate dark red marl limestone.

- **Cenozoic (Kz)**

Cenozoic is made of tertiary and quarter sediments. Within formations of tertiary sediment complex, there are separated the deposits belonging to palaeogene and Neogene's. They are

found from Svilaj (on north) to Alibegovića and Karuše (on the south). Within **palaeogenic** forms, there are the sediments of Paleocene and Eocene age.

- Paleocene –lower Eocene (Pc,E)

These rocks cover a smaller part of terrain in the vicinity of Usora confluence in Bosna and around Alibegovića and Karuša. They are presented in two packages: clastic and carbonate. Clastic package is built of four lithologic components: sandstone, aleurite, shale and rarely limestone. Carbonate package is built from massive to banked limestones, aleurite and shale.

- Eocene sediments (E)

These sediments cover the west area from alignment of Corridor Vc, from Vrbovca (north) to Modrica and Jakesa (south) and the area along both bank sides of Bosna, all up to Grapske. Detail position of individual stratigraphic components of Eocene period is shown on attached maps and profiles.

They were developed in limestone-sandstone facies and facie of flysch. Lower and upper Miocene (E1 and E2) were developed in the facie of clastic-flysch development as it follows:

- E₁ - close-grained and medium-grained sandstone with grade bedding in alteration with aleurolite and rarely marls;
- E₂ – made in the facie of marl sandstone, limestone, conglomerate and sand limestone, and
- E₃. massive banked sandstone, thin-laid shale, clay marlstone and rarely conglomerate.

- Neogene's (N) is made of the sediments of Miocene and Pliocene.

Miocene (M)

Miocene sediments cover the west area from the alignment of Corridor Vc, from Svilaja (north) to Modriča and Jakeša (south) and the area along bank side of Bosna all up to Karuše. Detail position of individual stratigraphic components of Miocene is shown in attached maps and profiles.

Older Miocene complex (**M_{1,2}**) was made of conglomerates, sandstone, clay and marl.

Middle Miocene (tectonic floor - **M₂²**) appears in the facie of organogenesis (lithotomic) limestone, sandy limestone, marl of conglomerates and sandstones.

Younger Miocene complex (**M₃**) was separated in three levels: sarmat (**M₃¹**), panon (**M₃^{1,2}**) upper Miocene (**M₃²**). Deposits of sarmata were made of olitical limestone, marl clay and marlstone conglomerates and marl sandstones. Deposits of panon are composed of marl, marl limestone and sandstone, while upper Miocene was developed in the facie of marl clay, marl limestone and sandstone.

Lower Pliocene (Pl₁) and Plioquarter (Pl,Q) is located in the same area as Miocene sediments, but deposited above them.

Lower Pliocene (Pl₁) was built of quartz sand, gravel, marl, clay, sandstone and coal, while plioquarter (Pl,Q) in lithological terms is presented with iron, mostly quartz gravel which is mixed with sand and clay.

- Quarter formations (Q)

In this sediment, it was disposed around 90% of the alternative routes of highway. There were developed in wide area which is actually the flat part of Bosnian Posavina. There were presented with following genetic types:

- Terrace, lake-river (t_3) and river sediments ($t_{1,2}$),
- Sediments of facie flood (ap);
- Sediments of abandoned channel (am);
- Sedge sediments (b) and
- Formations of river channels (a).

Sediments of third river terrace are presented with poor selected mixed clay and gravel-sand material, pointing to the piedmont origin.

Sediments of second river terrace are presented with the clay, clay sand, gold slurry clays and on the depth of 8 m above clay there are gravel and sand.

First river terrace is marked with scarp formed by surecent fret of Bosna river. It dominates gravel of alluvial deposits and only partially sediments of facie.

Sediments of facie are consisted of close-grained, plastic deposits where dominate sands, silts and clayed sand. Depth doesn't exceed 5 m.

Sediments of abundant basins are consisted of silt clay and mud filled with plant residues.

Organogenic -swamp sediments are consisted of close-grained, plastic material and plant residues. It dominates dark green and dark grey clay of illitic composition, and there are also close-grained sand and small lens of close-grained gravel. Depth of these sediments doesn't exceed 2 m.

Alluvial deposits are mostly made of boulder and sandy grains of sandstone, carbonate rocks, cherk, quartzite, gabbros, split, serpentine, quartzpophyry, amphiboles and other rocks.

4.4.2. Engineering – geological characteristic

Rock mass along target alignment are of heterogeneous composition and anisotropy features. They differ regarding the engineering-geological categories, groups and units, and especially according to the structural-textured and physical-mechanical features.

In compliance with the recommended "engineering-geological classification of rocks" (according to International association for engineering geology), within target area, rock masses can be classified in lithology complexes and types as it follows:

Lithology complexes

In solid rocks with crystalline bond, and sediment chemical with alternations of mechanical and chemical deposits, the special units present the following: sandstone, shale, cherk and silficated limestone of Jurassic age; marl sandstone, limestone, conglomerate and sand limestone of middle Eocene; alevrolits and shale paleocene-eocene; marl limestone, breccias limestone and marl of upper cretaceous; limestone and dolomites of middle Triassic, and sandstone, shale, clay marlstone, conglomerate and alevrolits of lower and upper Eocene.

In the category of diagenetic soft connected masses, there are the marl clays, marl limestone, sand and sandstone, and conglomerate of upper Miocene; limestone, marl, conglomerate, sandstone, clay and sand of lower and middle Miocene and Pliocene.

In the category of loose rock masses, there are plioquartar gravel, sand and clay, gravel, silts, clay, mild clay and mud of different genetic types of quarters, and Pleistocene and Holocene.

Lithological types

In the category of rock masses with crystalline connection, there are magmatic rocks presented with spilits, diabase and serpentine. First kilometers are found on very decomposed and shattered deposits, of soft consistency and poor hardness. These are mostly squeezed materials but the terrain seems stable because of flat area.

Remaining part of the alignment is located on the sediments of river terraces. These are more moderate decomposed and shattered deposits of hard consistency and moderate hardness, stable but not squeezed. They present a favorable environment for the construction of communication.

Section from Srnava to Osjecani of upper alignments is in the terrain made of quarternary deposits. First part of alignment is on the river terrace. Engineering-geological and physical-mechanical parameters are similar in the ending part of previous section that is, in total viewing very favorable. Second part (of the length around 2km) is found on blue sediments and with smaller part on half-bog and sediments of river basin. These materials are very decomposed and shattered, soft and poor hardness and changeable, from moderate to high permeability. Half-bog creations and blue sediments are squeezed, but terrain because of flat characteristic is in total stable. Third part of alignment is on river terrace of good physical-mechanical features.

Initial part of sector Osjecani Gornji – Doboj Jug is located on flooding and river sediments. Characteristics of material that makes this part of terrain are similar to those from above mentioned. On the part of alignment along Doboj, the alignment lies on marly and breccia limestone in exchange with marlstone of upper cretaceous and middle of juristic ophiolitic mélange. Terrain next to Doboj Jug builds tectonic mélange made of serpentine and spilitic magmatic forms.

From total point of view, section within upper cretaceous and juristic forms presents the environment of poor engineering-geological characteristic and poor physical-mechanical features. It would be particularly unfavorable setting up of the tunnel with relatively small surcharge of the height less than 10 m and construction of approach cutting, cutting, side cut and foundation of the object in relatively high grades is not advisable.

Ending part of the alignment is laid on the sediments of river terrace which present favorable environment for construction.

4.4.3. Seismotectonic characteristic

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

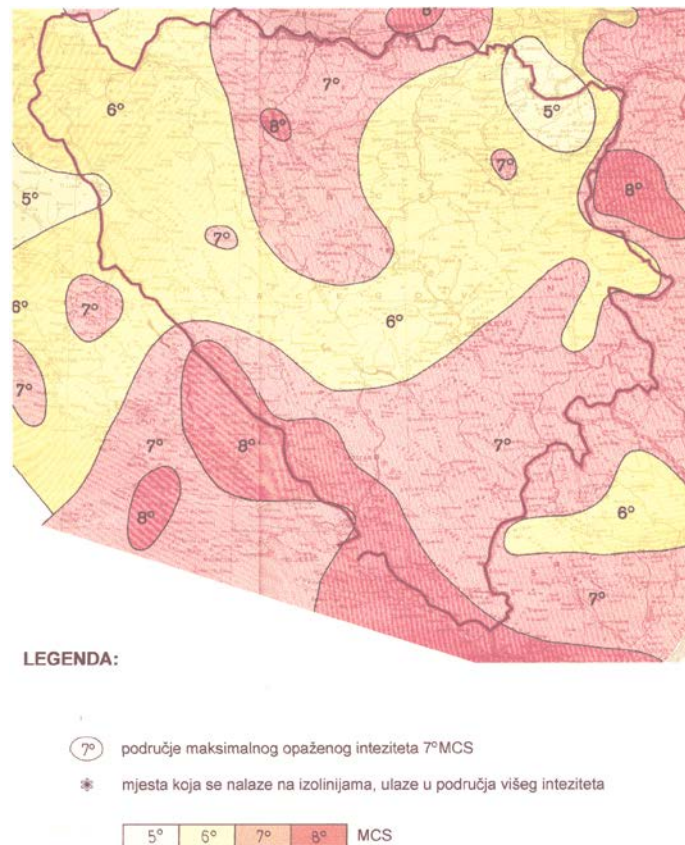
- Fault zone;

- Faulting-throw zone, and
- Faulting zone.

Within this Study, it is given only the outline of those seismic zones that cover a wide area of observed corridor and in attached map it was shown the spatial distribution of epicenter in relation to Corridor Vc.

Fault zone

Deep fractures in the earth's crust demonstrated with fault zones are the sources of tectonic impulses along which a certain block does not stay still. This happens because of thermo-dynamic processes in under-crust parts, making the blocks oscillate with different amplitudes, frequencies and intensity. Zones of deep faults at the same time present the areas of contemporary tectonic movements. Exactly in the territory of BiH, deep faults are the most frequent causes of earthquake appearance. Along corridor Vc in north Bosnia, it can be identified dominant lineaments within fault zones such as: faults of the river valleys of Sava and Bosna and Tuzla's fault.



Picture 4.4-01: Seismology map of Bosnia and Herzegovina for reverse period of 100 years

Faults of the river valleys of Sava and Bosna

This area covers the surrounding area of Bosanski Brod and Odzak, Derventa, Bosanski Samac and Modrica. In tectonic terms, this zone mostly covers 'the south Sava's fault' and deep fault

along the river valley of Bosna. Maximal intensity of the earthquake in mentioned area is VI and VII° MCS, while along the river Bosna from Svilaja to Maglaj, intensity of earthquake is VII° MCS.

It can be assumed that redistribution of stress in the zone of `Sava`s fault` is done gradually in long period, when there is no occurrence of earthquake. In terms of that, deep faults along Sava and Bosna rivers should be considered the potential seismic focus.

It is necessary to emphasize that in terms of structural-tectonic, engineering-geological and geomechanical soil characteristic, the earthquake impact on future facilities of highway can be significant one. Because of that, this area should be seismic more detailed tested especially in terms of the seismic hazard correction and in the following project phase it should be done more detail seismic regionalization.

Tuzla`s fault

This fault is laid out with gravimetric survey and registered epicenters on the lot Zvornik-Tuzla-Doboj. Indirect indicators of the existence of deep faults are also the thermal and mineral waters along this lot, and contemporary movements of Tuzla`s block on the background of ascending as well as the valley of Spreca on the background of subsidence. According to the mentioned appearances, this fault is also active in the contemporary age. However, salutation of the blocks along this fault are relatively rare, and there have not been registered the earthquakes of bigger frequency. In wider area of Doboj, it should also be done a seismic regionalization.

4.5. Hydrogeological and drainage characteristics and their hydrologic features

4.5.1. Hydrogeological characteristics

In the view of adopted alignment of highway on Corridor Vc in the LOT 1, it is possible to conclude that the surveyed area is mostly characteristic by hilly-flat relief, where the most dominant watercourse is the river Bosna with great number of tributaries (Usora, Spreca, Lukavica, Lovnica, Glogovica, Bosnica, Plavusa, Ljubioca, Botajnicka, Babesnica, Gnjonica and others) that gravitate within this river area. River Sava, in which empties the river Bosna at Bosanski Samac, marks a typical plain watercourse of wide alluvial area and makes almost complete north border towards the Republic of Croatia. On this section, as well characteristic by isometric lowest position and in the immediate proximity of settlement Svilaj, the alignment on Corridor Vc passes the mentioned watercourse and enters in the area of BiH.

On section of LOT 1, the alignment was set up along alluvion of rivers Bosna and Sava, crossing almost all above mentioned watercourses (river Bosna on many sites). On the site of Karuse settled in the proximity of the confluence of river Usora in Bosna, section of LOT 1 on the Corridor Vc ends up by crossing of this tributary after what it starts the section of LOT 2.

In terms of this linear object size, the surveyed area can not be observed as unique aquifer but as association of rocks of different hydrogeological characteristics, that reduce in geological plan and profile. In accordance with individual lithological types of variable and uneven physical-chemical features, there are more or less pronounced characteristics of permeability in the mentioned rock material, that is lithological complex of fracture, fracture-cavernous, or inter-gravel porosity.

Alignment on LOT 1, with the largest part (except of section 6) passing through alluvial area of the rivers Bosna and Sava, which can be taken as continuity of aquifer environment, both in the plan and in the profile.

According to hydrogeological features of rock material, the alignment of highway on the section of LOT 1 crossing the aquifer environment of inter-gravel and fracture-caverous porosity, where there are generally formed the aquifer with free level, of different yield that is water yield. According to the data from previously conducted hydrogeological survey and exploitation of intake structure, it is concluded that quartary (Q) alluvial water-bearers (rocks of inter-gravel porosity) exist as primary aquifer environment. Other rock complexes in the environment have the characteristic of secondary water-bearer, for water supply of less number of individual residential objects.

Characteristics of underground waters found in the alluvial terrace of the river Bosna, it is possible to pronounce through basic hydrogeological parameters. In terms of that, an average thickness of alluvial deposits on the section from Doboј to Modrica ranges from 8-15 m, transmission coefficients are from $K = 10^{-3}$ m/s to $K = 10^{-4}$ m/s, and transmissivity $T = 10^{-2}$ to 10^{-4} m²/s. Yield per one well ranges from 2 to 15 l/s, and sometimes 20 l/s. Underground water found in the alluvion of river Bosna is very significant resource of drinking water for population inhabitated along the course.

On section Modrica – Svilaj, in the corridor part in wider zone of Odzak, there is somewhat larger reservoir of underground waters found in the intergranular environment. Depth of gravel deposits in this area ranges from 50 to 100 meters. This is multiply reservoir of underground waters with differential water-bearing beds per depth. Transmission coefficient here were registered within the limits from $K = 10^{-4}$ m/s to $K = 10^{-5}$ m/s, and transmissivity from 10^{-3} to 10^{-4} m²/s. Capacity per well also oscillates from 5 to 20 l/s, depending on what water-bearing beds included. Replenishment of this aquifer is mostly done with waters of river Bosna and with smaller part, the waters of river Sava. Corridor Vc from Modrica to Svilaja crossing the central and west part of mentioned aquifer.

On few sites within alluvial sediments of rivers Bosna, Sava, and even Usora, the underground waters were used for the water supply of settlements. More relevant drinking water springs were located in the immediate surrounding of the municipalities Odžak, Modriča, LC Osječana, Doboј (Rudanka), Doboј-jug (Havdine), Tešanj (Kraševo), and Usora (Alibegovci, Matuzići, Ularice).

Taking into consideration above mentioned, there are marked the critical area on the map of limitations related to water resources (annex no: 12.3.5.) in terms of sensitivity and vulnerability of water-bearers i.e. underground waters of surveyed area. With orange hatch, it is marked the water-bearing area where the highway may be passing, but only with undertaking of all necessary measures of prevention and minimization of negative impact on underground waters, for negative impacts be prevented and completely avoided. This is particularly related to the area of protection zone of source area for public water supply in Odzak, Osjecani, Doboј, Tesanj and Usora, i.e.:

- On the section from chainage km 10+700 to km 17+000 the alignment passes through the proposed III sanitary protection zone of drinking water spring in Odzak.
- On the section from chainage on km 41+00 to 42+000 the alignment passes near to proposed sanitary protection zone of source area Bare-Osječani located on the left side of alignment in the direction of east.
- On the section from chainage na potezu od stacionaže km 49+500 do 52+000 the alignment passes in the proximity of existing zone of sanitary protection of source area of Rudanka located on the right side of alignment in the direction of west.

- On the section from chainage na potezu od stacionaže km 59+000 do 61+600 the alignment passes in immediate proximity of existing zone of sanitary protection of source area of Kraševo located on the left side in the direction of south-east, and 3 springs for water supply of the part of Usora municipality.

In relation to above mentioned facts, all characteristic places per sections of LOT 1 were marked in our survey area with eleven (11) orange spatial positions.

Outline of hydrogeological features of the terrain per sections along the alignment on LOT 1, has the aim to pay attention to specific critical sites, in which immediate or wider environment, the highway as linear object in future may cause certain, potentially negative impacts on underground waters. In terms of this, it is imposed the necessity of preventive actions, to avoid, limit, or completely eliminate unfavorable and negative sides within the phase of Preliminary design and further on in the main project. Special attention, taking into consideration the hydrogeological aspect, and aspect of endangered aquifer, has been given in terms of water resources protection as existing and potential springs in aim of water supply of population. After completion of survey works, it is needed to prepare more detailed hydrogeological map of narrow belt around the highway in M 1:5.000, and check all mentioned sensitive actions within this study.

Section 1. Svilaj – Odžak

On this section, the alignment passes through two characteristic sensitive parts. First position is the crossing of river Sava that is characteristic contact point of highway with open watercourse on entrance into BiH. Part of alignment up to chainage of km 2+925 is found in the facies of flooding.

Second sensitive part is on first and second river terrace of river Sava and river Bosna (t_1 and t_2) that present main aquifer environment from which it is performed the intake of underground water for water supply of settlement Odžak, as well as surrounding settlements that administratively belong to it. This section includes the chainage of km 2+925 to 10+890,787 that is to the end of section 1. From chainage of km 6+000 on short part it concerns third river terrace (t_3).

Section 2. Odžak – Vukosavlje

On this section, the alignment passes through two characteristic sensitive parts. First is from chainage km 10+890,787 to around 13+800, of second river terrace of river Bosna (t_2) that is natural extension of previous part from the first section, and which makes aquifer environment that is area where settled proposed sanitary protection zone of the source area of water supply in Odžak.

Second part is from chainage of around km 16+900 to 17+289,010 i.e. end of section where alignment crossing the river Bosna, that is open watercourse.

Section 3. Vukosavlje – Podnovlje

On this section, alignment passes through very sensitive area. From chainage of km 23+350 to km 28+000 alignment crossing the fret of river Bosna on three places, and then from chainage of km 29+000, it passes through alluvial sediments of river Bosnica.

Section 4. Podnovlje – Johovac

On this section, alignment passes through three characteristic sensitive sections. First section is from chainage of km 35+400 to 37+800 where the alignment passing over first river terrace of river Bosne, that potentially exists as aquifer environment. At same time, on this section alignment intersects the river Lovnica the tributary of river Bosna, on chainage of about km 37+150. Second section is from chainage of about km 38+050 to 38+175, where alignment intersects the river Bosna. On third section from chainage of km 39+800 to 40+500 alignment passing through right bank of first river terrace (t_1) of river Bosna, that is through the same sediments of chainage from km 42+250 to km 44+000. Described area on the section from the chainage of km 39+800 to km 44+000 belongs to the area of Osjecani, where it is set up the source area Bare-Osjecani, as the most sensitive area in terms of underground water protection. In the area between the chainage from km 45+800 to 46+624,139, alignment ends up in the same sediments.

Section 5. Johovac – Rudanka

On the beginning of this section, alignment passes through the section which presents the extension of previous section, where alignment intersects the river Lukavica, and the right tributary of Bosna. On the section from chainage of km 46+624,139 to 50+000 the alignment passes through long sensitive section of alluvial sediments of first river terrace of river Bosna. Here, the alignment passes on the section from chainage of km 50+000 to 51+250, in proximity of eocenic sand limestones that is not the primary aquifer environment but have the characteristic of water-bearer. On this section, the alignment passes through the right bank of river Bosna. On the section from chainage of 50+000 to 52+000 from right side of alignment and on left side of river Bosna, there is the source area of Rudanka with adopted zones sanitary protection. From chainage of about km 52+250 to 52+450 alignment intersects the river Bosna.

Section 6. Rudanka – Karuse

On chainage of about km 59+000, in the length of approx. 1, 5 km the highway passes along immediate marginal area of the source area of Krasevo, located on the left side in the direction of left side of alignment in the direction of south-east. According to the results of test drill and test patterns from previous survey it was determined different depth of alluvial-terrace deposits, as well as different taken patterns during certain reductions of water level in survey and exploitation water intake objects of source area Krasevo. These data point to uneven of filtration characteristics of water bearing gravel bedding and its different dip in the source area. According to the position of current marginal watercourse of river Usora and the source area of Krasevo, it is obvious that replenishment of alluvial terrace deposits is done in the main direction of south-west-north-east where the river Usora has dominant impact on regime of underground waters. Distance of source area from the river Usore is about 300 m, which provides the satisfactory conditions for self-treatment of recharge waters.

In immediate proximity of chainage km 59+000 the alignment approaches to fault area to the end of section 6 (chainage km 62+634,209), where it was created the contact of jurassic impermeable environment with palaeocene-eocene poor permeable limestones and alluvial sediments (first river terrace) of river Usora. On this section, the alignment creates direct contact with left bank of river Usora (the source area Makljenovac, Ularice and Alibegovci). On the right bank of river Usora there is the source area of Krasevo, also, settled in the alluvium of watercourse Usora. In terms of highway impact on underground waters, it is necessary to pay special attention to previous section, both because of described situation and because of the

proximity of source area of Makljenovac, Ularice and Alibegovci, and Kraseva for water supply of settlements in the municipalities Usora and Tešanj.

4.5.1.1. Underground water springs for water supply

In wider area along the alignment of LOT 1 there are underground waters mostly found in alluvial terraces located along the river Bosna and tributaries. Here there are emphasized the significant underground water springs for water supply of towns and villages, located along the river Bosna and its tributary Usora. From alluvion of river Bosna, it is performed the water supply of Doboj, Modrica and Odžak, then more smaller settlements such as Matuzici, Rudanka, Civcije and Kotorско, and some smaller villages located in the valley of river Bosna with less water supply demands. From alluvion of river Usora, it is performed the water supply of settlements in the municipalities Usora and Tesanj.

More important underground water springs in the public water supply system along the alignment of LOT 1 in the survey area are located in municipalities Odžak, Doboj and Tesanj.

On the map of limitations related to the water resources (Annex 12.3.5.) there are shown the sanitary protection zones of the source area in the public water supply system, and that are determined by adopted Decisions about protection of these springs. Within this context, there are shown the following:

- Sanitary protection zone of source area in Odžak – based on the Decision about sanitary protection zones and protective measures of source area in Odžak, Official Gazette of municipality Odžak, number 2/04 (section 1. Svilaj – Odžak)
- Sanitary protection zones of the source area of Rudanka-municipality Doboj- based on Decision about the protection of Rudanka source area, Official Gazette of municipality Doboj, number 9/85 (section 5. Johovac - Rudanka).
- Sanitary protection zones of the source area of Krasevo – Municipality Tesanj- based on Decision about the enforcement of spatial plan of Municipality Tesanj (section 6. Rudanka - Karuse).

During the laying of alignment, it was taken into account to avoid the source area of public water supply systems of above mentioned towns and settlements along the section LOT 1 as well as their associated water protection zone. Also, in the annex 12.3.5. there were shown the proposed sanitary protection zones of source area of waterworks in Odžak, as well as waterworks of Osječani in municipality Doboj, and that are proposed on the base of new survey works, and new valid rule books in FBiH and RS about the conditions for determination of sanitary protection zones and new valid rule books in FBiH and RS about conditions for determination of sanitary protection zones and protective measures for source area used for water supply.

In the survey area, there is a certain number of local springs not included in the public water supply system of municipalities on which territory found. These local springs were used for water supply of population in the settlements, through which area the highway passing or found in their immediate proximity. In that context, there were gathered the data about all springs from the municipalities that are further on in the below text presented per sections and marked on the map of limitations for water resources (Annex 12.3.5.) Filled questionnaires by the representatives of municipalities and waterworks along the alignment of LOT 1, were collected during the preparation of this study as well as data about quality of underground waters given in the Annex 12.2.

Section 1. Svilaj – Odzak

Springs of Odzak municipality

On chainage of the highway of km 2+000, on the right side of alignment on the distance of about 2000 m in the direction of west in the place Donji Svilaj-village Poljari, there is local well. From this well, there is water supply of 250 households. Water quality testing is done two times a year, and conducted by the Institute for public health of Tuzlanski canton and Sodaso Holding Tuzla.

On the same chainage but on the left side of alignment on the distance of about 2300 on the east in palce called Novi Grad, there is the local well. This artesian well is used for water supply, but there is no distribution system.

On chainage of the highway of km 4+000, from left side of alignment on the distance of about 2100m on the east, there is artesian well owned by enterprise Ratar. This artesian well is used for the needs of this enterprise. Dtaa about water quality from these wells have not been available.

On chainage of the highway of km 4+500, from right side of alignment on the distance of about 1400 m on the west in the place Vrbovac, there is local well. Yield of this well is about 20 l/s. There is no distribution system from this well. It was tested the water quality in 2005 year by the Institute for public health of Sarajevo Canton.

On chainage of the highway of km 9+000, from left side of alignment on the distance of about 1800 m in the direction of northwest in the town Prnjavor, there is local well. Yield of this well is about 9,5 l/s. About 250 households in the settlements Prnjavor, Lipik and Posavska Mahala are wtare supplied from this well. It was tested the water quality in 2005 year by Sodaso Holding Tuzla s.c. Institute for chemical engineering.

On chainage of the highway of km 10+500, from left side of alignment on the distance of about 2300 m in the direction of west, there is the source area in the public water supply in Odzak. Source area of waterworks in Odzak was located in the urban area of Odzak, at about 1,0 km northwest from the urban center itself. From this source area, there is water supply for population and economic and public consumers found in the narrow urban area of Odzak, and in the part of closer suburban settlements. The source area was formed in 1965 year, when it was built the first well on this site. In the following period, there were constructed three more wells on the same location and all mentioned water intake structure are as well today in use. Water from these wells has since June in 2003, been directly placed in the reservoir of water tower located in the circle of source area, and from that gravitationy distributed to the consumption area in Odzak. However, because of the presence of iron and mangan in underground water, in June of 2003 year, it was put into operation the drinking water terament unit located as well in the circle of source area. With this treatment unit, the intaken underground waters are treated before it has been completed the distribution towards consumers. This source area presents the only source of water supply for urban area of Odzak, with yield from 15 to 50 l/s of water. Source area was formed in alluvial sediments of rivers Bosna and Sava, in the area where dominates an intensive agricultural production and there is not more significant industrial activities.

Protection of the source area in Odzak is currently determined by Decision about sanitary protection zones and protective measures of source area in Odzak, made in May of 2004 year (Official Gazzette of municipality Odzak, number 2/04). However, this Decision is not completely

in accordance with Federal law on waters (Official Gazzette of FBiH, number 18/98), because the sanitary protection zones, that is protection regime of this source area has not been determined on the base of conducted survey works. From that reason, established regime of protection was evaluated as insufficient since with valid decision it is protected smaller area than the one need to be protected with valid legal regulations. For the source area in Odzak, in December of 2005 year, it was prepared the project of protection, according to the project assignment and the conditions for determination of sanitary protection zone prescribed by „Rule book about the conditions for determination of sanitary protection zones and protective measures for the source area used or planning to be used for water supply“(Off.Gazz.of FBiH no.51/02). Within this project, there were determined the proposed zones of underground waters protection, sanitary protection measures as well as pre-draft of Decision about protection of source area of waterworks in Odzak. It is about to be expected that in near future it will be adopted the Decision about source area protection in Odzak by the Federal Ministry of agriculture, water management and forestry. These proposed borders were given in the map of limitations – Annex number 12.3.5. in the scale 1: 25.000 and 1:5.000. On the section from chainage of km 10+700 to 17+000 the alignment passes through proposed III sanitary protection zone of the source area in Odzak. Data about water quality from the source area of waterworks in Odzak have been available in 2005 year.

Section 2. Odzak – Vukosavlje

Springs of Vukosavlje municipality

On chainage of the highway of km 12+000, from the right side of alignment on the distance of about 1200 m in the direction of northwest in the place Srnava, there is natural spring with pool. There is no distribution system from this spring. Data about water quality have not been available. Also, along the alignment of road on the section Srnava – Odzak there is set up few village wells from which water is not used for human`s needs. From main source area in Modricko polje except of urban area and suburban settlements of Modrica, there is water supply of urban area and suburban settlements of the municipality Vukosavlje.

Section 3. Vukosavlje – Podnovlje

Springs of Modrica municipality

Main source area for public water supply of Modrica is located in Modricko polje, and is quite far from the alignment of highway. The source area is composed of 3 bored well and total yield of source area is about 100 l/s. Control of water quality from urban waterwork is done once a week, and conducted within Regional institute of Doboj. Besides the main source area in Modricko polje, in wide survey area around the alignment of LOT 1 there is more local wells for more local waterworks, and further data about these local springs have not been available.

Section 4. Podnovlje – Johovac

Municipality Doboj

In the area between the chainage from km 41+00 to 42+000, the alignment passes in the proximity of source area of Osjecani, LC Osjecani Gornji-Municipality Doboj. The source area is set up from left side of alignment, on the east on the distance of about 1400 m from chainage of km 41+500. Local waterwork of Osjecani in municipality Doboj it was constructed with the own funds of households representatives included in this water supply system. From the source area of Bare (one dug well in first phase), there is water supply for the settlements Osjecani,

Brdjani and Covicje. Survey of source area protection of water supply system of Osjecani, municipality Doboj was prepared in January of 2005 year in accordance with Law on waters in RS (Official Gazette of RS, no: 10/98), and according to the conditions of Rule book about the measures of protection, the way of identification and maintenance of zones and appearance of sanitary protection, the area where found source area as well as water objects and waters for human's use (Official Gazette of RS, no: 7/03). Within this survey there were determined and proposed the zones of underground water protection, sanitary protection measures, as well as pre-draft of Decision about protection of source area of Bare in Osjecani. It is to be expected that in near future it will be adopted this Decision about protection of the source area of Bare in Osjecani by relevant municipal body in Doboj. These proposed borders were as well given on the map of limitations – Annex no: 12.3.5. in the scale 1: 25.000. Data about water quality from the source area of Bare-Osjecani have been available in 2005 year. Pictures from the site of source area of Osjecani were given in the annex 12.2. Within local community of Osjecani there are as well the springs Slatina, Vranjesevac, and Donja voda of small yield. .

Section 5. Johovac – Rudanka

Municipality Doboj

On the section from chainage 50+000 to 52+000 from the right side of alignment, and on the left bank of river Bosna, there is the source area of Rudanka. The source area is protected by adopted Decision about protection of the source area of Rudanka from 1985 year (Official Gazette of municipality Doboj, no: 9/85). Doboj town has the water supply from two physically separated source area that is Rudanka and Luke. Source area of Rudanka was located in the alluvion of river Bosna on its left side of bank, downstream from town Doboj. Water is supplied from eight wells of average depth of 7-11 m, and average yield of 6-10 l/s in summer period. Water from this source area is regularly controlled on wells-pumping station, sump and in the distribution system. In the area of municipality Doboj there is more local springs of smaller capacity and the ones are outside of survey zone and mostly in hilly parts of municipality. Data about water quality from the source area of Rudanka have been available in 2005 year.

Section 6. Rudanka – Karuse

Municipality Usora

Three registered springs in the municipality Usora are the part of waterwork in construction, and in future it is expected to be under authority of PCE Usora Sivša.

On chainage of km 59+000, in the area of municipality Usora in local community Makljenovac, from the left side of alignment on the distance of about 250 meters in the direction of east there is local well of yield 5 l/s constructed in period 2002-2004 year.

On chainage of about km 59+300, in the area of municipality Usora in LC Ularice, from the left side of alignment on the distance of about 10 meters in the east direction there is local well of capacity of 5 l/s constructed in 2002 year.

On chainage of about km 61+500, in the area of municipality Usora in local community Alibegovci, from the left side of alignment on the distance of 25-50 meters on the east there are two local wells of yield 10 l/s constructed in 1986 year.

From these springs it is performed the public water supply of settlements Ularice, Bejici, Makljenovac and Alibegovci in the municipality Usora. Water quality of these springs is

conducted in Health institution Tesanj. Data about water quality from the source area of Alibegovci in 2005 year have been available but only from distribution system.

In the area of municipality Usora there is small number of nonregistered local springs for water supply of some houses. It should be mentioned that in January of 2000 year, Municipal council of Usora brought the Decision about determination of urban area, land use and construction terms in the area of municipality Usora which treated the area of watercourse Usora and the source area that are in the system of public water supply in this municipality. With this Decision for the source area that are in public water supply system, it is determined narrow protective zone (30x30 m), first protective zone (from 100 m in radius of source area), second protective zone (from 200 m in radius of source area) and third protective zone (from 300 m in radius of source area), while the behaviour regimes in these zones should be determined with appropriate Decisions in accordance with law on waters.

Municipality Doboj-jug.

On chainage of km 59+200, in the area of municipality Doboj-jug in local community Matuzici, from the left side of alignment on the distance of about 2000 m on the east there is main source area of Havdine. Capacity of source area is 10-18 l/s and that is water supply for about 500 households in Matuzici. Water quality is monitored regularly and conducted in the Institute for public health of Zenicko-Dobojski canton. Data about water quality from this spring have been available in 2005 year and given in the annex 12.2.

On chainage from km 60+000 to 62+634,21 (end of section LOT 1), in the area of municipality Doboj-jug from the left side of alignment on the east on larger distance there is more local springs: Vis (yield of about 0,5 l/s), Šumska voda (yield of about 0,8 l/s), Sječa (yield of about 0,3 l/s), Breza (yield of about 0,3 l/s), Čatrlja (technical water of yield 0,2 l/s), Bukovac (yield of about 0,2 l/s), Bukvik (yield of about 0,8 l/s), Perasluka (yield of about 0,2 l/s), Dubrava and Otavica (yield of about 0,7 l/s). Data about water quality from some local springs have been available in 2005 year, and given in the annex 12.2.

Municipality Tešanj

On chainage from km 60+000 to 61+500 the highway passes through the edge area of Krasevo source area, that is located on the left side of alignment in the direction of south-east. Source area of Krasevo was formed in 1986 year for the needs of water supply of settlements Krasevo, Lepenica and Mravici, in the zone of alluvial terrace sediments, on the right bank of river Usora in the settlement Krasevo. For intake of underground waters, there were constructed three discharging wells and in 1998 year additional two wells as first phase of provision of additional water amounts. Second implementation phase of additional water provision was completed in 1999 year by the construction of drainage in length of 80 m, on which start it was constructed impregnate absorbing well. Of 5 wells that makes the source area in the alluvion of Usora, today there are 4 in operation, and one in nonoperative because of pollution. On the source area, depending on the weather situation and the level of underground waters there is capacity from 8 to 15 l/s of water.

From this source area, there is water supply for the settlements Krasevo, Lepenica and Mravici. There is totally 950 registered consumers of which 924 households (approx. 3700 inhabitants) and 26 other beneficiaries. Water quality control is done by the laboratory CE "Rad" Tesanj according to the annual plan of sampling. Supervision of bacteriological water quality on the source area of Krasevo is done by the hygienic service of Health institution Tesanj. During the drought periods, on the wells of Krasevo it is controlled the replenishment of wells to avoid

violation of natural quality of nonprocessed water and water in distribution system. Available data about water quality from this source area in 2005 year were given in the annex 12.2.

Source area of Krasevo is protected on the base of Decision about enforcement of spatial plan of Tesanj municipality in which defined sanitary protection zones of this source area. By the Law on waters of Zenicko-dobojskog canton (Official Gazette of ZE-DO canton no: 8/00) and Rule book about the conditions for determination of sanitary protection zones and protective measures for source area used or planning to be used for water supply (Official Gazette of ZE-DO canton no: 51/02, 56/04) there were set up the procedures of determination of protection zones and protective measures for the source area and for making of appropriate decisions. With mentioned laws for source area, regardless have they already identified the protection zones or not, it was planned to implement the projects of source area protection on which base the Government of Canton makes the Decision about protection of source area for water supply. Communal enterprise started, according to the mentioned law, the procedures for making of the Decision about protection of relevant source area. For the source area of Krasevo it was done the project assignment for the preparation of source area protection project that are delivered in PE for «Water area of Sava river basins» Sarajevo for the selection of contractor.

All registered springs of underground waters in the survey area and which are used for water supply of the municipalities along LOT 1 are given in the below Table 4.5-01.

Table 4.5-01. Registered springs within analysed area

Chainage of the highway	Source of water included in the public water supply system	Local source area
km 0+000,00 to km 10+890,787	Municipality Odzak - 4 wells in main water supply system of Odzak	Municipality Odzak - 1 well in LC Donji Svilaj - 2 wells in LC Novi Grad - 1 well in LC Vrbovac - 1 well in LC Prnjavor
km 10+890,787 to km 17+289,010		Municipality Vukosavlje - capture in LC Srna
km 17+289,010 to km 33+466,591	Municipality Modrica - 3 wells in main water supply system of Modrica (Modricko polje)	Municipality Modrica
km 33+466,591 to km 46+624,139		Municipality Dobo - 1 well in LC Gornji Osjecani that is included in the water supply system in this local community
km 46+624,139 to km 52+816,019	Municipality Dobo - 8 wells in main water supply system of Dobo town – source area of Rudanka	
km 52+816,019 to km 62+634,209	Municipality Usora - 1 well bunar Makljenovac - 1 well bunar Ularice - 2 wells bunara Alibegovci Municipality Dobo jug - 3 wells – source area of Havdine Municipality Tesanj - 5 wells – source area of Krašev	Municipality Dobo jug - 9 wells of less yield

Upon the above mentioned facts, it can be concluded that given alignment of the highway on section of LOT 1 on Corridor Vc passing through the future protection area of active spring of drinking water (Odzak), as well as through the area where potential pollution can in significant measure impact on quality of few springs of underground waters (Gornji Osjecani, Usora). In terms of that, it is necessary to design, construct and maintain the highway and associate structure in the way of maximally protection of the I quality class of underground waters.

4.5.2. Hydrographic characteristic

In relation to existing study degree of characteristics of individual watercourses, there are the most of data for the river Bosna, which is the main watercourse in the analyzed area. Used data that are presented within this study were taken from the study "Highway on Corridor Vc – Technical study, February 2005 and Preliminary design", Book IV – Textual part, October 2005. year, „Framework water management bases of BiH", 1994. year. And „Preliminary hydrologic basement for the project Highway on corridor Vc", February in 2005 year.

Main watercourse in the surveyed area is the river Sava and Bosna with its smaller and larger tributaries: Spreča and Usora as larger tributaries and other tributaries, streams and channels (Srnotača, Kamenica, Kosjerača, Jošava, Gnojnica, Duša, Babešnica, Ljubioča, Bosnica, Plavuša, Glovnica, Ljuteš, Lovnica, Foča, Lučir, Pećinac, Popovac, and Rudanka).

In relation to current level of analyzed characteristics of individual watercourses, there are the most data for the river Sava, and Bosna and its main tributary Spreča (though the corridor is not in direct contact with the river Spreča) and Usora.

The river Bosna is the biggest right tributary of the river Sava in the territory of Bosnia and Herzegovina and it belongs to catchments area of the river Sava. The spring of the river Bosna is strong karsts spring located in the plinth of Igman Mountain, near Sarajevo town. River basin of Bosna has the surface of 10.460 km². It covers a central part of Bosnia and makes approximately fifth of total area of Bosnia and Herzegovina. It borders on the following river basins of: river Vrbas on west, river Drina on east, river Neretva on south and river Sava on north. The length of natural watercourse of river Bosnia is 275,5 km. Middle altitude of the catchments is 640 m, the spring of river Bosnia is 491,67 m, and confluence of the river is 77,73 m. Total difference in elevation of watercourse is 413,94 m, while middle grade is 0,0015. In upper course the river Bosna passes through Sarajevsko, Visočko, Kakanjsko and Zeničko fields. In the middle course, it penetrates through the gorges cut in solid rocks, and in lower course, from Doboј to confluence it flows through instable river bed through alluvial plain where makes anabranches and river islands and empties in the river Sava at Samac and belongs to Black Sea catchment.

Basically, it can be said that along the analyzed section of the corridor Vc mostly sited in the valley of the river Bosna, there is quite surface drainage pattern. Besides the river Bosna, it is also important to mention its main tributaries: the river Usora, the river Spreča, the river Rudanka and the river Lukavica, and line of small streams and rivulets which size of the catchments is from 1 up to 20 km². Density of the river network, expressed as ratio of all watercourses length and surface on which they are located, totally for the river basin of Bosna ranges around 0,35 km/km². Mentioned data points to existence of developed network of watercourses as well in the zone of corridor Vc. Water regime of the river Bosnia is pluvial-snow with high waters in spring made with snow melting, and somewhat lower autumn discharges as result of more intensive precipitations and low summer and winter discharges.

When it is defined a possible negative impact of the highway on surface waters, and their regime and quality, it is necessary to know basic characteristic of those watercourses.

Main watercourse of the river Bosna in its lower course flows through analyzed section on the lot from Doboj to Modriča, in the length of around 45 km. Increment of the catchments area on mentioned section is around 4.500 km². Average discharge on this section increases from $Q_{sr} = 118 \text{ m}^3/\text{s}$ directly upstream from Doboj to $Q_{sr} = 161 \text{ m}^3/\text{s}$ on profile of Modriča.

The biggest tributaries of the river Bosne on analyzed section are the following: the river Usora with catchments area on confluence from 848 km² and average discharge from $Q_{sr} = 17 \text{ m}^3/\text{s}$, then the river Spreča which catchments surface on confluence is 1.944 km², and middle discharge is $Q_{sr} = 23,9 \text{ m}^3/\text{s}$.

4.5.2.1. Outline of watercourses crossing the alignment of highway

For the purpose of definition of possible negative impacts of highway on surface waters that is on their regime of flowing and quality there are presented the watercourses as part of drainage pattern and located in the zone of highway alignment passage. Outline of watercourses is given per sections of LOT 1. Having in mind that there have not been available the final designs on the level of Preliminary design about flow control and the objects on the alignment of highway to the main designers of study, the below cited data are related to assessment in accordance with work version of Preliminary design. Pictures of the watercourses that are intersected or found in their immediate proximity by highway alignment, were presented in the Annex 12.2.

Section 1. Svilaj – Odzak

Start of section LOT 1 is characteristic by the crossing of alignment across the watercourse of Sava by bridge. On the chainage from km 0+300 to 1+400 the alignment intersects on two places, the temporary watercourse. On chainage of about km 1+500, the alignment intersects temporary watercourse of Srnotaca. On chainage of about km 2+400, the alignment intersects temporary watercourse. On chainage of about km 5+000 the alignment intersects temporary watercourse of Kosjerača. On chainage of about km 7+800 the alignment intersects temporary watercourse of Kamenica, and on about km 8+200 Josavu.

Section 2. Odzak – Vukosavlje

On chainage of about km 13+900 the alignment intersects temporary watercourse of Gnionica. On chainage of about km 14+400 the alignment intersects temporary watercourse. On chainage of about km 16+600 the alignment intersects watercourse of Rijeka, the left tributary of river Bosna. On chainage of about km 16+800 to 17+289,010 the alignment crosses the river Bosna.

Section 3. Vukosavlje – Podnovlje

On chainage of about km 17+600 the alignment intersects the river Dusa. On chainage of about km 19+600 the alignment intersects temporary watercourse of Dubokovac, and on about of km 20+150 the alignment intersects the river Babesnica. On chainage from about km 23+400 to 24+200 the alignment intersects the river Bosna. On chainage of about km 25+200 the alignment intersects permanent watercourse. On chainage of about km 27+000 the alignment intersects temporary watercourse. From chainage km 27+100 to 28+000 the alignment intersects river Bosna on two sites. On chainage of about km 28+150 the alignment intersects temporary watercourse. On chainage of about km 30+600 the alignment intersects temporary watercourse. From the chainage of km 31+000 to 32+000 the alignment intersects on two places the permanent watercourse. On chainage of about km 32+300 the alignment intersects the river Glogovica.

Section 4. Podnovlje – Johovac

On chainage of about km 33+600 the alignment intersects temporary watercourse of Mrki potok, and on the chainage of about km 35+400 the alignment intersects temporary watercourse of Ljutes. On chainage of about km 37+200 the alignment intersects the river Lovnica. On chainage of about km 38+050 to 38+180 the alignment intersects the river Bosna. On chainage of about km 40+050 the alignment intersects temporary watercourse, and on about km 40+500 the alignment intersects river Dijelovaca. On chainage of about km 41+350, on km 42+150 and on km 44+050 the alignment intersects temporary watercourse. On the section from km 45+000 to 46+000 the alignment intersects on three places the temporary watercourse.

Section 5. Johovac – Rudanka

On chainage of about km 46+850 the alignment intersects the river Lukavica. On chainage of about km 47+600 and 48+400 the alignment intersects temporary watercourse. On chainage of about km 49+000 the alignment intersects permanent watercourse of Grapska rijeka. On chainage of about km 50+050 the alignment intersects temporary watercourse. From chainage of about km 52+250 to 52+450 the alignment intersects the river Bosna.

Section 6. Rudanka – Karuše

On chainage of about km 53+300, 54+000, 55+700, 56+300, 56+750, 57+600 the alignment intersects temporary watercourses. On chainage of about km 59+050 the alignment intersects the permanent watercourse of Duboki potok. On chainage of about km 60+450 the alignment intersects temporary watercourse of Alibegovacka rijeka. From chainage of about km 61+700 to 62+500 alignment intersects the river Usora.

For all smaller watercourses there were designed the culverts of dimensions $\varnothing 100 - \varnothing 400$ in the way not to change the regime of surface waters, that is to provide adequate passage of these waters through the road base. Larger watercourses are crossed by the bridges with respect of minimum superelevation above the level of high water.

4.5.3. Hydrologic characteristic

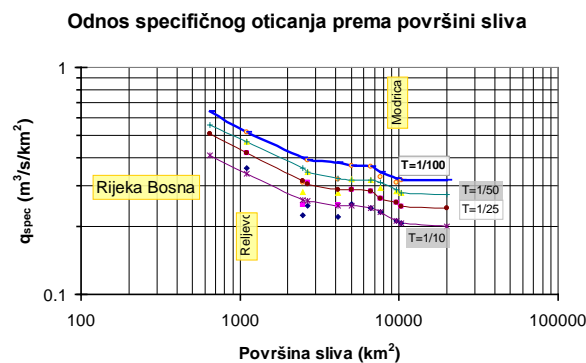
River Bosna with its larger and smaller tributaries is the main watercourse in the survey area. Basic hydrologic parameters that quantify the hydrologic characteristics of river Bosna along the course and its main tributaries were given in the Table 4.5-02.

Table 4.5-02. Main hydrologic characteristics of river Bosna along the section and its main tributaries

Watercourse	Annual Monitoring line.	Water gauge station	Flood flow appearance range (m ³ /s)				Catchments surface up to the water gauge station. F(km ²)	Coefficient of discharge. 100 ann. range appearances (m ³ /s/km ²)
			10	25	50	100		
Bosna	50	Reljevo	400	465	520	560	1104	0,507
Bosna	50	Visoko	551	642	704	762	2486	0,306
Bosna	24	Dobrinja	660	810	920	1040	2663	0,390
Bosna	49	Zenica	880	1062	1190	1330	4124	0,322
Bosna	28	Zavidovići	1260	1500	1690	1870	5033	0,371

Bosna	33	Maglaj	1623	1975	2220	2442	6619	0,369
Bosna	40	Usora	1754	2005	2250	2623	7672	0,317
Bosna	53	Doboj	2008	2430	2720	3008	9618	0,313
Bosna	43	Modriča	2150	2500	2900	3300	10308	0,320
Tributaries of the river Bosna								
Watercourse	Annual Monitoring line.	Water gauge station	Flood flow of appearance range (m ³ /s)				Catchment surface up to the water gauge station F(km ²)	Coefficient of discharge. 100 ann.range appearances (m ³ /s/km ²)
			10	25	50	100		
Zujevina		Blažuj	72	92	106	120	172	0,698
Fojnica		Visoko	218	272	310	361	721	0,501
Krivaja	29	Zavidovići	703	858	1020	1176	1387	0,848
Spreča	18	Stanić rijeka	315	380	430	490	1932	0,253
Usora	20	Karuše	429	495	608	681	847	0,804
Lašva	30	Merdani	187	290	391	466	949	0,491
Lepenica	24	Homoljska ćuprija	80	114	140	176	177	0,994

On the base of data presented in the Table 4.5-02, it was made the relation of impermeability factor and the surface of the river basin along the river Bosna. Data about impermeability factor of the high tide from selected water gauge, determined by statistical analysis of available line of discharge, were used for the establishment of the relation of impermeability factor and the surface of associate catchment for the data of water gauge stations (Picture 1.) Such established relation provides that for any profile on the river Bosna (with familiar surface of the catchment), is determined the appropriate size of maximum discharge. Relation of impermeability factor and the surface of catchment was shown on the Picture 4.5-01.



Picture 4.5-01: Relation of impermeability factor according to the surface of catchment

In the Table 4.5-03, there were presented the results used for hydraulic model of the estimate of flood line of the watrecourse along the highway alignment of Vc. There were defined the flooding zones along LOT 1 and given in the Annex 12.3.6 In the same annex, there were marks as well hydroelectric plants on the river Bosna and Usora, and according to available planning documentation.

Table 4.5-03. Summary of the flood flow quota on analyzed water gauge stations

Water gauge station	Quota «0» of water gauge	Discharge Q_{100} (m ³ /s)	Water level at appearance of v.v. certain range of appearance of H (m.n.m.)			
			10	25	50	100
Visoko	411.97	994	415.27	415.83	415.97	416.41
Dobrinja	392.04	1044	395.34	396.29	396.64	397.14
Zenica	311.05	1546	314.67	315.00	315.37	315.59
Zavidovići	200.71	1862	206.11	206.56	206.96	206.48
Maglaj	168.92	2416	172.9	173.5	173.94	174.42
Usora	140.16	2685	145.61	146.06	146.66	147.06
Doboj	137.01	3097	141.50	141.93	142.05	142.51

4.5.4. Quality of surface and underground waters

Within this item, it will be presented the `zero` (initial) condition of surface and underground waters quality along the section of LOT 1 of highway on Corridor Vc. The subjects of consideration are the surface watercourses that with their course normally flowing besides the adopted alignment of highway, or the alignment crossing them. On the section of LOT 1 the focus was given on the river Bosna and its larger tributaries.

In terms of underground waters, the focus will be given on those springs of underground water that are involved and used in the public water supply systems, as well as on those springs of local character that are found in our research scope.

4.5.4.1. Quality of surface waters

Pollution of watercourses is very complex and dynamical process depending on different factors in the first line of amount and type of polluters and reception ability of the watercourses. From these reasons it is difficult to give real estimate of quality without systematic observation of waters that is long-term continuative sampling and testing.

Quality of surface waters in the area of alignment zone of the highway will be shown through two periods:

- Period up to 1992 year – historical data and
- Period from 1992 to 2005 year.

Such approach is conditioned by the fact that in period up to 1992 year it was systematic monitoring of surface watercourses in BiH. In period from 1992 to 2000 it was not the continuous monitoring of water quality. From 2000 year it has started the monitoring of surface water quality in Republic of Srpska.

*Historical data about quality of surface waters within the area of section of **LOT 1***

The control of surface watercourses quality was carried out systematically on the river Bosna and its tributaries by 1992 year. In the area of the section of the corridor Vc (LOT-1) quality of the surface waters was monitored on the river Bosna, the river Usora and the river Spreča. On the river Bosna, along the surveyed section the quality was monitored on the profile of Maglaj downstream, Doboj downstream from the confluence of Usora, downstream from Doboj and downstream from Modriča. Besides that, it was also monitored the quality on the tributaries of Usora-confluence and Spreča confluence.

According to the Regulation about the water classification and the waters of coastal sea of Yugoslavia in the borders of FR BiH (Official Gazette of FR BiH, number 19/80), there were also prescribed the classes of the Bosnia watercourses and its tributaries of Usora and Spreca which was obligatory to keep on that level. According to the mentioned classification along the surveyed section, the river Bosna should be kept on the level of three classes, as well as its tributary Spreca. Only the bonity of Usora was prescribed on the level of 2 classes. Control of maintenance the prescribed the class of water courses in BiH by 1992 year, was carried out the Republic Hydro meteorological Institute from Sarajevo. The control was based on the random water samples. There were performed the physical-chemical, bacteriological and hydro biological analyses. Within the physical-chemical analyses, there were analyzed the temperature, appearance, pH value, alkalinity, dissolved oxygen, saturated oxygen, total compact substances, consumption of KMnO₄, orthophosphate and total iron, and azotes compound only on selected profiles. Hard metals were analyzed only temporarily and by the technique which provided only general introduction but not reliable concentrations characteristic for the watercourse.

As illustration of the condition of the water quality of surface watercourses in this area by 1992 year, in below table. T.4.5-04 the summary of determined and prescribed class of watercourses on the profiles along the river Bosna in the intake area of the corridor Vc (LOT1). Estimate of the condition of prescribed and determined class of watercourses was done on the base of analyses data during 1985, 1986, 1987, 1988. and 1989 years. Basic indicators of the quality on which was carried out the mentioned analysis are the following: dissolved oxygen, suspended matters, consumption of KMnO₄, biological consumption of oxygen (BPK₅), content of iron, bacteriological pollution and the presence of micronutrients, For general estimate of the quality it was used the saporbological water analysis.

Table T.4.5-04: Summary of the prescribed and found class of watercourses in the survey period 1985.-1989. year⁹

River	Profile	Prescribed class	Determined class of watercourses					It fulfills the class YES/NO
			1985.	1986.	1987.	1988.	1989.	
Bosna	Downstream from Maglaj	3	4-VK	VK	4	4	3-4	NE
Bosna	Doboj downstream from Usore	3	4-VK	4	3-4	3	3-4	NE
Bosna	Downstream from Doboj	3	4-VK	4-VK	4-VK	3-4	4	NE
Bosna	Downstream from Modriča	3	4-VK	4	VK	3	3-4	NE
Usora	Confluence	2	2-3	2	2	3	2-3	NE
Spreča	Confluence	3	VK	VK	VK	VK	VK	NE

From above table, it is clear what condition was in period by 1989 year, when in the catchments of the river Bosna worked the most of installed industrial drives. Water quality of the watercourse was in the largest part much worse than prescribed one. On some sections, it was marked complete destruction of water quality. In the table T.4.5-05 there were presented the survey results in one series on analyzed profiles of the river Bosna during 1988 year while in the

⁹ VK – out the class

Table 4.5-06. there were presented the microbiological parameters of water quality on the same profiles during the same year.

Table T.4.5-05: Results of the analysis of the physical-chemical parameters of water quality (1988. year)

Parameter	MDK	Bosna Doboj upstream.	Bosna Doboj downstream	Usora (confluence) Doboj	Spreča (confluence) Doboj	Bosna Modriča
Data (1988.)		August	August	August	August	August
Time of sampling (h)		09: 05	07:40	09:30	09:15	08:10
Water level (H cm)		36	-120	58	75	0
Discharge (Q m ³ /s)		21,5	34,4	6,8	4,3	30,0
Water temperature (°C)		26,0	23,4	21,6	23,0	25,0
Air temperature (°C)		24,0	16,5	21,0	21,0	24,0
pH value	6,0-9,0	7,90	7,65	8,20	7,30	7,55
Electric conductance (\square S/cm)		470	1500	380	8500	1460
Visible color	Poor visible	have	have	have	have	have
Visible waste matters	Without	have	have	have	have	have
Odor	Poor visible	have	have	have	have	have
Alkalinity p (mg CaCO ₃ /l)		-	-	-	-	-
Alkalinity m (mg CaCO ₃ /l)		135	122	185	120	124
HPK –from consumption of KMnO ₄ (mg O ₂ /l)	20	12,90	10,90	5,00	46,00	9,70
HPK – from consumption of dichromates (mg O ₂ /l)		32,0	31,44	-	80,00	12,00
Dissolved oxygen (mg/l)		3,80	3,10	9,0	3,40	5,20
Saturation of oxygen (%)		48	37	105	41	64
BPK ₅ (mg O ₂ /l)		4,80	1,10	3,00	9,07	6,50
Nitrite (mg N/l)	0,5	0,18	-	-	-	0,48
Nitrate (mg N/l)	15,0	1,76	-	-	-	1,10
Ammonium ion (mg N/l)	0,5	0,010	-	-	-	0,39
Total evaporated residue dried (mg/l)	1500	323	1260	235	4666	1001
Total evaporated residue calcinated (mg/l)		-	-	-	-	-
Loss with calcinations		-	-	-	-	-
Total suspended matters (mg/l)	80	34	10	18	46	25
Total hardness (mg CaCO ₃ /l)		208	564	168	1730	416
Calcium (mg/l)		63,7	155,1	43,3	638,9	155,5
Magnesium (mg/l)		11,8	42,5	14,4	32,6	6,7
Total phosphates (mg/l)		0,006	0,006	0,006	0,006	0,006
Total Kjeldahl azote (mg N/l)		-	-	-	-	-
Iron (mg/l)		0,29	0,17	0,69	0,40	0,09
Zinc (mg/l)	1,0	0,006	-	-	0,011	0,005
Copper (mg/l)	0,1	0,005	-	-	0,007	0,003
Chromium (ng/l)	100,0	17,0	-	-	28,0	22,0
Nickel (ng/l)	100,0	0,00	-	-	1230,0	0,00
Cadmium (ng/l)	10,0	0,00	-	-	11,0	0,00

Table T.4.5-06: Results of the analysis of microbiological parameters of water quality (1988. year)

Profile	Total number of bacteria in 1 ml (22 °C)	Total number of bacteria in 1 ml (37 °C)	NBK of coliphorm bacteria in 100 ml	NBK of fecal colli in 100 ml	Determined class according to	Determined class according to Khol
Doboj downstream	-	-	6,7	-	IV	-
Doboj upstream	-	-	6,7	-	IV	-
Usora Doboj	-	-	4,4	-	II	-
Spreča Doboj	-	-	4,4	-	IV	-
Bosna Modriča	-	-	6,7	-	IV	-

Current (zero) condition of surface waters quality within the zone of section LOT 1

In current circumstances, because of the seizure of the work of installed industrial facilities the environment condition is much better. Currently in the catchments of the river Bosna, polluters worked with significantly reduced capacity. Namely, during the war from 1992 to 1995 year, the largest polluters in the catchments stopped the work. Before of all, it is necessary to mention metal processing, leather and paper industry. Currently, those facilities are partially reconstructed and working with 10-15 % of pre-war capacity. Chemical industry, located in the catchment of the river Spreče, also either stopped the work or it is reconstructed and working with the similar level of production as the metal industry.

During the preparation of this study, Investor of overall project assumed the attitude that `zero` condition of surface and underground water quality is presented on the base of existing data gathered in relevant institutions of water sector, as well as in the waterworks enterprises. All eventual additional data about water quality, and in aim of determination of `zero` condition, are foreseen in the following phases with obligation of future investor, that is contractor to implement them before any construction works.

Current condition of surface water quality will be presented with data received within regular monitoring of surface water quality in Republic of Srpska, and funded by Directorate for waters of republic of Srpska. Monitoring of surface water quality is continuously conducted from 2000 year.

Profiles on which tested the water quality of river Bosna and the tributaries, and which are interested for our consideration are the following:

Bosna – profile B-12 - Doboj, upstream from confluence of Usora
 Bosna – profile B-12`-Doboj, downstream from confluence of Spreca
 Bosna – profile B-13 – downstream from Modrica
 Usora – profile of Us-1-confluence of Usora in Bosna
 Spreca – profile Sp-2 – confluence of Spreca in Bosna

In Table 4.5-07, there are data about water quality of river Bosna and the tributaries on mentioned profiles during 2000 year while they are in the table 4.5-08 there are presented the microbiological parameters of water quality on the same profiles during the same year.

Table T.4.5-07. Results of the analysis of physical-chemical parameters of water quality (2000 year)

Parameter	MDK	Bosna Doboj upstream.	Bosna Doboj downstre am.	Usora (confluen ce) Doboj	Spreča (conflue nce) Doboj	Bosna Modriča
Data (2000.)		August	August	August	August	August
Time of sampling (h)		09:20	19:00	11:40	12:50	12:45
Water level (H cm)		-	-132	-10	-	-6
Discharge (Q m ³ /s)		-	-	-	-	-
Water temperature (°C)		25,2	26,9	28	24,6	26,8
Air temperature (°C)		26	27	31	30	27,5
pH value	6,0 - 9,0	8,64	8,78	8,55	7,98	8,59
Electric conductance (\square S/cm)		383	942	267	2510	861
Visible color	Poor visible	without	without	without	without	without
Visible waste matters	without	without	without	foam	without	foam
Odour	Poor visible	without	poor	without	without	without
Alkalinity p (mg CaCO ₃ /l)		15,0	25,0	12,5	0,00	18,5
Alkalinity m (mg CaCO ₃ /l)		165	175	145	187,5	172
Consumption of KMnO ₄ (mg/l)		10,8	15,8	16,1	20,2	14,7
HPK (mg O ₂ /l iz KMnO ₄)	20	2,73	4,00	4,08	5,11	3,72
Dissolved oxygen (mg/l)		10,3	13,0	11,2	10,5	12,3
Saturation of oxygen (%)		127	165	145	127	156
BPK ₅ (mg O ₂ /l)		3,4	5,9	4,9	10,8	4,0
Nitrite (mg N/l)	0,5	0,015	0,12	0,007	0,48	0,068
Nitrate (mg N/l)	15,0	0,50	1,18	<0,05	3,50	1,07
Ammonium ion (mg N/l)	0,5	0,08	0,10	0,16	1,00	0,09
Total evaporated residue dried (mg/l)	1500	285	656	228	1690	626
Total evaporated residue calcinated (mg/l)		184	471	122	1471	431
Loss with calcination		101	185	106	219	195
Total suspended matters (mg/l)	80	2,7	1,8	2,0	4,0	7,4
Total hardness (mg CaCO ₃ /l)		205	246	149	384	242
Calcium (mg/l)		34,5	51,80	51,80	67,50	59,60
Magnesium (mg/l)		9,00	23,61	15,30	62,01	27,30
Total phosphates (mg/l)		0,22	0,20	0,05	0,168	0,136
Total Kjeldahl azote (mg N/l)		0,34	1,37	1,00	0,28	0,50
Iron (mg/l)		0,15	0,12	0,09	0,09	0,10
Zinc (mg/l)	1,0	0,03	0,02	0,05	0,03	0,04
Copper (mg/l)	0,1	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02
Chromium (ng/l)	100,0	< 2,0	< 2,0	2,5	< 2,0	3,0
Nickel (ng/l)	100,0	< 10,0	50,0	< 10,0	< 10,0	12,0
Cadmium (ng/l)	10,0	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2

Table T.4.5-08: Results of the analysis of physical-chemical parameters of water quality (2000. year.)

Profile	Total number of bacteria in 1 ml (22 °C)	Total number of bacteria in 1 ml (37 °C)	NBK of coliphorm bacteria in 100 ml	NBK of fecal colli in 100 ml	Determine d class according to	Determine d class according to Khol
Doboj downstream	400	150	880	380	II	I-II
Doboj upstream	200	100	1500	880	II	I-II
Usora Doboj	6000	5000	12000	3800	II	II
Spreča Doboj	1000	1000	380	380	II	I-II
Bosna Modriča	300	100	3800	500	II	I-II

According to the quality analysis data from 2000 year (Table T.4.5-07 and the table T.4.5.-08), it can be given the general estimate that this quality is certainly much better than the prewar one, and the quality of the surface waters is still within the limits of prescribed class for analyzed section . Results of bacteriological analysis of the samples from the river Bosna and selected tributaries refer to the conclusion that the analysed water fulfills the limiting values prescribed for II class of water. In the tables 4.5-09 there are the data about water quality of river Bosna and its tributaries on mentioned profiles during 2004 year.

According to the analysis of RS surface waters quality during 2004 and 2005 (Table T.4.5-10. and 4.5-11), it can be said that trend of surface water quality hasn't been changed significantly comparing to the one recorded in 2000 year. Water quality of the river Bosna and its tributaries Usora and Spreča fulfills the legally prescribed III category of the watercourses and within most parameters also II category of the watercourse.

Table T.4.5-09: Results of the analysis of the physical-chemical parameters of the water quality (2004. year.)

Parameter	MDK	Bosna Doboj upstream.	Bosna Doboj downstream.	Usora (confluence) Doboj	Spreča (confluence) Doboj	Bosna Modriča
Date (September 2004.)		14.09.	14.09.	14.09.	14.09.	16.09.
Water level (cm)		665	-128	-6	235	-2
Discharge (m ³ /sek)		23	33	1,9	7,7	41
Water temperature (°C)		21,5	21,1	22,4	20,1	19,3
Air temperature (°C)		25,0	24,0	24,0	25,0	16,0
pH value	6,0 - 9,0	8,58	7,92	8,53	8,12	7,98
Elect.conductance (μS/cm)		407	539	325	2510	852
Total alkalinity CaCO ₃ (mg/l)		225	190	170	153	195
Consumption of KMnO ₄ (mg/l)		10,1	21,1	9,3	18,0	12,3
HPK (mg O ₂ /l from KMnO ₄)	20	2,6	5,3	2,4	4,5	3,1
HPK (mg O ₂ /l from dihydromata)		8,0	18,0	10,0	42	20,0
Dissolved oxygen (mg/l)	>4	12,48	11,19	13,55	11,32	9,08
Saturated oxygen (%)	50 - 75	130,8	127,3	158	126,4	98,7
BPK ₅ (mg/l)	6	4,2	10,2	3,3	3,1	3,9

Nitrite (mg/l)	0,5	0,015	0,029	0,006	0,047	0,015
Nitrate (mg/l)	15,0	0,89	0,82	0,14	1,36	0,84
Ammonium ion (mg/l)	0,5	0,05	0,15	0,16	0,14	0,08
Tot.dried residue (mg/l)	1500	378	489	362	532	1727
Total calcanated resid. (mg/l)		212	254	255	349	1487
Loss with calcination		166	235	107	183	240
Total suspended matters (mg/l)	80	8,0	17,8	5,0	7,5	4,5
Total hardness (mg CaCO ₃ /l)		206	228	166	338	252
Calcium (mg/l)		56,5	58,8	41,1	87,6	72,1
Magnesium (mg/l)		15,9	19,9	15,4	29,1	17,1
Total phosphates (mg/l)		0,204	0,356	0,042	0,196	0,154
Total Kjeldahl azote (mg N/l)		0,144	0,259	0,028	0,162	0,108
Iron (mg/l)		0,94	1,74	0,28	2,41	0,50
Zinc (mg/l)		0,04	0,08	0,05	0,09	0,06
Copper (mg/l)		0,13	0,43	0,05	0,13	0,13
Chromium (ng/l)	1,0	0,00	0,00	0,00	0,00	0,00
Nickel (ng/l)	0,1	0,00	0,00	0,00	0,00	0,00
Cadmium (ng/l)	100,0	<1.00	<1.00	<1.00	<1.00	2,00
Niki ng/l	100,0	<10.0	<10.0	<10.0	<10.0	<10.0
Cadmium ng/l	10,0	<0.5	<0.5	<0.5	<0.5	<0.5

It is not realistic to expect that previous industrial plants within the catchments of the river Bosna will be reconstructed for certain period of time, which in that case could endanger the quality of the river waters up to the registered level before 1992 year. It is more realistic view that the volume and structure of industry in the catchments will significantly be changed and reduced, so the water quality of the river Bosna will remain within the limits of prescribed class or even better.

Table 4.5.10. Results of the analysis of the physical-chemical parameters of the water quality (2005. year.)

Parameter	MDK	Bosna Doboj upstream				Bosna Doboj downstream				Usora (confluence) Doboj			
Date (2005.)		07.06.05.	27.07.05	06.09.05.	11.10.05.	07.06.05.	27.07.05	06.09.05.	11.10.05.	07.06.05.	27.07.05	06.09.05.	11.10.05.
Water temperature (°C)		17,6	24	20,05	13,5	18,2	24,6	20,4	13,8	20,4	26	19,6	12,4
Air temperature (°C)		22	29	26	9	19	34	26	9	22	29	24	8
pH value	6,0 - 9,0	8,33	7,55	7,65	7,73	8,34	7,65	7,16	7,42	8,52	7,75	7,86	7,47
Elect.conductance (μS/cm)		398	405	407	395	421	410	428	401	323	323	297	295
Total alkalinity CaCO ₃ (mg/l)		175	167,5	200	180	200	200	187	185	358	170	150	150
Consumption of KMnO ₄ (mg/l)		10,27	10,59	9,98	10,9	14,86	14,7	16,5	15,9	8,85	7,43	7,17	10
HPK (mg O ₂ /l from KMnO ₄)	20	2,6	2,7	2,52	2,7	3,8	3,76	4,17	4	2,2	1,9	1,94	2,5
HPK (mg O ₂ /l from dichromata)		6	4	5	<5	10	12	16	30	30	6	5	10
Dissolved oxygen (mg/l)	>4	8,95	7,29	8,25	7,34	8,28	7,08	7,23	7,13	9,8	9,33	10,32	7,55
Saturated oxygen (%)	50 - 75	93,8	87	93,2	71,8	88,2	85,8	81,6	70,3	106,8	116,9	116	71,6
BPK ₅ (mg/l)	6	1,9	1,4	1,51	1,79	6,3	7,1	11,98	11,8	1,5	1,5	1,28	1
Nitrite (mg/l)	0,5	0,029	0,024	0,016	0,038	0,032	0,03	0,029	0,037	0,016	0,013	0,012	0,018
Nitrate (mg/l)	15,0	1,16	1,095	0,19	1,045	1,06	0,985	1,055	0,87	0,76	0,495	0,4	0,475
Ammonium ion (mg/l)	0,5	0,03	0,074	0,007	0,004	0,44	0,414	0,62	0,755	0,15	0,077	0,076	0,032
Tot.dried residue (mg/l)	1500	384	379	432	251	397	457	392	242	369	266	398	276
Total calcanated resid. (mg/l)		163	168	175	121	189	275	264	156	136	127	209	146
Loss with calcination		221	211	257	130	208	182	128	86	233	139	189	130
Total suspended matters (mg/l)	80	24,25	33,2	45,25	20	27,75	29,5	55,5	16,3	5,25	5,5	6,75	<1,0
Total hardness (mg CaCO ₃ /l)		193	220	191	203	238	224	206	206	213	210	157	190
Calcium (mg/l)		57,35	65,6	62	58,7	72,5	68	63,4	59,1	51,1	48,8	46,7	41,4
Magnesium (mg/l)		12,3	13,7	8,9	13,7	46,7	13,9	11,6	14,2	20,8	21,5	9,8	12,2
Total phosphates (mg/l)		0,094	0,13	0,17	0,178	0,262	0,234	0,274	0,276	0,056	0,048	0,042	0,32
Orthophosphate (mg/l)		0,25	0,099	0,123	0,091	0,168	0,173	0,173	0,15	0,033	0,013	0,015	0,041
Total Kjeldahl azote (mg N/l)		<0,001	0,42	0,17	2,02	0,06	1,29	1,79	4,06	0,08	0,25	1,76	3,33
Mangan (mg/l)		<0,004	0,005	0,005	0,005	<0,001	0,006	0,006	0,006	<0,001	0,004	0,004	0,004
Iron (mg/l)		<0,002	<0,004	<0,004	<0,004	<0,004	<0,004	<0,004	<0,004	<0,004	<0,004	<0,004	<0,004
Copper (mg/l)	0.1	<0,004	<0,002	<0,002	<0,002	<0,002	<0,002	0,005	<0,002	<0,002	<0,002	<0,002	<0,002
Chromium (ng/l)	100.0	<0,004	<0,008	<0,006	<0,004	<0,004	0,005	0,007	0,005	<0,004	<0,004	0,004	0,005
Mercury mg/m ³		<0,1	<0,1	<0,1	<0,1	<0,1	0,1	<0,1	<0,1	0,1	<0,1	<0,1	0,1

Table 4.5.11. Results of the analysis of the physical-chemical parameters of the water quality (2005. year.)

Parameter	MDK	Spreca (confluence) Doboj				Bosna Modriča.			
Date (2005.)		07.06.05.	27.07.05	06.09.05.	11.10.05.	08.06.05.	28.07.05	06.09.05.	11.10.05.
Water temperature (°C)		17,5	22,2	20,4	14,7	15	26,3	21,5	14,4
Air temperature (°C)		19	29	26	8	12	34	23	10
pH value	6,0 - 9,0	7,76	7,2	7,18	7,12	7,45	7,35	7,77	7,74
Elect.conductance (μS/cm)		1742	1433	1431	2666	599	658	578	572
Total alkalinity CaCO ₃ (mg/l)		212	210	220	243	195	190	195	190
Consumption of KMnO ₄ (mg/l)		15,3	10,75	14,97	16,5	9,79	13,9	7,17	10,3
HPK (mg O ₂ /l from KMnO ₄)	20	3,9	2,7	3,78	4,2	2,47	3,5	1,94	2,6
HPK (mg O ₂ /l from dichromata)		20	16	8	36	8	22	10	6
Dissolved oxygen (mg/l)	>4	6	5,49	6,77	5,5	7,7	6,96	8,08	7,7
Saturated oxygen (%)	50 - 75	63,5	63,6	77,5	56,2	77,5	86,9	94,7	78,4
BPK ₅ (mg/l)	6	2,2	2,8	1,31	1,33	1,7	2	0,69	1,3
Nitrite (mg/l)	0,5	0,186	0,25	0,062	0,21	0,04	0,06	0,013	0,051
Nitrate (mg/l)	15,0	1,52	2,35	1,565	2,33	1,025	1,47	1,215	1,085
Ammonium ion (mg/l)	0,5	0,3	0,203	0,055	0,349	0,08	0,019	0,019	0,088
Tot.dried residue (mg/l)	1500	1363	1012	1102	1771	569	485	424	351
Total calcanated resid. (mg/l)		705	756	741	1356	290	349	279	276
Loss with calcination		658	256	361	415	279	136	145	75
Total suspended matters (mg/l)	80	8	27	11,75	2,3	20,2	22,5	7,75	10,7
Total hardness (mg CaCO ₃ /l)		367	362	340	249	262	262	217	227
Calcium (mg/l)		125	108	97	77,9	96	97	72,9	71,5
Magnesium (mg/l)		13,7	22,5	23,9	13,2	5,47	7,5	8,5	11,9
Total phosphates (mg/l)		0,152	0,132	0,116	0,208	0,13	0,12	0,126	0,176
Orthophosphate (mg/l)		0,111	0,069	0,075	0,147	0,088	0,061	0,096	0,088
Total Kjeldahl azote (mg N/l)		0,95	1,34	<0,06	4,51	<0,06	2,52	<0,06	2,8
Mangan (mg/l)		<0,001	0,006	0,006	0,006	0,001	0,006	0,006	0,006
Iron (mg/l)		<0,004	<0,004	<0,004	<0,004	<0,004	<0,004	<0,004	<0,004
Copper (mg/l)	0,1	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
Chromium (ng/l)	100.0	<0,004	0,007	0,005	0,006	<0,004	0,006	<0,004	0,006
Mercury mg/m ³		<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1

4.5.4.2. Quality of underground waters

Quality of the underground waters has not been controlled systematically in this area. Analysis of the underground water was carried out on the location where there are the springs of drinking water, in aim of monitoring of the water type quality for the needs of water supply. Those are mostly marked springs of the drinking water for the water supply of the following Doboja, Odžaka, Kotorškog, Tešanjke and other smaller settlements. Continuous testing of underground water quality is performed on the following springs:

- Source area of the waterworks Odzak, Municipality Odzak
- Source area of Bare - Osjecani, Municipality Doboj
- Source area of Rudanka, Municipality Doboj
- Source area of Krasevo, Municipality Tešanj

Analysis results of drinking water quality on these springs were attached in the Annex 12.2, and water from all springs meet the requirements of `Rule book about hygienic standards of drinking water` (Off.Gaz.of R BiH no.2/92), and `Rule book about hygienic standards of drinking water` (Off.Gaz.of RS no.40/03). Data about water quality in 2005 year from the waterworks of LC Alibegovci (Municipality Usora) are only available from the distribution system and it is about microbiological water testing. From available data from October, the water sample in terms of bacteriological features met the requirements of Rule book for treated waters of closed type, while water sample from September did not meet the same requirements. These data are also given in the Annex 12.2.

In terms of other local source area found in the area of FBiH, within the alignment of LOT 1 and that are used for water supply of larger or smaller number of households, it should be emphasized that these village waterworks are managed by group of inhabitants or local community, where they constructed. Valid Cantonal Laws on waters (article. 90. and 89, in the cantons where the highway on section of LOT-1 passing, i.e. Posavski and Zenicko-Dobojski canton), prescribe the obligations to the owners of village waterworks for establishment and maintenance of the sanitary protection zone of the source area, as well as taking of minimum water samples for the hygienic control of water quality from those objects in the adequate laboratories. With gathering of data about local springs along the alignment of LOT-1 during the preparation of this Study, it was determined that most of these springs do not have the established zones of sanitary protection (Cantonal law on waters, article 92, and 91). In terms of water quality control on these springs, valid law prescribes, on registered sources the minimum number of prescribed hygienic and health control of drinking water. Since the most of these springs are not registered or are in the phase of registration, the water quality is not tested continuously but it is organized by own initiative of the group of citizens that constructed these waterworks. It should emphasize that in the municipalities and the local communities where there are located these local springs, it has been difficult to provide the data about water quality. In that context, there were received the data about water quality on the following local springs (attached in the Annex 12.2.):

- In the area of municipality Odzak (well in LC Svilaj, well in LC Vrbovac, well in LC Prnjavor)
- In the area of municipality Doboj-jug (springs Šumska voda, Bukovac, Brezik, Vis, Perasluka).

From attached analyses, it is obvious that these are the springs with water quality that mostly meet requirements of Rule book about hygienic correctness of drinking water. Water sample from the well in LC Svilaj from April in 2005 year did not meet the requirements of `Rule book about hygienic correctness of drinking water` (Off.Gaz of R BiH no: 2/92), while the water sample from the well Vrbovac from November in 2005 in terms of bacteriological features did not meet the requirements of the Rule Book for waters of closed type.

Water sample from local spring Šumska voda from May in 2004 year, and Perasluka from September in 2005 year in terms of bacteriological features did not meet the requirements of Rule book about hygienic correctness of drinking water.

All local springs, received by the questionnaire from municipalities on which territory found, are marked on the map of limitations related to water resources along the section of LOT-1 (Annex 12.3.5).

4.6. Soil and agricultural land (presentation of the current land status) «zero state»

4.6.1. Applied research methodology

Geological substrate upon which the key soil types formed along the projected route of the corridor Vc was examined based on: Katzer's Geological map in 1: 200 000 scale (Katzer, F., 1906), Geological map of Yugoslavia in scale of 1: 500 000, and Geology (Katzer, F., 1926). As a basis for the analysis of the condition of soils on the LOT 1 section of the route, we used BiH Pedology map of 1: 50 000 scale, Explanation of sections Brod 3 and 4 (1974), Derventa 1 (1972), Derventa 2 (1974) and Derventa 3 (1977). Additionally, we made a detailed recognition of the terrain and drew 1: 25 000 maps, compared the current data and situation on the field using orthophoto backgrounds in scale of 1: 5 000. A map in 1: 25 000 scales was used to present the information.

The assessment of impact on all segments of environment, to include soils, was carried out in two basic steps:

- Previous assessment of environmental impacts for the phase of development of Technical study and General design
- Assessment of environmental impacts for the phase of development of General Design.

In order to be able to meet the set objective, based on available information, we analyzed all major general characteristics of the highway route area influencing the soil formation and agro-hydrological status. The most significant characteristics include:

- Climate of the area
- Parent material (geology - lithology) conditions
- Relief of the area.
- Soil properties

4.6.2. General characteristics of the route area

a) Climate of the area

The climate of the area was analyzed based on data obtained from two meteorological stations: Slavonski Brod and Modriča. The average annual precipitation data in S. Brod and Odžak meteorological stations are similar. Therefore, for the flatland we use data from the meteorological station in S. Brod, while for the elevated (hilly) area we use data from the meteorological station in Modriča. For the purpose of assessing the climate as a pedogenetical driver, we used annual and monthly rain factors by Lang, shown in table 1. computed based on respective precipitation and temperature averages. The annual rain factor for Slavonski Brod and Modriča ranges average value of the area which are characterize with semi-humid climate.

Because of the above stated, it can be expected that dominant climate in the entire area is the semi-humid climate, with tendency to develop brown soils, which is confirmed by previously conducted penology research. Certain discrepancies are the result of relief, substrate and vegetation properties. However, it is necessary to stress the area of Doboј is on the elevation by 40m higher relative to Modriča, which results in colder and more humid climate, with average temperature lower by 0,9 0C than in Modriča. We could expect even more distinctive discrepancies in the hilly area with higher altitude, where the climate is even more humid and cold, winters are more severe, and summers moderately warm. In this area, there are conditions suitable for development of Humic accumulation soils.

Meteorological stations Slavonski Brod and Modriča

Table 1.

Month	Average precipitation 1896-1942		Average temp. 1896-1942		Rain factor by Lang		Type of climate	
	Slav. Brod	Modriča	Slav. Brod	Modriča	Slav. Brod	Modriča	Slav. Brod	Modriča
I	44	57	-0,3	-0,2	-	-	Snow	Snow
II	41	55	1,1	0,9	37,3	61,1	Over-humid	Over-humid
III	53	55	7,1	6,0	7,5	9,2	Half-humid	Humid
IV	64	72	11,6	11,7	5,5	6,1	Half-humid	Half-humid
V	82	85	16,8	16,4	4,9	5,2	Half-humid	Half-humid
VI	88	90	20,0	19,7	4,4	4,6	Half-humid	Half-humid
VII	68	72	22,0	22,0	3,1	3,3	Arid	Arid
VIII	67	56	21,2	21,2	3,2	2,6	Arid	Arid
IX	70	60	17,0	16,7	4,1	3,6	Half-arid	Half-arid
X	81	84	11,6	11,5	7,0	7,3	Half-humid	Half-humid
XI	60	85	6,3	6,4	9,5	13,3	Humid	Humid
XII	52	68	2,1	1,8	24,8	37,8	Over-humid	Over-humid
Annu.	770	839	11,4	11,2	67,5	74,9	Half-humid	Half-humid

b) Parent material (geology - lithology) conditions

Based on a 1: 200 000 scale Geological map by Katzer, (Katzer, F., 1906), Geological map of Yugoslavia 1: 500 000, and Geology (Katzer, F., 1926), it has been concluded that dominant litology substrata upon which the current soils were formed in a wider area of the Vc corridor route from Svilaj to Doboј, are the following: alluvial-dilluvial deposition, terciar clay, clay and loams, sends, schist's, sandstones, gravel, marle and hard limestone.

No eruptive rocks were found on the entire route. The bedrocks of the existing soils are mostly sediment, primarily watherid, originating from younger geologic formations. Even lime-stones, which appear to be hard sediments, are on the surface and easily crushed and watherid. Such a structure of the mother bedrock on which these soils were formed indicates its erodibility and movability through erosion.

In the valley of the Sava, from Svilaj south-westward to Odžak and Modriča, there are the youngest Holocene sediments of mostly middle heavy and heavy mechanical composition. The most recent alluvial soils, then older alluvial soils that are no longer in the area of regular flooding, were developed on these substrata. These soils had formed their profiles during the

pedo-genesis. Here we have fluvial meadow carbonate and non-carbonate soils with and without gleyic horizon. Additionally, there are mineral gleyic and marshland gleyic (Piglets) soils formed under the impact of underground moderately movable waters, as well as surface and occasionally flooding waters. Pseudo-galyak distric valley soils developed on slightly elevated terraces on the valley diluvium or Pleistocene, while pseudo-gleyic terrace and slope soils developed on the terraces of slope Pleistocene. There is also some tertiary clay on which fluvial meadow gleyic and pseudo-gleyic soils had developed. Heavy clay soils – vertisols - developed on marls stone, marls clays, carbonate and non-carbonate clays.

In the Bosna valley from Modriča toward Doboj, the most represented mother substrate for the formation of soils are carbonate alluvium, colluvial clays, and occasionally valley diluvium. Under the changed hydrological conditions and depending on age of these sediments, alluvial carbonate sandy, loams and clay carbonate and non-carbonate soils had been formed, which, on certain locations get mixed with diluvium moved down from the nearby elevations. Sometimes, these soils may be even marshy. The most significant tributaries of the Bosna along this section are Foča, Zarić and Rudanka with predominant quaternary sediments similar to those in the Bosna valley. The sediments have different layer structure, with alternating layers of sand, gravel and occasionally clay (further from the river bank) beneath the superficial layer of humus. In the broader strip of this section, there are also some other mythological formations present, such as marls and clay slates (Eocene flysches). Distic camisoles developed on sandstones and gravels. These soils are of lighter mechanic composition and more acid pH reaction if on Pliocene sands.

Cretaceous and partly Jurassic formations appear when it comes to Mesozoic. The most represented cretaceous sediments include marl, slate clays and lime-stones. The presence of Eocene lime-stone was identified on the right bank of the Bosna downstream, where several quarries had been built.

From the above stated we may conclude that the mother substrate, being an important pedo-genetic factor, had played a very significant role in formation of various soils, while relief, climate and humans directed pedo-genetic processes to a degree corresponding with the constellation of the stated factors.

c) Relief of the area

The highway route goes across flat terrain stretching from the Sava river between Novi Grad and Svilaj, along the collection canal Svilaj-Potočani, past Potočani to the Bosna river between Modriča and Vukosavlje.

In this area, there are numerous micro-depressions, minor and major watercourses and, despite huge collection canal Svilaj-Potočani, the superficial waters jeopardize all flat relief soils, which, with almost no exception, have heavy and very heavy mechanical composition of the surface and subsurface horizons.

At km 17+289, the highway route crosses to the right bank of the river Bosna. After that point, it follows the river Bosna crossing it several times until it reaches km 52+554, where it enters the hilly part of the area.

This river valley is fertile, but often flooded. The Bosna often floods its valley and changes its bed meandering in a relatively narrow area surrounded by hilly terrain. The relief is still jeopardized by surface waters, therefore the soils have heavy mechanical composition.

From km 52+554 in Pločnik, the highway passes through a slightly rolling and terrace-shaped terrain with a 10 - 15 % inclination, and altitude reaching up to 310 m. The terrain is prone to erosion and still polluted by land mines from the past war. This part of the terrain is actually the furthest spur of the Borja mountain massif. It is a mildly wavy low-hilly relief, crisscrossed by a number of small hollows and occasional watercourses pouring into the Usora River. At chainage km 59+930 in Makljenovac, the route descends into the valley of Usora.

The final 4 km of the highway route LOT 1, pass through the valley of Usora, which is, just like the Bosna, jeopardized by flooding and superficial waters. This fact reflects in mechanical composition of the soils.

Erosion is present on the surrounding terrain, while sub-surface waters are present along the river.

d) Land characteristics

In this phase, some of the most important characteristics of pedo-systemic units of the land within the scope of our research will be presented as a cross section of the status on the entire length of the LOT 1 route.

4.6.3. Soil type representation in a broader area of the Corridor Vc route

In the broader area of the corridor route a total of 24 sub-systemic units were identified, of which 7 from Automorphous order and 17 from Hydromorphic order of soils. Among the Automorphous division soils, predominant types are those from Cambic and Hums- accumulative classes, while among the Hydromorphous predominant types are from the class of Fluvial and Fluvial-gleyic soils.

A. Order of Automorphous soils

Basic characteristics of the soil types within particular classes of this division are the following:

Class of Cambic soils A - (B) – C type of profile

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

Dystric cambisols, (Acids – brown soils) in this area appear in a number of varieties, depending on type of mother substrate upon which they developed:

- Dystric cambisol – medium deep soils on schist's
- Dystric cambisol – shallow and medium deep soils on schist's
- Dystric cambisol – soils on shale's
- Dystric cambisol – podzolic soils on clays
- Dystric cambisol – degraded soils on clays
- Dystric cambisol – degraded, gleyic soils on clays

The characteristic profile type is of Aoh (or Aum)-(B)v-C (or R) structure. This soil type had formed on acidulous substrata such as non-carbonate gravels, marls, non-carbonate clays, shale's and sands, that can be less compact or loose, poor in bases (alkalis), with presence of very intensive wathering of primary minerals and argillogenesis; however, due to lack of bases there is no significant formation of clay. Unfavorable climate conditions and big precipitation cause bigger accumulation of humus, leaching and acidification. The level of cation exchange capacity, (adsorption) complex base saturation is below 50%, while reaction in water is below

5.5. The substrata richer with bases evolve into lesvage soil. These are poor soils, with favorable physical, but unfavorable chemical properties. They are often skeletal and with poor water capacity, except for those formed on flysches and shales. The content and character of the humus depend on altitude, exposition, character of vegetation. In terms of agriculture, they are primarily used as meadows and pastures, less as arable land (potato, ray, barley an oat). Generally, these are forest soils. Reclamation measures include: protection from erosion, calcification, humification, fertilization with NPK. In these soils, like in luvisols, if pH is low, it is possible for free phyto-toxic Al^{+++} ion. Generally, they are suitable for development of a successful animal husbandry and crop production of standard quality, provided that good agro-melioration and agro-technical measures are appropriately applied. In this area, these are the soils of the elevated part of relief. These are the soils with pasture, natural meadow and forest vegetation.

If kept under permanent vegetation, these soils can be rather resistant to the process of erosion. Disadvantages of these soils mainly pertain to their distinctive water permeability, poor retention properties both for water and potential pollutants that would be produced along the highway route. From the agricultural point of view, these are the soils relatively poor in nutrients, but, through agro-melioration actions they could be easily transformed into relatively fertile soils suitable for agricultural production. Generally, these are mainly very good forest soils.

Eutric cambisols – Brown carbonate soils on marls (Eutric brown soils) in the area of the highway route appear on marls, and by their character they fall into the group of carbonate soils. Brown carbonate soils on marls do not cover significant areas. In morphological sense they are similar to brown soils on wathering lime-stones. They are usually shallow soils with eroded humus layer and wathering marl on the top. They are carbonate across entire depth, loamy, structured and water permeable. Their fertility to a great extent depends on depth of humus layer that can be used to grow continental fruit varieties. They are very sensitive to the water erosion processes, even on slightest inclinations, unless covered by vegetation.

B. Order of Hydromorphic soils

Basic characteristics of soil types within individual division classes include:

Class of alluvial or Fluvial - galyic soils, (A)-I-II...

Alluvial soils, or recent river alluvium – Fluvisols, have (A)-I - II...C type of profile. These are our best soils and they appear in flooding zones of all rivers, to include the Bosna, where the major part of the highway will be placed, as well as a part of the alluvial terrace of the Usora. The term alluvium means river detritus of recent (young) character and stratified structure. Sedimentation is a dominant process so that pedo-genesis can not “prevail”. They have good natural fertility already at depositing of material.

Basic properties depend on type of material, however, in terms of mechanic composition, they are very heterogenic soils, from skeletal to loamy soils, but generally of favorable physical properties. They can be carbonate and carbonate-free, they are with less humus, while content of biogenic elements depends on the type of material they have originated from. In terms of production, they are used to grow various crops provided that the land is not affected by flooding, or, in sandy forms, that there is irrigation provided during the summer period. They can be used in all types of agricultural production.

At the same time these are the most jeopardized soils from both physical damaging and pollution by community and industrial waste. All major urban settlements in our country had

developed in the river valleys, thus permanently excluding thousands of hectares of such land from agricultural production.

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

Within the scope of this research, these were the most represented soils, grouped into varieties based on the mother substrate on which they developed:

- Alluvial carbonate gleyic soils
- Alluvial carbonate loamy soil
- Alluvial carbonate sandy soil
- Alluvial carbonate soil on sands
- Alluvial carbonate sandy soils on sand
- Alluvial carbonate soil on gravels
- Alluvial carbonate sandy soils on gravels
- Aluvijal-delluvial soil

Presence of mother substrate largely indicates their properties and may even determine protection measures. These are pedo-systemic units located on lower relief elevations, generally in areas of accumulation of dry and wet aeolian deposition. Since these soils are occasionally exceedingly wetted or in direct contact with surface and underground watercourses, they could be potential source of their pollution. On the other hand, these soils are being used in extensive agricultural production. That is why they require the most intensive protection, to include closed water drainage systems and windshield wind-break.

Class of Semigley soils, A-C-G type of profile

Brown (meadow) soils (Humofluvisoli), or half-gley soils, A -C -G profile structure, developed along the river Bosna. Their name – brown meadow soils – was taken over from the classification typical for a 1: 50 000 scale pedology map in the seventies. However, these soils are often followed by fluvial meadow soils, while G horizon may be differently gleyic (r, So). Within the framework of this class on the area in beat win different tip, depending on the wetting regime, we can find Semigley soil – which means “half- gley”- as gleyic horizon appears much deeper in the mother substrate. Disposition in the river valley is such that we have Semigly in the central part of the field, Gleyic soils close to the river teases part, and Alluvial soil (recent) deposits in the river valley.

Listed below are the seven varieties determined by dominant process type:

- Brown (meadow) carbonate soils
- Brown (meadow) carbonate- free soils
- Gray-brown (meadow) carbonate soils with poor drainage
- Gray-brown meadow carbonate-free soils
- Gray-brown meadow carbonate-free, sporadically gleyic soils
- Gray-brown meadow degraded soils
- Gray-brown meadow degraded little gleyic soils

These are potentially the most fertile soils. Usually, they are natural meadows with excellent hay yields, while only those parts with regulated water regime, i.e. flooding protection, are used in agricultural production. Such areas with regulated water-air regime provide conditions for growth of a range of crops, depending on agro-ecological situation. Structuring of these soils would create excellent conditions for a high-quality agricultural production. However, these soils may have great importance in terms of biodiversity, as they can be habitats to many organisms.

When it comes to the road construction, these soils should be avoided wherever it is possible, leaving their established ecosystems undisturbed. Physical damages would certainly lead to a significant disturbance of the water regime, and thus of the ecosystem in whole.

Class of Epigley-soils, A -Eg -Bg -C type of profile

Pseudogleys, A-Ig-Ilg-C of primary and A-Eg-Bg-C of secondary profile structure, are found in flat parts of the field and have very specific properties. Here they appear as a sub-type:

- Podzolic Pseudogleys soil of valleys as a primary pseudogley

Pseudogley is a soil type formed on the substrate with differentiated texture, whose relatively permeable layer covers a water impermeable layer. It is characteristic for its wet and dry phases, with reductive conditions prevailing in wet, and oxidation conditions in dry phase. This causes the formation of Fe and Mn concretion and gives marble-like appearance to the profile. It is developed on both flat and slightly inclined terrains.

They are very unfavorable habitats and without complex hydro/agro-melioration, production is unreliable and yields low and inconstant. Due to significant presence of dust fraction, the soil is prone to compressing and forming crust, and if there is even minimum inclination, to erosion. These are very acidulous soils, poor with humus, with no structure and with low adsorption capacity. For the purpose of optimization of the use of soil in agricultural production, following the implementation of hydro and agro-melioration actions, it is necessary to introduce conservative soil cultivation practices, as well as shorten or even completely avoid the period with bare land. Any activity undertaken on this soil during its wet phase is more detrimental than beneficial

These soils are included in the second class (group) of high protection from the construction of highway.

Class of Hypogleyic soils, A -G type of profile

The class of hypoglejnih soils is characterized by continuous excessive wetting by underground water, mainly in the lower part of the profile. The underground water has no major oscillations throughout the year, therefore we have a high degree of anaerobic, as well as the process of gleyic through reduction of Fe and Mn and in presence of CaCO_3 . In the upper part of the profile occurs the secondary oxidation, i.e. red ox potential (Eh) goes up. On such locations it is possible to identify even micro-biological processes in the gleyic horizon. Unspecific anaerobic bacteria are capable of reducing iron, or producing reduced compounds such as CH_4 and H_2S which, being the active oxygen receptors, have negative impact on environment. In this area, it comes in one of its varieties:

- Epigley noncarbonated clay soils

Marshy-gleyey mineral soil - Eugley, has A – G profile structure. The humus A horizon shows the signs of hydromorphic, while gleyic G horizon is with strong differentiation of a Gso and Gr sub- posthorizonte. Gleying is caused by surface, primarily flooding waters, which stagnate up to 1 m of depth, and it loses its intensity as we go deeper. It has a low level of biological activity, lacks oxygen in pedosphere, and shows unfavorable chemical properties. This soil type is characteristic for the area of tertiary deposition. As for agricultural production, without melioration and regulation of unfavorable water-air regime, the Epigley could be considered a limitedly productive soil. Closed water drainage systems should be applied in their case too, in

order to prevent pollution of soil and underground waters that regularly accompany the soils in this class, by water being drained from the highway. If possible, these types of soil should be avoided in the lay-out of the future highway.

Associations of soil types on particular mother substrates by divisions and with area of each individual type within the separated associations are presented in Table 2.

HIGHWAY ROUTE – SOIL TYPES

Encompasses 250 m on each side of the main axis of the Highway
(Total width 500 m)

Table 2.

No.	Pedo-systemic unit	Area in ha	Use-value category	Protection category
A) ORDER OF AUTOMORPHIC SOILS				
1	Dystric cambisols- medium deep soils on schist's	14,10	V	IV
2	Dystric cambisols- shallow and medium deep soils on schist's	22,80	V	IV
3	Dystric cambisols- soils on shale's	136,65	IV	III
4	Dystric cambisols- podzolic soils on clays	67,80	IV	III
5	Dystric cambisols- degraded soils on clays	99,60	IV	III
6	Dystric cambisols- degraded, gleyic soils on clays	23,75	IV	III
7	Eutric cambisols – Brown carbonate soils on marls	14,90	V	IV
B) ORDER OF HYDROMORPHIC SOILS				
8	Alluvial carbonate gleyic soils	13,40	II	I
9	Alluvial carbonate loamy soil	635,10	II	I
10	Alluvial carbonate sandy soil	326,55	II	I
11	Alluvial carbonate soil on sands	362,40	II	I
12	Alluvial carbonate sandy soils on sand	64,80	II	I
13	Alluvial carbonate soil on gravels	88,85	II	I
14	Alluvial carbonate sandy soils on gravels	144,60	II	I
15	Aluvijal-delluvial soil	133,00	III	II
16	Brown (meadow) carbonate soils	66,85	II	I
17	Brown (meadow) carbonate- free soils	33,35	III	II
18	Gray-brown (meadow) carbonate soils with poor drainage	21,20	III	II
19	Gray-brown meadow carbonate-free soils	38,55	III	II
20	Gray-brown meadow carbonate-free, sporadically gleyic soils	254,20	III	II
21	Gray-brown meadow degraded soils	28,85	III	II
22	Gray-brown meadow degraded little gleyic soils	13,40	IV	III
23	Podzolic Pseudogeys soil of valleys	374,85	IV	III
24	Epigley noncarbonated clay soils	152,15	IV	III
	TOTAL	3.131,70		

4.6.4. Review of the land use-value categories

All aforementioned pedo-systemic units are grouped in four use-value categories, shown in Table 2. The best class of the use-value is II (second), and the worst is V (fifth). This indicates that the highway route, for its major part, goes across the agricultural land which is, given the terrain forms, being used in more or less extensive way.

Physical, mechanical and chemical properties of the stated sub-systemic units are shown in Tables 3 and 4. Based on permanent soil properties, such as inclination, depth, mechanical

composition, drainage, as well as other physical and chemical properties, it was possible to distinguish the following use-value categories for the soils in the area of research:

II use-value category

The **second** use-value category includes the soils from the class of alluvial soils, which are mainly carbonate, with divergent mechanical composition – from heavy clay to loamy and sandy. They had developed mainly on sands, gravels or both sands and gravels, depending on conditions during the sedimentation 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 crops, particularly at lower elevations, while reclamation measures are relatively simple. Relative to the first, i.e. the best use-value category, these soils have different hydrological regime which can vary depending on the level of regulation of water regime of the river Bosna, or appearance of gravel sublayers pijeska as a skeleton on which these soils had been formed. Since these are the most significant agricultural soils, it is very important to have good understanding of their agro-ecological aspect. These are soils relatively sensitive to various pollutants and polluters. That is the result of their lighter mechanical composition and hence lowers retention capacity, or they have sublayers of very porous sandy or gravels layers that establish quick contacts with the aquifer. In case they are not carbonate, their buffer properties are reduced, and their sensitivity increased.

III use-value category

The **third** use-value category includes the soils from the class of Alluvial – Colluvial and class of Semigley soils. These are reasonably good agricultural soils with certain limitations related to the soil properties, topography or drainage. In the separated pedo-systemic units shown in Table 2. the most significant limitations pertain to hydrological regime, i.e. drainage, regardless of whether they are from the class of Semigley or Alluvial - Colluvial soils. Because of this phenomenon, range of crops is reduced, particularly winter crops, and therefore certain actions in the area of hydro and agro-melioration are required. *Ecological aspect* of the soils of this category found on the highway route should be viewed through the fact that they have a high level of underground waters, which enables introduction of harmful highway-generated pollutants into the watercourses and underground aquifers. Buffer and retention properties of these soils are limited due to presence of strata containing sands or gravel skeleton.

IV use-value category

The **fourth** use-value category includes soils from the class of Cambic soils, with distrični kambisol or acidulous brown soils as dominant. This category also includes the gray-brown meadow degraded soil from the class of Semigley soils, as well as Mineral hydromorphic gleyed acid soils and Mineral hydromorphic gleyed carbonate soil. From the agricultural point of view, these soils are considered to be rather good, although with certain strong limitations. The selection of crops is significantly reduced to just a few, when compared with the previous use-value category. Soils included in this category could be divided into two sub-categories. The first sub-class is comprised of those which do not require hydro-melioration, but have poor natural fertility (acidulous brown soils), degraded and inclined; while the second sub-class includes the flatland soils (valley) which require hydro-melioration. As for Clay Mineral hydromorphic and Pseudogleys soils, they are usually used as natural meadows, which is the case here, or for growing crops with very uncertain end result. In terms of ecology, these are sensitive areas due to their distinct hydromorphic, regardless of whether the underground or surface waters are involved. 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 may attach to the clay fractions abundant in these soil types, however, due to acidulous pH reaction their buffer capability is reduced.

V use-value category

The **fifth** use-value category includes mainly the forest soils from the class of Cambic, Distric or Eutric soil types, with natural meadows and pastures appearing within the forest frame. These soils had generally developed on schists rocks on the slopes. They can be very good forest soils, however, they don't have to be prone to erosion, as they are covered by vegetation. They have a number of limitations which mainly concern cultivation and production of the majority of crops, therefore, they are rarely used as arable land. They are generally situated on the slopes with up to 20⁰ inclinations, and on suitable expositions, they are often used for orchards. These are the terrains of natural associations of forest and its accompanying vegetation, and they require less protective measures.

LOT 1 - Corridor Vc route: Mechanical & Physical properties of identified pedo-systemic units

Table 3

#	Pedo-systemic unit	Depth cm	Texture composition in %			Texture mark	Bulk density g/cm ⁻³		Pore volume %
			Sand 2-0,05	Silt 0,01-0,05	Clay <0,01		Volume	True	
1	2	3	4	5	6	7	8	9	10
1	Dystric cambisols- medium deep soils on schist's	0-22	16,00	24,80	59,20	Loamy clay	2,662	1,303	51,05
		22-50	8,00	26,20	65,80	Clay	2,709	1,414	47,60
2	Dystric cambisols- shallow and medium deep soils on schist's	0-25	8,48	30,08	61,44	Clay	2,665	1,142	46,17
		25-53	9,48	21,40	69,12	Clay	2,718	1,463	42,59
3	Dystric cambisols- soils on shale's	0-17	5,36	31,04	63,60	Clay	2,684	1,315	51,01
		17-51	7,40	22,60	70,00	Clay	2,741	1,484	45,86
4	Dystric cambisols- podzolic soils on clays	0-23	5,60	40,88	53,52	Loamy clay	2,630	1,066	59,47
		23-48	7,80	41,20	51,00	Loamy clay	2,719	1,375	49,43
5	Dystric cambisols- degraded soils on clays	0-23	5,80	32,00	62,20	Clay	2,649	1,207	54,44
		23-60	9,00	29,00	62,00	Clay	2,710	1,395	48,52
6	Dystric cambisols- degraded, gleyic soils on clays	0-22	4,81	36,13	59,06	Loamy clay	2,692	1,411	47,59
		22-44	9,44	30,92	59,64	Loamy clay	2,734	1,399	48,83
7	Eutric cambisols – Brown carbonate soils on marls	0-20	21,40	34,60	44,00	Clay loam	2,664	1,400	47,45
		20-40	10,60	31,40	58,00	Loamy clay	-	-	-
8	Alluvial carbonate gleyic soils	0-18	8,80	30,04	61,16	Clay	2,706	1,275	52,86
		18-54	9,12	29,36	61,52	Clay	2,732	1,301	52,38
9	Alluvial carbonate loamy soil	0-16	12,72	36,96	50,32	Loamy clay	2,619	1,386	47,08
		16-52	18,48	32,72	48,80	Clay loam	2,657	1,405	47,12
10	Alluvial carbonate sandy soil	0-20	63,60	14,28	22,12	Clay Loamy sand	2,766	1,364	50,68
		20-44	53,88	20,08	26,04	Clay sandy loam	2,757	1,488	46,02
11	Alluvial carbonate soil on sands	1-19	8,76	24,84	66,40	Clay	2,732	1,346	50,73
		19-56	1,40	29,48	69,12	Clay	2,746	1,372	50,04
12	Alluvial carbonate sandy soils on sand	0-11	30,12	28,16	41,72	Clay loam	2,707	1,195	55,85
		11-25	29,48	25,56	44,96	Clay loam	2,751	1,597	41,95

Table 3, cont.

1	2	3	4	5	6	7	8	9	10
13	Alluvial carbonate soil on gravels	0-29	6,00	53,00	41,00	Clay loam	2,720	1,543	43,27
		29-53	11,00	48,00	41,00	Clay loam	2,701	1,436	46,83
14	Alluvial carbonate sandy soils on gravels	0-19	48,20	27,20	34,60	Clay sandy loam	2,653	1,112	58,09
		19-110	81,60	7,00	11,40	Clay Loamy sand	2,682	0995	62,90
15	Aluvijal-delluvial soil	0-22	25,80	32,20	42,00	Clay loam	2,709	1,291	52,34
		22-60	41,00	22,80	36,20	Clay sandy loam	2,721	1,536	43,55
16	Brown (meadow) carbonate soils	0-17	1,92	34,16	63,92	Clay	2,706	1,199	55,69
		17-48	5,76	27,88	66,36	Clay	2,722	1,387	49,04
17	Brown (meadow) carbonate- free soils	0-15	7,80	36,36	55,84	Loamy clay	2,664	1,247	53,19
		15-38	15,04	27,04	57,92	Loamy clay	2,688	1,375	48,85
18	Gray-brown (meadow) carbonate soils with poor drainage	0-13	12,20	31,80	56,00	Loamy clay	2,650	1,178	55,55
		13-36	8,00	33,60	58,40	Loamy clay	2,715	1,507	44,49
19	Gray-brown meadow carbonate-free soils	0-23	8,44	19,16	72,40	Clay	2,694	1,311	51,34
		23-52	12,24	19,64	68,12	Clay	2,774	1,384	50,11
20	Gray-brown meadow carbonate-free, sporadically gleyic soils	0-12	16,68	22,48	60,84	Clay	-	-	-
		12-21	14,96	21,44	63,60	Clay	2,673	1,261	52,82
21	Gray-brown meadow degraded soils	0-10	6,72	9,48	83,80	Clay	2,607	1,230	52,82
		10-35	6,40	7,28	86,32	Clay	2,674	1,165	56,43
22	Gray-brown meadow degraded little gleyic soils	0-17	44,64	19,44	35,92	Clay sandy loam	2,659	1,396	47,50
		17-53	49,52	15,68	34,80	Clay sandy loam	2,719	1,530	43,73
23	Podzolic Pseudogeys soil of valleys	0-22	10,40	21,00	68,60	Clay	2,683	1,104	58,85
		22-53	17,04	15,56	67,40	Clay	2,667	1,278	52,08
24	Epigley noncarbonated clay soils	0-12	7,32	27,83	64,85	Clay	2,680	1,240	52,00
		12-43	8,92	21,43	69,65	Clay	2,740	1,320	48,00

LOT 1 - Corridor Vc route: Chemical properties of the pedo-systemic units

Table 4

#	Pedo-systemic unit	Depth in cm	pH in		Content in %		100/g soil	
			H ₂ O	n-KCl	Humus	CaCO ₃	P ₂ O ₅	K ₂ O
1	2	3	4	5	6	7	8	9
1	Dystric cambisols- medium deep soils on schist's	0-22	5,60	4,06	2,88	0,00	0,8	9,0
		22-50	5,04	3,85	1,14	0,00	0,5	6,5
2	Dystric cambisols- shallow and medium deep soils on schist's	0-25	5,65	4,32	2,44	-	0,6	13,0
		25-53	5,30	4,05	0,98	-	3,4	5,3
3	Dystric cambisols- soils on shale's	0-17	5,12	3,88	2,00	0,00	0,5	10,5
		17-51	5,06	3,70	0,72	0,00	0,4	7,5
4	Dystric cambisols- podzolic soils on clays	0-23	4,50	3,75	2,62	0,00	0,3	5,3
		23-48	4,52	3,63	0,80	0,00	0,3	2,5
5	Dystric cambisols- degraded soils on clays	0-23	5,34	4,12	2,54	0,00	0,8	7,5
		23-60	5,22	3,86	0,82	0,00	0,5	3,5
6	Dystric cambisols- degraded, gleyic soils on clays	0-22	6,10	4,73	2,62	-	1,2	15,8
		22-44	5,85	4,40	0,82	-	0,0	11,5
7	Eutric cambisols – Brown carbonate soils on marls	0-20	7,73	7,08	2,72	11,75	0,8	10,0
		20-40	8,14	7,24	0,52	12,35	0,4	5,5
8	Alluvial carbonate gleyic soils	0-18	7,94	6,64	3,41	5,38	3,7	8,77
		18-54	7,72	6,38	2,08	1,15	-	-
9	Alluvial carbonate loamy soil	0-16	8,10	7,22	2,70	4,33	-	-
		16-52	7,64	6,66	1,60	5,52	-	-
10	Alluvial carbonate sendy soil	0-20	7,16	5,53	1,11	0,37	0,5	8,0
		20-44	7,50	6,98	0,89	0,37	-	-
11	Alluvial carbonate soil on sends	1-19	7,836	6,79	1,19	6,32	0,3	7,5
		19-56	7,84	6,80	1,02	8,19	-	-
12	Alluvial carbonate sendy soils on send	0-11	7,92	6,92	3,35	0,38	0,5	15,5
		11-25	7,94	7,00	1,93	0,53	-	-

Table 4, cont.

1	2	3	4	5	6	7	8	9
13	Aluvijalna karbonatna tla na šljuncima	0-29	6,85	5,8	2,82	5,25	0,6	7,5
		29-53	7,35	6,15	2,40	15,76	0,4	4,5
14	Aluvijalna karbonatna pjeskovita tla na šljuncima	0-19	7,90	7,62	2,20	39,74	1,0	4,8
		19-110	8,10	7,92	0,88	47,54	1,1	2,0
15	Aluvijalno – deluvijalna tla	0-22	7,56	6,35	3,14	2,38	0,6	7,7
		22-60	7,90	6,65	1,44	3,68	0,5	4,7
16	Brown (meadow) carbonate soils	0-17	8,00	6,86	3,88	7,16	0,2	6,5
		17-48	7,99	6,70	3,56	2,26	-	-
17	Brown (meadow) carbonate- free soils	0-15	5,28	3,95	2,90	-	0,5	3,5
		15-38	5,24	3,95	2,69	-	-	-
18	Gray-brown (meadow) carbonate soils with poor drainage	0-13	6,50	5,20	3,36	0,00	0,2	6,5
		13-36	6,65	5,42	2,20	0,00	0,0	3,5
19	Gray-brown meadow carbonate-free soils	0-23	5,95	5,18	3,30	0,00	0,9	9,5
		23-52	6,65	5,62	1,58	0,00	0,8	8,0
20	Gray-brown meadow carbonate-free, sporadically gleyic soils	0-12	6,43	5,14	4,19	0,00	0,3	15,0
		12-21	6,14	4,96	3,67	0,00	-	-
21	Gray-brown meadow degraded soils	0-10	5,53	4,70	5,12	0,00	-	-
		10-35	5,84	4,42	3,61	0,00	-	-
22	Gray-brown meadow degraded little gleyic soils	0-17	6,06	4,64	2,02	-	3,5	14,0
		17-53	6,25	4,70	0,93	-	-	-
23	Podzolic Pseudogeys soil of valleys	0-22	5,90	4,98	2,66	0,00	0,4	9,5
		22-53	4,25	3,69	1,16	0,00	0,0	4,7
24	Epigley noncarbonated clay soils	0-12	5,97	4,23	4,94	-	2,5	26,0
		12-43	5,93	4,49	2,01	-	1,9	4,2

4.7. Flora

Intake area is characteristic by variety of hydrologic, hydro geological, pedology and geological entities, as well as landscape variety while on the other side it is characteristic by homogeneous of climatic occurrences (especially of moderate warm rain climate), where less variations appear because of relief spatial features.

Natural conditions, relief and climate, directly affected on the appearance and condition of vegetation cover within intake area. Primary appearance of the vegetation was significantly changed by anthropogenic factors, but inspite of that the area is distinguished by variety of ecological system and habitat.

According to the origin, ecological systems were divided in the primary and secondary. The primary ecological systems are forests, and the secondary (anthropogenic) ecological systems are agricultural (plow land, lawn), urban (settlements, towns), artificial water ecological systems (reservoirs, fishponds), forest cultures and others.

Therefore, the intake area is characteristic by the following ecological systems:

- Forests
- Lawns
- Plowed fieldsOranice.

4.7.1 Forests

According to the phito-geographical classification, wider impact area belongs to the Euro Siberia - North American region and regarding the forest communities it can be divided on lower and higher part.

Mountain belongs to plant-geographical province of Illyrian beech forest, and lower part of the plant-geographical province of Illyrian hornbeam forest.

On the north part of the section LOT1 along the river Sava there is the belt of English oak. This belt of English oak, it is partially broken by the forest of oak sessile and hornbeam. In spatial terms, this belt is continued on forest belt in Slavonic under the title `Slavonian oak forests`. On hilly and elevated area, there is forest community of sessile oak and hornbeam, and partially are also developed the beech forest of sub mountain belt.

Therefore, the section LOT 1 is characteristic by the following forest phitocenoze that are formed depending on the relief, climatic conditions and other factors:

1. Forests of oak sessile and hornbeam of Illyrian area (*Querco-Carpinetum illyricum*)
2. Acidophil forest of sessile (*Quercetum petraeae montanum*)
3. Hilly forest of the beech of Illyrian area (*Fagetum montanum illyricum*)

Forest of oak sessile and hornbeam of Illyrian area (*Querco-Carpinetum Illyricum*)

Forest of oak sessile and hornbeam of Illyrian area belongs to the class of mesophile forests of the hornbeam with an average of precipitation of 900 mm, average annual temperature from 8,5 to 11,5°C, and height interval for the area of Croatia and Bosnia and Herzegovina is up to 700m.

Forest of oak and hornbeam is found on the great area of Republic Srpska as climate forest. In the layer of trees, divided on dominant and subdominant floor, there is distinguished the following: *Quercus petraea*, *Carpinus betulus*, *Prunus avium*, *Acer campestre*, *A. pseudplatanus*, *Ulmus campestris*, *U. montana*, *Tilia platyphyllos*, *Sorbus tarminalis*,; on some

surfaces there are: *Quercus robur*, *Q. cerris*, *Acer tataricum*, *Fraxinus excelsior*; in the bush layer there are: *Corylus avellana*, *Evonymus europaeus*, *Rosa arvensis*, *Daphne mezereum*, *Lonicera caprifolium*, and other species; in the layer of low flora there are many middleeuropean species, but also many illyrian elements: *Lamium orvala*, *Helleborus atrorubens*, *Epimedium alpinum*, *Hacljuetia epipactis*, *Erythronium dens canis*, *Anemone nemorosa* and others.

Within this cliamtogenic community of wider regional diffusion, earlier differentiated sub associations are: *-C. staphylletosum* Horv.; *Q.-C. caricetosum pilosae* Horv. I *Q.-C. erythronietosum* Horv. Raised on the level of self associations (Horvat et al., 1974):

STAPHYLEO-CARPINETUM Horv.et al. 1974. Forest of oak and hornbeam is developed on the fresh land of basic and neutral reaction, the most often in the river valleys-on limestone coluvial soil of rich humus.

There is a characteristic species of bear's-foot (*Helleborus dumetorum* ssp. *atrorubens*), and differentiated species distinguish this community from other forests of oak and hornbeam in the Illyrian area: *Staphylea pinnata*, *Rhamnus cathartica*, *Hacljuetia epipactis*, *Carex digitata*, *Vicia oroboides*, *Salvia glutinosa*, *Asperula taurina*, *Aconitum vulparia*, *Ranunculus lanuginosus*, *Campanula trachelium*, *Marcurialis perrenis* and others.

CARICI PILOSAE-CARPINETUM Horv.et al. 1974. Forest of oak and hornbeam on acid brown and ilmerizovate (also rare on pseudogley soils) belong amongst the most spread forest communities in Croatia and north BiH, where covers a significant surface especially on tertiary sediments. These soils are poor acid to the neutral reaction and moderate fresh. Community avoids dry shallow limestone and dolomite, and very access soils in hilly area or wet soil in the flood area. Optimum of its diffusion is from 250 to 500 m of altitude on warmer positions.

Besides a line of mutual species of oak-hornbeam forests, there are characteristic: *Carex pilosa*, *Hepatica nobilis*, *Knautia drymeia*, *Crocus albiflorus*. In terms of large number of spring wheat, the appearance afforest in spring is a very characteristic one.

ERYTHRONIO-CARPINETUM ILLYRICUM Horv. Et al. 1974. Forest of oak sessile and hornbeam hornbeam on acid brown, ilmerizovate and oglely soils of moderate acid reaction also presents more spreader variant of this community in Croatia and BiH. It covers hilly terrain with mild characteristic relief on silicates substratum's of Paleozoic, Mesozoic and tertiary formations. These soils are potentially tropical, but they are very often poored with long-term effects of anthropogenic factors (tree chopping, pasture, rifle range etc.).

In the composition, this forest has besides a line of mutual elements for oak-hornbeam forests also some differential, *Erythronium dens canis*, *Lathyrus montanus*, *Luzula pilosa*, *Melampyrum pratense*, *Polytrichum formosum*, *Primula vulgaris* On very degraded soils, there are extremely acidophil elements, which approach this community significantly approach to very different forest of oak sessile and chestnut. They are especially expressed in utter degradation phases appear in the zone of this community. In progressive phases, helophytes have higher significance: *Betula verrucosa*, *Populus tremula*, *Salix caprea* (Ziani 1957).

RUSCO-CARPINETUM ILLYRICUM Horv. et al.1974. There are found on deeper luvisols of poor acid to neutral reaction on the crossing to climatogenic forest of pomegranate and cerise. For this forest it is characteristic the presence of *Ruscus aculeatus* and linden *Tilia tomentosa* which present a very poor forest type of very mixed and rich vegetation of earlier tertiary and quarter (Jovanović, 1951).

On limestone and other basic substratum's, there are widely found a transitional phases of brush wood and bush (especially of hazel tree, hawthorn or juniper bush), which passing in the community of the lawn of xero-mesothermo character from the order of Brometalia erecti.

On acid silicate foundations, by a clearing the forest of oak and hornbeam, they are created the communities of the lawns of mesothermo conditions from the order of Arrhenatheratalia

Acidophil forests of oak (*Quercetum petraeae montanum*)

Soil is acid to extremely acid reaction (pH 4-5). Characteristic and differentiated species of the community are the famous acidophil: *Luzula albida*, *L. luzulina*, *Melampyrum pratense ssp. vulgatum*, *Vaccinium myrtillus*, *Calluna vulgaris*, *Pteridium aljuilinium*, *Genista pilosa*, *Cytisus nigricans*, *Veronica officinalis*, *Leucobrium glaucum*, *Potentilla micrantha*, *genista ovata*, *Juniperus communis*, and others.

The communities are the following:

QUERCETUM MONTANUM ILLYRICUM Stef. (1964) 1966. It is widely spreaded community in Bosnia on Paleozoic, tertiary and verfenic substratums of north and inside areas. It covers warmers postures as orographic-edafogenic phitozenose with more sub associations which most often present certain phases of forest degradation. Differential species are extreme acidophilus, so this community together with its vicar variant *Betulo-Quercetum* Fab. et al. 1963. was divided on the sub associations: *vaccinetosum myrtilli*, *pteridio-callunetosum*, *callunetosum*, *leucobritetosum* and others. In north Bosnia the forests of oak sessile are also found in the complexes of peridotite, on diluvia sandy substratums, where there were formed the leached and pseudogley soils.

Hilly forest of the beech of Illyrian area (*Fagetum montanum illyricum*)

Unlike the beech forest of middle Europe, this Illyrian forest is characteristic by greater wealth of species, where besides the neutrophyl middle European elements also entering very characteristic Illyrian elements, which distinguish this community as special flora-genetic entity. Some of these elements (. *Omphalodes verna*, *HacIjuetia epipactis*, *Cardamine trifolia*, *C. polyphylla*, *Scopolia carniolica*, *Lamium orvala* and others) are more characteristic for central part of the Illyrian area and are loosing in southeast direction already on the section Velebit-Plješevica-Grmeč-Klekovača-Osječenica. However, a line of neutrophyl-mesophyl elements remain.

Beech is edificator and build the formations of compact assembly with mixture of: *Acer platanoides*, *A. pseudoplatanus*, *Ulmus montana*, *Sorbus torminalis*, *Tilia platyphyllos* (in some formations *Taxus baccata* and *Ilex aljuifolium*); In the layer of bush there are: *Daphne mezereum*, *D. laureola*, *Evonimus latifolius*, *E. europaeus*, *Lonicera xylosteum*, *Ruscus hypoglossum*, *Sambucus racemosa*, *Rhamnus fallax* and others, in the layer of low flora there are: *Cardamine bulbifera*, *C. trifolia*, *C. savensis*, *C. polyphylla*, *Asperula odorata*, *Paris ljuadrifolia*, *Pulmonaria officinalis*, *Sanicula europaea*, *Asarum europaeum*, *Anemone nemorosa*, *A. ranunculoides*, *Mercurialis perrenis*, *Aspidium filix mas*, *Athyrium filix femina*, *Lilium martagon*, *Mycelis muralis*, *Allium ursimum*, *Geranium robertianum* and others.

Depending on the intensity and the effects of anthropogenic factors, it appears all types of degradation phases-from low sprout forests, from brush wood to bushes, and are composed of different elements *Corylus avellana*, *Crataegus monogyna*, *Prunus spinosa*, *Juniperus communis* and others. It depends on the way and intensity of anthropogenic factors performance.

Beech forest is divided on more sub associations, among them the most included area: *lathyretosum* Horv. 1938; *corydalitosum* Horv. 1938; *festucetosum silvaticae* Stef. 1963; *cardaminetosum* Fab. 1966; *tilietosum*, Fab. 1966; *carpinetosum betuli* Stef. 1966; *mercurialetosum* Fuk. 1968. and others.

4.7.2. Lawns and plowed fields

Lawns and plowed fields are the ecological systems made by direct or indirect man's impact on the area that naturally used to be covered by forest.

4.7.2.1. Lawns

Lawns, in spite of the fact that they are not of natural origin present the habitat which in great measure enrich biological and landscape diversity of the intake area. They are settled by plant species which partially derive from forests and partially from other steppe area of east Europe and Asia, while some polymorphous species developed just on anthropogenic effects on the lawns.

In the intake area, it is traditionally applied an extensive way of lawn use, mostly endangered because they are turn into the plow fields. They are today very extensively and temporarily used for pasture and haymaking. For lawns, there're characteristic a different species from the family of grasses (*Poaceae*), composite *Asteraceae*, *Juncus*, *Mentha*, extremely related to the humid habitats.

Lawn area resisted to the anthropogenic effects is the area of different representatives. Characteristic continental meadows characteristic for the intake area are the following:

- Meadow of oatcake (as. *Arrhenatheretum eltioris*)
- Meadow (as. *Bromo-Cynosuretum cristati*)
- Meadow (as. *Bromo-Plantaginetum mediae*)

4.7.2.2. Plowed fields

Plowed fields are artificially made ecological systems intended to exclusively agricultural production and plowed in the way which insufficiently respect protection of biological diversity, because it is used in intensive way with application of artificial fertilizers and chemical means for plant protection.

Those are nitrophyl ecological systems including the orchards, vineyards, gardens, border surface along the fields, channels and houses, pod area of roads and yards, and waste dumps. Their mutual feature is increased amount of nitrogen which leading to the flora relation which is reflected in the multitude of common nitrophyl plants (so called. Ruderal communities). Here, it is performed a very strict plant selection with different agricultural measures (plowing, digging, fertilization, pesticide use).

Vegetation of pod area and ruderal habitats is the following:

- Pasture of bearded darnel and broad-leaf plantain (as. *Lolio-Plantaginetum majoris*)
- (as. *Polygono-Bidentetum*)
- Community of tansy and (a. *Tanaceto-Artemisetum*)
- Meadow of (as. *Potentilletum anserinae*)

4.8. Fauna

Current fauna situation is current condition of historical product of all depending factors, and it is not fixed and permanent, because they are together with animals submitted to the uninterrupted changes. In terms of that, the fauna of corridor Vc is likely changed in relation to the most recent available data regarding the war conflicts at the end of the last century in the area of Croatia and BiH. At same time, it should be taken into consideration the anthropogenic output of this area after the war especially in the area where increased the settling.

During the preparation of this „Preliminary environment impact study for the corridor Vc“ we took the pre-war data and data based on the terrain visits and conversation with inhabitants.

Before the preparation of this so called `final` `Environment impact study` we are going to visit more sites in order to get more objective picture of real world, but for the insight of the real condition it will be necessary to carry out several long-term scientific survey requiring a significant material funds.

The beginning of the Corridor Vc, the flat area of Posavina, in zoogeographical terms belong to the so called European sub area panonia subprovinence and subalpic slavianian Srem border area, while the remaining part belong to the middle European alpic area.

4.8.1 Flat area of the corridor Vc

In this flat area, there are found the plain and famous European animals.

Mammals

There are the following mammals: fox (*Vulpes vulpes*) and smaller wild animals, marten (*Martes martes* *Martes foina*), *Mustela putoris* (*Mustela erminea*) polecat, (*Mustela nivalis*), (*Meles meles*) stoat, weasel, badger, by the waters: (*Lutra lutra*) otter, then rabbits (*Lepus europaeus*), (*Sorex sp.*), (*Soricidae*) shrew, (*Talpa europaea*) mole, (*Erinaceus concolor*), hedgehog, small Rodentia (*Apodemus sp.*, *Micromys sp.*), (*Microtus sp.*) such as mouse, (*Myoxidae*), (*Cricetus cricetus*), vole, hamster, (*Sciurus vulgaris*), squirrel, (*Glis glis*) dormouse etc. Since 1932 year, it was settled American muskrat (*Ondatra zibethica*).

There are also different type of bat (*Pipistrellus sp.*), and in the forests wild boar (*Sus scrofa*), roe deer (*Capreolus capreolus*), and in the higher forests deer (*Cervus elaphus*) and (*Dama dama*). And fallow deer in some hunting grounds.

Birds

This area is rich with the following birds: flying fish (*Hirundo rustica*), whitethroat (*Sylvia sp.*), bleak, (*Muscicapa sp.*), thrush nightingale, pipit, wagtail, chaffinch, goldfinch, titmouse, lark, goldfinch, starling, oriole, shrike, jay, crow, cuckoo, quail, hoopoe, roller, kingfisher, falcon, harrier, hawk, sparrow etc. In forest area, there are pigeon, turtledove, woodpecker, green woodpecker and spotted eagle, and by the waters black stork. In humid forests, there are the snipe over the summer which even hatching the young's.

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In the villages of the flat area, there are hatching white storks, and along the swamps and marshes there're heron, duck, diver, raven, moorhen, sedge warbler, pigeons, tumbler pigeon, white-tailed sea eagle etc. During the last years it has showing up in greater number turtledove `kumrija`.

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Reptiles

Among the poisonous snakes, the most often found is common viper (*Vipera berus*) and hop (*Vipera ammodytes*) is a very rare. Among water snakes the most often is (*Natrix natrix*) two-stripe snake. Then, there are (*Coronella austriaca*), aesculapius` snake and among small (*Lacerta agilis* and *Podarcis muralis*.) lizards, there is grey and wall lizard (*Anguis fragilis*) and less present blindworm. Along the waters live (*Emys orbicularis*). marsh turtle.

Amphibians

There are the following frogs: fire-bellied toad (*Bombina bombina*), (*Hyla arborea*), tree frog, green frog, toad of the Bufo genus and rarely found (*Pelobates fuscus*). All within this area live big (*Triturus cristatus*).green newt.

Insecta

Great surface of plowed soil favors to the (*Orthoptera*), insecta, especially grasshoppers, but also (*Hemiptera*) semiwings, coleoptera, (*Lepidoptera*), butterflies, biplanes, hymenoptera and others. Among them appear steppia forms. There are numerous (*Leptinotarsa decemlineata*) and insecta and big farming and forest pest such as: gypsy moth, potato beetle and others.

Along the waters there is flying the (*Odonata*) water flowers, (*Ephemeroptera*), quiver, and among the swarm of mosquitoes there is also somewhat malarial.

In the waters, there are freshwater coleoptera, such as water beetle, and among semicoleoptera scorpion, and others. In the water there are developed larva of mosquitoes and similar dipterous insect, water flowers and others.

Invertebrate

There are found the different snails everywhere: (*Helix pomatia*), roman snail, garden snails, and among rare land kružnozjalac.

In all waters live školjkasi, and at the end of XIX century came from Black sea over Danube-trokutnjaca.

The most often found snails are the following: (*Viviparus sp*), and some smaller such as Neritine, Amphimelanije and others.

Spiders

On the land there are different kind of diplopode and chilopoda, and many other spiders.

Among the small spiders there is watermite, and of real spiders there is silver-shiver water spider.

Fish

In the rivers and other waters, there can be found the following fish: (*Cyprinus carpio*) carp, In some other rivers and waters there are the most found (*Carassius carassius*) (*Tinca tinca*), (*Barbus barbus*), (*Chondrostoma nasus*), (*Abramis brama*) (*Miscropterus salmonides*) and

others. The biggest found fish is sheatfish growing over 100 kg, and there is also huchen that can reach the weight of over 30 kg.

From the fishponds, there were brought some species of North American type of catfish and sunstroke.

Crayfish

Among bigger crayfish (*Astacus astacus*), here can be found crab, and swamp crayfish and in the smaller mountain streams there are (*Austropotamobius torrentium*) crayfish, while of small crabs there are small crabs, amphipode, water toad as well as Branchipus, Chirocephalus, Apus and Limadia.

Other animals

Of other animals there are leech (*Hirudo medicinalis*), oligochete worms, such as (*Nematodes*), (*Turbellaria*), (*Bryozoa*) and there is a famous Fredericella sultana.

Underground waters

Besides the surface waters, there are also underground waters flowing easily in porous, sandy and gravel soil with their special animal world, especially adapted to the underground conditions. Because of the protection of underground waters, there have been protected some ancient animal, especially crabs such as Bathynella and some others, which deserted on the surface so today they are only found in Australia and Tasmania.

Warm springs

There are also some warm springs where live smaller and simpler plants and animals specially adopted to the conditions of increased water temperature. The most important ones are trepetljikaši, then virnjaci, oblići, maločetinaši, kolnjaci, small crabs, some insects and their larva and watermite and small snails.

Stagnant water

In the fishponds and lakes it was developed living community of planctons, where there are in great number found microscope ancient animals, trepetljikasi, veslonošci, waterbugs and kolnjaci. Of the insecta larva there is only larva of mosquitoes Chaoborus crystallinis.

4.8.2. Mountain part of the corridor Vc

The largest part of Bosnia and Herzegovina belong to the middle European alpic area as well as mountain part of the corridor Vc. Below, it will be mentioned the characteristic species of that area.

Mammals

Of big mammals, there is bear which vanishing and wolf which can be found rarer and rarer. Wild cat is also rare, and there are also fox, badger and polecat, stone and pine marten. In Bosnia it can only be found black brown squirrel, there're two kinds of rabbits Bosnian and Herzegovacki, the last area smaller and light grey color. In the high mountains lives chamois and roe deer is rarer found because of the tree cutting and other unfavorable activities? As well, there are the following mammals in the Bosnia: wild boar and it can be found otter, many species of bats, hedgehogs, shrew, mole, ermine, weasel, and many species of dormouse: (*Dryomys nitedula*), (*Eliomys ljuercinus*) and (*Muscardinus avellanarius*). Besides the house rat and carrier rat, there is also the forest and field rats, and in all waters (*Arvicola scherman*) and (*Spalax monticola*).

Birds

Among the birds, these are the most significant ones (*Pyrrhocorax alpinus*), rarely found (*Pastor roseus*), oriole is often found, during the winter it can be found (*Acanthis flammea*), in mountain forests red crossbill, and in the highest mountain area (*Montifringilla nivalis*). It is also important to mention (*Emberiza cia*), it is rarely found (*Calcarius lapponicus*), and more often (*Passerina nivalis*), on the highest peaks (*Otocorys penicillata*). In the west part of Bosnia and Herzegovina, it is built nest (*Budytes melanocephalus*). There are also (*Sitta caesia* and *neumayeri*), in high hills (*Tichodroma muraria*), and in hallow trees (*Parus lugubris*). In the high mountain it can be found (*A. cervina*). Among the shrikes, there is rare (*Lanius senator*), and in Bosnia rarely coming from the north (*Bombicilla garrula*). During the migration through Bosnia it passes (*Muscicapa albicollis*) and other related birds. The most found nightingale is (*Locustella luscinioides*), then (*Acrocephalus aljuaticus*) on swamp places during the migration. There is also (*Erithacus luscinia*) and (*E. cyaneculus*). It is also significant for High Mountain (*Accentor collaris*). In Bosnia there is also (*Coracias garrula*), (*Merops apiaster*), (*Alcedo ispida*). At higher altitudes, it is heard (*Turdus torluatus alpestris*) and (*Monticola saxatilis*). It is also interested (*Dendrocopus leuconotus lilfordi*), and in the mountain coniferous forests (*Picoides tridactylus alpinus*). There is wild pigeon in Bosnia, and rarely (*Tetraestes bonasia rupestris*), (*Tetrao urogallus*) in coniferous forests. It is very rarely seen during the winter (*Otis tarda*). It is rare guest in this area (*Tringa stagnatilis*) and (*Limosa*). Reiser cited, that it was hedged (*Scolopax rusticola*), also found in autumn. Among the Egyptian vulture, there is a very useful bird (*Gyps fulvus*). Of 8 species of eagles in this fauna, it is important to mention the following :(*Aljuilla chrysaëtos*), and rare (*A. heliacea*) and (*Pandion haliaëtus*). It is also mentioned (*Hiëraëtus pennatus*) and (*Circaëtus gallicus*). During the winter, it is rare to find (*Buteo lagopus*), and more often is (*B. rufinus*). Of the falcons, it is very interested (*Cerchneis versperinus*), which at the end of April and the beginning of June passing through Bosnia in great number hunting the bugs and going from the south in the flat area together with young ones it uses the other way not going through Bosnia. The most glorious bird of Bosnia and Herzegovina is (*Gypaëtus barbatus aureus*), and it feeds with bones and emaciated animal. Besides the sparrow hawk and hawk it should be mentioned (*Astur brevipes*). Among harriers it is nested in BiH (*Circus aeruginosus*) and harrier (*C. pygargus*). There is around 10 types of owls in Bosnia, so in the high mountains of coniferous it can be found (*Aegolius tengmalmi*) and (*Glaucidium passerinum*), big one is (*Bubo*), and the smallest one (*Pisorhina scops*) coming in the Bosnia at the end of April.

(*Fuligula fuligula*) and (*F. nyroca*) belong to the Bosnian fauna which from time to time spend the winter on unfrozen places even the rebuilding the nest. During the migration it is seen (*Nyroca ferina*) and rarely (*N. marila*). On the running water there is during the winter (*Clangula clangula*),

Reptiles

There are the poisonous snakes and the most found is (*Vipera ammodytes*), which is fed with (*Apodemus sylvaticus dichrurus*) and lizards, in higher mountain there is (*V. macrops*) and bosnian characteristic snake (*V. Mesocoronis bosnesis*) for which it is said that it is "the most poisonous snake of Europe and its poison is as strong as of cobra in India " (Bolkaj 1929), and it is also familiar *V. pseudaspis*. In Bosnia and Herzegovina there are about ten non-poisonous snakes with several local characteristic. Of ten Bosnia-Herzegovina small lizards it is important to mention (*Lacerta agilis bosnica*), then (*L. vivipara*) on humid mountain meadows, and it is famous as "the rarest small lizard on whole Balkan peninsula".

Amphibians

There were identified 12 species, of which it is necessary to mention Greek frog (*Rana graeca*) and forest frog (*R. dalmatina*), showing a climatic transition from land to Mediterranean form, significant for south Bosnia. There is also very present inhabitant (*R. ridibunda*). The most common is (*Bombina variegata*, Kolombatovici), (*Salamandra atra*, Prenj), and from Bosnia and

especially from Herzegovina is (*Proteus anguinus*); current geographical territory of *Proteus anguinus* coming from the Slovenia and Istra, west Herzegovina, west Bosnia all up to Dalmatia and Herzegovina.

Moluska

Among snails (*Clausilia*) there are many endemic species in karst area *Campylaea* – forms *Dinarica*, *Liburnica*, and *Helix* and *Zonites*-forms. From balcanian forms it comes in Bosnia *Xerocampylaea zelevori*, from mediterranean forms *Fruticicola cinctella*, *Helix aspersa*, *Iberus vermiculatus*, and in the river Bosna *Unio bosniensis*.

Arthropoda

The fauna of centipede of Bosnia and Herzegovina is rich with endemic forms, even more in the orders such as *Microchordeuma*, *Microbrachysoma*, *Heterolathelia*, *Typhiogomeris*, and there is endemic forms from the orders *Julus*, *Brachyiulus*, *Lysiopefalus*, *Brachydesmus* itd.

Fish

The most significant ones are trouts: (*Trutta obtusirostris*), (*T. fario*), (*Salmo hucho*), (*S. fontinalis*), (*S. salvelinus*), (*Thymalus vulgaris*); then (*Barbus petenyi*), (*Alburnus bipunctatus*), (*A. mento*) and others.

Arachnida

With different forms of *Euscorpius* Europeans there are also found in the caves *Neobisium spelaeum*. The typical spiders are from the karts *Argipe lobata*, *A. brunichi*, *Lycosa apuliae*, and in the south Bosnia a cave form *Taranucnus patellatus*. The untypical spiders important for BiH are *Ischiropsalis*-forms, big form of *Trogulus* in the caves of *Nelima troglodytes* and (*Eschatocephalus Haemalastorgracillipes*).

Insecta

For the insecta of Balkan peninsula V. Apfelbeck cited that their fauna is composed of middle European, Siberian, Mediterranean, east new comers from west Asia, adopted to alpinic species and of endemic forms then residues from the Ice age and main part is composed of middle European (Siberian) and east species. According to Apfelbecku, endemic balcania insecta belong to the most alpinic region, and there is a great number of karst endemics. Obstacle to Mediterranean species is the mountains of Dalmatian and Herzegovina.

There are 13 endemic butterflies characteristic for Bosnia and Herzegovina, of which the most valuable ones are *Hiptelia apfelbecki*, and in the high mountains of *Erebia gorge hercegovinensis* and *coenonympha tiphon occupata*.

Of other insecta, there are many domestic species of quiver in Bosnia. Among typical neuropterans, there are 11 families and 17 species of ant lion (Apfelbeck). Of flat wings, there are 2 cm long *Labidura riparia*, many domestic *kožokrilaca*, then *Trixalis nasuta*, in the middle and south Bosnia the type of *Psorodonotus fieberi* (with stunted wings). Among Hymenoptera, it is very significant in the southeast of BiH as the biggest European wasp it is Mediterranean form of *Scolia flavifrons* (5 cm), the biggest wasp is *Cimbex (femorata)*. In the forests on the snow or under the leaves there is the fly (*Chionea araneoides*), which looks like the spider, and (*Echinomyia fera*).

According to Apfelbecku, for Bosnia and Herzegovina there are very significant the races of the order carabus as *C. caelatus sarajevoensis*, *C. croaticus bosnicus*, *C. cancellatus apfelbecki*, then *Nebria bosnica*, *apfelbecki* and *speiseri*, endemic suborder *Stenochoromus* (*Molops*), *Pterostichus meisteri*, *Tapinopterus setipennis*, *Omphreus apfelbecki*, *O. beckianus*, and many endemic forms of cave Coleoptera. Of semi-wings it is important to mention a big cricket of middle and south Bosnia and Herzegovina (*Tibicen haematodes*).

Cave fauna of Bosnia Herzegovina area in big underground area and waters under uniform living conditions of the light, warm, humidness and others presents a very special biotope, where developed many special forms. In this geographical area, according to Apfelbeck, "there are favorable conditions for development of big fauna, especially rich with endemic forms. Further to east that fauna was reduced because of the development of crystal forms, and the richest is in the area of BiH, and the west neighboring countries which is already confirmed with the 21 order of coleopteran with 70 species, at other Arthropoda there are also famous endemic orders and species. . V. Apfelbeck already found first cave insecta in BiH and described them.

Cave fauna

As the surveys showed, most balcan endemic animals of the caves are Arthropoda. They are real `inhabitants` of the caves without pigment, without eyes and with very woundable senses of smell and touch, and on the long lengs. Fauna of insecta in the caves of BiH contains many domestic forms, for example. Anthoherpon has 18 famous species. Those forms are filogenetically completely isolated in current fauna and present `the oldest recent forms between coleoptera". Except of Coleoptera, less other insecta live in the caves, such as some grasshoppers, without wings insecta; there is also endemic Verhoeffiella cavatica and others.

Of cave animals there are also pale colored species of Niphargus and Typhlogammarus, and for the Herzegovina it is endemic Stygodytes (balcanicus), and Antroplotes. For karst area it is significant to mention Titanethes hercegovinensis, t. biseriatus, Monolistra hercegovinensis (Asellus cavaticus), and of crabs Troglocaridella hercegovinensis (Vjetrenica). There are also found cave centipede: Typhloglomeris coeca, Brachydesmus zavalensis, Br. hercegovinensis, Apfelbeckia lendenfeldi, Lithobius leostygus, and of : Obisium anophthalmum, Stalita hercegovinensis. It is also endemic cave small snail (Phloeoteras euthrix), and blind leech (Dina absoloni) and worm (Marifugia cavatica).

4.9. Landscape

With framework survey of landscape characteristic of this area, characteristic type of settlement, its location and relation to the surrounding area, the way of agricultural plowing of the area which surrounding the settlement, spatial organization-matrix of the settlement, characteristic and the way of typical plot use, structural, morphological and functional features of residential and economic architecture, there have been reached the following conclusions:

Wider intake area belongs to the north peripannonia part of Republic Srpska which is characteristic by hilly terrain which gradually lowering in the inland area.

Relief structure is consisted of low flat area, arable river valleys and flats, slight uplifted terrains and slopes. In the intake area, there is mostly valley and hilly relief (up to 200 m. altitude), and less low hilly area (200-600m). Lowlands include the area up to 200 m.altitude and make the largest part of the intake area. Piedmont regions cover the hilly parts of the area. These are the area with altitude between 200 and 500 m. .

Piedmont of the target area includes the slopes that lowering in the valley of the river Bosna. Higher parts are covered with the forest (beech, fir, maple). The lowest slopes were cultivated in the agricultural land, where there are changing the hilly meadows and forests.

Wider area of the intake area is characteristic by valley type of landscape bordering with the hilly one. For wider intake area it is characteristic the zone of inflow of these two areas with collimation lines containing the elements of both types. Landscape of the lowland areas is mostly determined with forest and agricultural land which changing and the picture of

landscape. Valley landscape is longitudinally crossed with the river Bosna, almost through the middle part. Elevations of hilly landscape are covered with forest and pastures. In that hilly area, there are constructed the family houses of the suburban type with developed garden agriculture.

The landscape of wider spatial entity can be divided into four basic categories of the landscape:

- Natural landscape
- Cultivated landscape
- Constructed landscape
- Cultural-historical landscape.

4.9.1 Natural landscape

This landscape type is related to the area with mostly natural elements, without any civilization intervention, and if they occurred, they happened permanently and without any radical movements. In the largest part, these are the water and coastal land and the forests.

Forest

Forest cover approximately one third of total surface of the intake area. As the most exposed element of the landscape in this area, forest is the bearer of the landscape` identity, but level of the native conserved forests is low since they are in the largest part scattered with agricultural plots.

Natural landscape is in the largest part found in the hilly area where there are found smaller settlements and scattered individual structures, agricultural activity is undeveloped, and it dominates the forests and scattered vineyard land. Due to poor economic development of this area, there haven't been performed any interventions so it remained the original landscape, and the greatest danger presents depopulation which leaving behind the neglected residential objects and agricultural land.

4.9.2 Cultivated landscape

Preserved natural area and relatively low level of urbanization protected the larger part of the area from the larger damages and it was preserved a recognizable identity of rural structure joining with natural background. Exactly those small settlements, villages and numerous hamlets which intersecting and melting with natural background and fitting in the landscape, together with way of living and land use, make the picture of typical rural landscape.

This type of the landscape is characteristic by agricultural land, the settlements of not high population density, and the construction which significantly don't disturb the natural landscape but melting with it. There are characteristic larger rural settlements of dispersion type.

Large agricultural land is in larger part cutted on small plots, which exchange with forest zones. Within this area, it passes the network of road and railroad, in longitudinal and transferzal direction, but they are not of significant dimension and capacity to make an impact on the quality of landscape.

In some parts, a specific rural landscape was changed with excessive plotting of the farms in fruit and wine growing area, with uncontrolled (illegal) residential construction without associate infrastructure so the rural area lost their native values.

Physiognomy of rural landscape is disordered with improper construction of facilities that are not adopted to natural particularities of the area and constructed on visually valuable and exposed sites and on the contact with forests and watercourses.

4.9.3 Constructed landscape

This landscape is related to the urban structure, and the natural landscape is so changed in that area that it becomes unrecognizable. This type of landscape is related to three towns (Odzak, Modrica, and Doboj), industrial zones and facilities out them and some larger municipal centers having semi urban character. In the lowland landscape, higher residential and industrial objects are big accents in the collimation lines. With extension of the settlements along the roads, it is lost their original morphology; it disappears the points of the beginning, center and the end of the settlements, and there is created the urban unnatural ensembles. In larger settlements it is already noticed the trend of longitudinal construction near the roads. It is also unsatisfactory the quality of construction forms.

Water surface

Water surface as landscape element has also big significance in overall area. The river Bosna with its natural attraction, in ecological and esthetical terms presents the category giving the special quality to this area.

Settlements

In the system of the settlements and population density, there are identified the settlements-complexes, because they are of broken type and cover a large territory. System of the settlements is extremely dispersive. Most of the settlements are of rural structure, where only recently started the entry of urbanism elements, so they are well consolidated in the landscape. The largest settlements are Odzak, Modrica and Doboj.

4.9.4 Cultural-historical landscape

This landscape has been created for long time period, and made of ensembles and structures having monumental value together with their direct surrounding area. Because this landscape is the ensemble with recognizable spatial, historical, cultural and other values, it will be expressed an integral approach of the protection of cultural monuments and natural surrounding heritage.

4.10. Protected nature area (natural heritage)

According to the Spatial Plan of Republic Srpska, that is the insight into basements for planning documents of the highway on Corridor Vc –LOT1, it has been concluded that there are no specially protected nature parts. The identified plant **species proposed for protection** in this are are the following ones:

1. *Cerastium dinaricum g. beck*
2. *Dianthus knarii ascherson*
3. *Dianthus liburnicus bartl.*
4. *Dianthus sanjuineus vis.*
5. *Minuartia bosniaca k. mali*
6. *Silene sendtneri boiss*
7. *Silene reichebachii vis.*
8. *Silene tommasinii vis.*
9. *Aljuilegia dinarica g. beck*
10. *Aljuilegia grata f. mali*
11. *Aljuilegia kitaibelii schott.*
12. *Ranunculus scutatus njaldst*
13. *Corydalis ochroleuca koch*
14. *Barbarea bosniaca murb.*

15. *Hesperis dinarica* g. beck
16. *Saxifraga prenja* g. beck.
17. *Potentilla carniolica* a . kerner.
18. *Potentilla montegrina* pant.
19. *Potentilla visianii* pančić
20. *Astragalus illyricus* bernh.
21. *Shammaecytisus tomassini* rothm.
22. *Genista sericea* njulfer. in jac.
23. *Lathyrus Binatus* Pančić
24. *Oxytropis campestris* dc.
25. *Vicia montenegrina* rohl.
26. *Vicia ochroluca* ten. subsp. *dinara* k. maly
27. *Euphorbia gregeri* k maly
28. *Haplophyllum boissierianum* vis i pančić
29. *Rhamnus intermedius* stendel
30. *Rhamnus orbiculatus* bomm.
31. *Kitaibela vitifolia* njilld.
32. *Daphne malyana*
33. *Viola beckiana* fiala
34. *Viola elegantula* sschott.
35. *Viola zoysii* njulf. subsp.
36. *Fumana bonepartei* maire.
37. *Athamanta hainaldii* borbas
38. *Bupleurum karglii* vis.
39. *Caerophyllum coloratum* l.
40. *Eryngium alpinus*
41. *Grafia golaka* reich.
42. *Pancicia serbica* vis.
43. *Pucedanusm neuma yerii* reich.
44. *Seseli globiferum* vis.
45. *Seseli malyi* a kern.
46. *Gentiana dinarica* g. beck.
47. *Vincetoxicum huteri* vis.
48. *Asperula scutellaris* vis.
49. *Halacsya sendtneri* dorf.
50. *Onosma stellulata* njald.
51. *Acinos majoranifolius* šilić
52. *Micromeria croatica* schott
53. *Micromeria perviflora* reich.
54. *Micromeria thymifolia* fritsch.
55. *Salvia brachyodon* vandas
56. *Saturea horvatii* šilić
57. *Saturea subspicata* bartl. ex vis.
58. *Stachys anisochila* vis.
59. *Teucrium arduini* l.
60. *Thymus braceosus* vis.
61. *Euphrasia dinarica* murb.
62. *Pedicularis hoermannianum* k. maly
63. *Scrophularia bosniaca* g. beck
64. *Scrophularia tristis* k. maly
65. *Verbascum bosnense* k. maly
66. *Veronica saturejoides* vis.
67. *Plantago reniformis* g. beck.

68. *Lonicera glutinosa vis.*
69. *Viburnum maculatum pant.*
70. *Valeriana bertisceae panić.*
71. *Cephalaria pastricensis dörf.*
72. *Knautia sarajevensis szabo.*
73. *Scabiosa fumarioides vis.*
74. *Scabiosa silenfolia njald .*
75. *Succisella petteri g. beck*
76. *Campanula hercegovina degen*
77. *Campanula portenschagiana schultes*
78. *Campanula njaldsteiniana schultes*
79. *Edraianthus serpyllifolius a. dc.*
80. *Edraianthus tenuifolius a . dc.*
81. *Symphyadra hofmanni pant.*
82. *Achillea abrotanoides vis.*
83. *Centaurea glaberima tausch.*
84. *Centaurea derventana vis.*
85. *Cicerbitra pancicii beauverd.*
86. *Crepis dinarica g. beck*
87. *Omalotheca pichler j. holub*
88. *Leucanthemum chloroticum a. karn.*
89. *Leucanthemum ilyricum papeš*
90. *Reichardia macrophylla vis.*
91. *Tanacetum cinerariflorum shultz.*
92. *Fritillaria gracilis ascherson*
93. *Lilium cataniae vis.*
94. *Scilla litardierei*
95. *Crocus dalmaticus vis.*
96. *Iris reichenbachii var. bosniaca. g. beck*
97. *Iris pseudopallida vrin*
98. *Arum petteri schott*
99. *Nigritella nigra rchb.*
100. *Homogyne discolor cass.*
101. *Amphoricarpus autariatus bleč.*
102. *Achillea clavenae l.*
103. *Achillea liugulata njald. et kt.*
104. *Leontopodium alpinum cass.*
105. *Aster alpinus*
106. *Aster bellidiastrum scopo.*
107. *Arnica montana l.*
108. *Edraianthus sutjeskae lakuš*
109. *Campanula thirsoidea l.*
110. *Campanula alpina jaclj.*
111. *Knautia travnicensis szabo*
112. *Gentiana kochiana pert. et song.*
113. *Entiana lutea l.*
114. *Gentiana punctata l.*
115. *Plantago gentianoides sibth.*
116. *Lamium gargamicum l.*
117. *Scutellaria alpina l.*
118. *Pinljuicula leptoceras rohö.*
119. *Pedicularis brashydonta schlos.*
120. *Veronica aphylla l.*

121. *Veronica alpina l.*
122. *Ligusticum mutellina srautz.*
123. *Linaria alpina mill.*
124. *Primula uricula l.*
125. *Androsaceae lactea l.*
126. *Androsaceae villosa l.*
127. *Soldanella pusilla baumg*
128. *Soldanella alpina l.*
129. *Armeria canescens host.*
130. *Linum capiatum kit.*
131. *Daphne oneorum l.*
132. *Geum bulgaricum panč.*
133. *Geum montanum l.*
134. *Dryas octopetala l.*
135. *Saxifraga caesia l.*
136. *Saxifraga oppositifolia*
137. *Sedum alpestre bill*
138. *Sempervivum schlechanin schott*
139. *Alyssum scardicum var. bosniacum nayek*
140. *Papaver kernerii hayek*
141. *Trollius europaeus l.*
142. *Ranunculus crenatus nj. k.*
143. *Anemone anrcissiflora l.*
144. *Pulsatilla alpina schrank*
145. *Saponaria bellidifolia sm.*
146. *Silene acaulis l.*
147. *Drypis spinosa l.*
148. *Dianthus superbus l.l*
149. *Polygonum bistorta l.*
150. *Rumex sotuatus*
151. *Asplenium fissum kit.*
152. *Taxus bacatta l.*
153. *Alnus viridis*
154. *Salix retusa*
155. *Leontopodium nivale hent.*
156. *Dactylorhiza sambucina soo*
157. *Dactylorhiza cordigera soo*
158. *Adaianthum capillus veneris l.*

4.11. Cultural-hystorical heritage

Within the survey area and for the purpose of setting up the alignment of planned highway on the corridor Vc, section Svilaj-Doboj in the area of municipal territory where it will be passing the planned alignment according to the available spatial-planning documentation and data related to the Commission work for preservation of the national monuments of BiH, it was recorded the archeological and construction heritage. Due to the lack of legal provisions deal with the issues of classification and keeping the records of cultural heritage in Republic Srpska it was only given the summary of recorded cultural-historical heritage per municipalities but without their origin, determined significance, classification and the protection measures.

The summary given below doesn't have a detail specification regarding a precise position, the accurate title, and type of cultural-historical heritage. It is thought that data at this level with emphasis on the relation to the alignment of highway.

4.11.1. Municipality Odžak

Within the survey limits and having in mind the proposed alignments of planned highway, in the area of this municipality there are currently 10 cultural-historical monuments not endangered by the project.

4.11.2. Municipality Vukosavlje

Potential alignments can make an impact on (2) cultural historical monuments of which most of them were sited in the area of municipality Vukosavlje. Mentioned monuments are located within the survey limits.

4.11.3. Municipality Modriča

In the area of the municipality Modriča, among many existing cultural-historical monuments, one (1) is not located within the survey area limits and the one is located next to the border of area where passing two potential alignments.

Stationary cultural-historical heritage of Republic of Srpska was divided and especially analysed as: archaeological heritage and heritage of history and culture.

Municipality Modrica has a very rich archaeological and cultural heritage, the cultural monuments classified on the temporary list of national monuments of Bosnia and Herzegovina. The list of archaeological goods in the area of municipality:

Prehistory:

BRDO IZNAD JAKESA, Jakes. Pre-history ruin

MODRICA, Srpska varos. Pre-history pantry

Pre-history, Rome, Middle Ages:

CRKVINA, Jakes. Remains of old church next to the spring Pecare, DOBOR, Jakes. Pre-history ruin, Roman and early-Slovenic settlement, medieval town and medieval necropolis.

CIGLA, Skugric Gornji. Roman settlement and medieval thomb.

GRADINA, Skugric Gornji. Pre-historic, roman and early-slovenic settlement.

Temporary list of national monuments of Bosnia and Herzegovina

1. Church Uspenja Bogorodice
2. Koprivna – Church Vaznesenja Hristovog
3. Osjecani – Church Vavedenja Bogorodicinog

4.11.4. Municipality Doboj

Immobile cultural historical heritage of Republic of Srpska was divided and especially surveyed as: archeological heritage and heritage of history and culture.

Municipality Doboj is rich with archeological and cultural heritage, and it has the monuments of culture listed on temporary list of national monuments of BiH. List of archeological monuments in the area of municipality:

Pre-history:

BARE, Grabovica. Pre-historical necropolis with tumulims.

HENDEK, Makljenovac. Paleolithic station and settlement from Irons age.

KAMEN and LONHA, Makljenovac. Paleolithic stations.

DANILOVIĆA BRDO, Podnovlje. Paleolithic station and traces of neolithic settlement.

GRABOVCA BRDO, Podnovlje. Paleolithic station.

GREDA, Podnovlje. Pre-historical necropolis.

DOBOJ-CENTAR, Dobo. Pre-historical settlement.

ĐUKIĆA VIS, Božinci. Paleolithic station and pre-historical necropolis with arson

KUŠUM, Karuše. Paleolithic station.

Rome period:

GRADINA, Dobo. Roman castrum and sofa.

Middle Ages:

BAŠČA, Alibegovci. Medieval necropolis.

KOSICA, Alibegovci. Medieval necropolis.

CRKVINA, Podnovlje. Medieval church on right side of stream Glogovina.

GREBLJE NA LIPI, Podnovlje. Medieval necropolis.

HAMIJA NA ČARŠIJI, Dobo. Necropolis and medieval church.

GRAD, Dobo. Medieval fortress. (On temporary list of national monuments of BiH).

DOBOJ, old town. (On temporary list of national monuments of BiH).

GRČKO GREBLJE, Brestovo. Medieval necropolis next to contemporary rural cemetery.

GRADINA, Mravici. Medieval fortress and necropolis.

ULER, (Razvale), Bukovica Velika. Medieval necropolis.

Prehistory, Rome, middle ages:

GRAČAC, Alibegovci. Pre-historical and roman settlement.

CIGANIŠTE, Brestovo. Pre-historical settlement above Ukrina, and higher medieval fortress called Gradina.

CRKVINA, Makljenovac. Paleolithic station, lateeliolithic, lateneolithic, latebronze and early iron settlement, lateclassical refugij, medieval church and necropolis.

KUŽNO GREBLJE, Mali Prnjavor. Roman settlement and medieval necropolis.

GRADINA, Kožuhe. Prehistorical ruins, fortress and settlement from Middle ages.

Temporary list of national monuments of BiH

1. Fortress
2. Old town
3. Boljanić – Church Silaska sv. Duha
4. Dragalovci – Cemetery chappel ad cemetery
5. Srpska Grapska – Church Vaznesenja Hristovog

4.12. Hunting

According to valid ecological-vegetation division of Bosnia and Herzegovina forest area, all alternative routes of the highway „Svilaj – Dobo jug“with its whole length passing through Pripannonia area, i.e. north Bosnian area. Northbosnian area where it is passing it is characteristic by the flat and hilly area and the slopes of hilly-mountain area where apear specific lowland forests. Target area is the flat of alluvial terrace, lowland and low-hilly area which is characteristic by the mesophyl forests of oaks.

In north part of the LOT1, on the most humid places there are the habitats of the forest of black alder (*Alnetum glutinosae*), and the habitats of field European ash (*Leucoio- Fraxinetum angustifoliae*). On recent fluvisols there are the forests of willow and poplar (*Populetum albo – nigrae*). In lowland area and the flats of diluvial terraces there are the forests of the hornbeam (*Carpino betuli – Quercetum roboris incl. Genisto elatea – Quercetum roboris*). In wider belt of hilly area, these forests are partially in the contacts with the forests of hornbeam (*Quercetum Carpinetum*) and fragments of the beech and fir (*Fagetum montarum*) in the south part of the LOT1.

In terms of specific climatic, geomorphologic conditions of the area, where there are planned the alternative routes, mentioned ecological-vegetation communities in the part of „Svilaj - Mala Bukovica“ occur in small fragments as the group of small number of trees, as line of trees along the roads or as individual trees in all development forms. These fragments of vegetation communities have first of all protective function.

General characteristic of the area in terms of hunting – management aspect

All proposed alternative routes of the future alignment with the largest part cover the habitats of small game and with one part also of big game. Species that live in the area included in the proposed alternative routes and which are significant for hunting-management are first of all: Rabbit (*Lepus europaeus* Pallas), Gray partridge (*Perdix perdix* L.), Pheasant (*Phasianus colchicus* L.), Quail (*Coturnix coturnix* L.), and different kind of swamp birds (wild ducks and goose, moorhen etc.), mostly along the water courses, and of the big game there are roe deer (*Capreolus capreolus* L.) and wild boar (*Sus scrofa* L.).

4.13 Condition of communal noise

There are no data about the level of existing noise for the area of planned intake. The area where it will be passing the corridor of the highway Vc, pass through different zones having defined the different maximum of allowed noise level. In order to get any data, it will be used data about noise survey in Modriča for the purpose of the construction of the bridge across the river Bosna. Maker of this apt of the study is aware of the fact that these are strictly local data which can not fully be applied for whole intake area, but giving the framework picture about the noise level that can be applied (at least approx.) for the assessment of the communal noise level along the town settlements.

Noise survey in Modrica environment was carried out in period 19.-20.11.2003 year on two survey places. Subject of survey is determination of noise level in the area close to existing roads, but in the yone of future facilities impact. Choice of the survey places was also made to overview the intensity of usual noise, and the results will serve as zero and initial condition of noise assessment during the construction and exploitation of the facilities.

Noise survey in environment was carried out in accordance to international standard ISO 1996 and ISO 9613, as well as regulations following these standards. Used survey equipment belongs to the class 1 of instruments, and completely fulfills the standard IEC 62672 (which replaced the standards IEC 60651 and IEC 60804). Standards and provisions for noise estimate are different ones and allowed noise level is not same in all countries. The parameters that figure in the assessment are the most often or just equivalent noise level L_{eq} (dBA), or rating noise level ("Rating level"), L_r which includes certain additions depending on the noise type.

Instrument for the noise survey

Survey of the noise level was conducted with following instrument:

Integrating Sound Level Meters (class 1) 2238 Mediator™-Bruel&Kjaer-Danska, serial number 2368859 with compositional following variants:

- Basics Sound Level Meter Softnjure BZ 7126
- Enhanced sound Level Meter Softnjure BZ 7125
- Logging Sound Level Meter Softnjure BZ 7124
- Frequency Analysis Softnjure BZ 7123
- Sound Level Calibrator – Type 4231 Bruel&Kjaer as well as software for computer data processing
- Noise explorer 7815.

For above mentioned survey, it was used the software version: Enhanced Sound Level Meter, Softnjare BZ 7125 since it best reflects the traffic noise, which is the most essential in this case.

Noise survey was conducted in the way that the instrument is fixed on tripod on 1,5 m from land. In proximity of the construction facility the instrument was always on the distance larger than 5 m. Since the noise is measured in outside environment, microphone was focused towards the noise source in the position "Frontal". To establish the noise intensity, the survey was done in more time intervals during the day.

4.13.1. Description of the survey places

On the observed location, the survey of noise level was done on several survey places. Selection of these places was made based on the impact zone of future highway in the aim of overview of current condition and common noise level near the future highway. There were determined two characteristic points from the left and the right bank of the river Bosna. (Survey places MM-1, MM-2).

Survey place MM-1 was located in the circle of the construction material storage about 40 m from the bridge of primary route Bijeljina – Doboj. Instrument was set up in the direction of the bridge. On that direction there is no obstacles or barriers. Instrument was set up in the direction of bridge. On the right and left side of the survey place watching towards the bridge, there are pallets with construction material of the height up to 2 m, and on the 20m from the left side there is prefabricated building of the open storage.

Survey place MM-2 is located about 80 m downstream from the future road alignment, 150 m downstream from existing transmission line, 30 m from the river bank and 50 m upstream from the weekend house belongs to the parcel with cadastre number 879/16. Surrounding terrain, except of the river bank, was not overgrown with vegetation and those are mostly the meadows and fields.

4.13.2. Noise sources

Main noise source on the survey place MM-1 presents the traffic on mentioned bridge of the primary route Bijeljina – Doboj. Additional but not decisive noise source present the works performed in the circle of the storage. Efficiency of this noise is of limiting character and it occurs in the moments of loading of the pallets with forklift in the truck. Traffic noise, which is very frequent in this part of the primary route can be characterized as broken, variable intensity with temporary impulses that appear during the passing the truck with trailer.

Noise sources on this survey place MM-2 can be spotted on the larger distance. Constant noise measured here has the character of background noise and derives from the traffic ran on the existing bridge in Modriča. Second registered noise source is settled downstream for 200 m and derives from dredge loading of the gravel excavated from the river bed. At the location of survey place there is no more significant noise source.

4.13.3. Survey conditions

Noise was measured in the outside environment, with parameters given in the survey reports and with described methodology. On the survey place MM-1 there are constructed objects. It is significant to mention prefabricated object in the form of half-open storage of the height about 5 m in which proximity was set up the noise meter. As possible reflecting surfaces it can be taken into consideration the palette with construction material of the height up to 2m. In the survey

direction there is no obstacles. Overgrown with the vegetation is present in the coast area and not significantly impact on the survey results.

Middle weather values were shown in the table T.4.13-01, and equivalent noise levels on the survey places were shown in the table T.4.13-02.

Table T.4.13-01: Middle value of weather situation

SURVEY PLACE	AIR TEMPERATURE (°C)	AIR PRESSURE (mbar)	Speed of air flow (m/s)	Weather situation
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 T.4.13-02: Equivalent noise level on the survey places

SURVEY PLACE	SURVEY DATA	START NAD END OF SURVEY	TIME OF SURVEY	EQUIVELANT 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

4.14. Infrastructure

4.14.1. Municipality Odzak

4.14.1.1. Road network

The area of Odzak municipality is located on north border of Bosnia and Herzegovina and leaned on the right bank of the river Sava. Through the area of Odzak municipality, it extends the primary route of M14.1 with section Vukosavlja – Odzak- Svilaj, as well as the regional roads R464 Odzak – Samac and R464 Odzak – Svilaj. These three roads are crossed in the central area of Odzak, making the junction with very high degree of capacity use and poor service level.

These three directions make the primary traffic network in the area of Odzak municipality. The length of primary route M14.1 through the municipality Odzak is 24 km. Surfacing of this section is in comparative good condition. Regional roads R464 and R464a through the area of Odzak municipality extend with length from 16 and 14 km successively.

Besides the mentioned primary road network, the rest of network includes the number of local and unclassified roads in the area of Odzak municipality. Concerning the fact that the area of

Odžak municipality is located in plain area of BiH, that is the relief as impact factor has not made too big impact on geometric elements of road network.

The table below gives the outline of local roads delivered by the authorities of Odžak municipality.

Table 5.2.1.7: 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.	Bijeje Bare-Novo Selo	5.40 km		5.40 km
5.	Donjani-Lužnjani	1.70 km		1.70 km
6.	Donjanji-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-Panjička	1.30 km		1.30 km
20.	Gornja Dubica-Noví 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-Bijeje 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.	Bijeje bare-Novo Selo	15.00 km		15.00 km
34.	Čivčije Bukovačke-Grabovica	7.50 km		7.50 km
	TOTAL OF LOCAL ROADS	118.40 km		118.40 km

4.14.1.2. Electric power system

In the area of Odžak municipality, the future the highway alignment of Vc at few sites will cross the 04/10 and 0, 4 kV ducts while 35 kV transmission line Odžak – Novi Grad is found in wide zone of the corridor Vc.

4.14.1.3. Telecommunications

The network of telecommunication system in the area of Odžak municipality includes the regional automatic switchboard (AS) located in the town center and local AS (projected degrees of RSS) in the following settlements: Svilaj, Pavlovac, Vrbovac, Novi Grad, Posavska Mahala, Gornja Dubica, Novo Selo, Ada, Malo Polje, and Kacevi.

From Odzak municipality, according to the mentioned projected degrees it was laid the optical cable.

On one part of future highway of Vc passing through municipal area of Odzak, there are telecommunication cables which with one part going parallel with planned highway alignment on the distance from around 0.7 to 2.5 km.

It was planned the laying of optical cable along the regional road Svilaj-Novi Grad, and in less numbered settlements there are the postal counters and mail boxes.

4.14.4. Water supply and disposition of waste waters

Main source area for the water supply of the urban area of Odzak municipality are underground waters pumped from 4 well located in the proximity of settlement, with total capacity of around 25 l/sec. Water intake occupies the area of around 2,5 ha of the land owned by PE "Komunalac", j.s.c. Odzak.

Storage capacity presents the metal tank of 200 m³, set up on the water tower of 40 m above ground surface.

Besides the main source area located in Odzak, there are also water intakes-wells in the settlements such as Odzak, Ada, Novo Selo, Gornja Dubica – Papučja, Vojskova, Zorice, Prud, Prnjavor, Donji Svilaj, Vrbovac, Novi Grad.

It is general conclusion that current underground waters in the territory of the municipality are not sufficient for long-term water supply.

According to previous studies of Odzak municipalities, the sufficient water supply could be provided with the new connection to the regional system of waterworks "Sjeverna Bosna". As the source area of regional waterworks "Sjeverna Bosna", where according to the plan will be connected the Odzak municipality there are the following alternatives: surface impounding reservoir in the middle flow of the river Bosna (out of the territory of municipality Odžak) and underground waters of Modricko – Odžačkog luga (partially covers the are of municipality).

Problem of waste water disposition has only been solved in the narrow urban area of the settlements of Odzak municipality. Current sewage system is of mixed type, where the same canal used for the drainage of storm and waste waters produced by population and industry. Main sewer of Ø1000 mm was constructed to the natural depression of Neteka, where without previous treatment it was done the waste water disposition. Sewage treatment plant was not constructed yet. Existing way of waste water disposition creates very difficult sanitary situation: there is intensive organic mattes decomposition, with all harmful consequences, and in the period of high waters it occurs effusion of waste waters on surrounding terrain.

For the urban area of municipal center of Odzak, planned site of sewage treatment plant is southeast, directly in back of the urban area at Tuk site. It was planned that reclaimed waste and storm waters be discharged with common main drain in the river Bosna.

Other settlements in the most cases do not have any sewage system, but using the individual septic tanks or directly discharge the waste waters in the nearest water flows.

4.14.2. Municipality Vukosavlje

4.14.2.1. Road network

The area of Vukosavlje municipality occupies the north part of Republic of Srpska. The area of municipality crossing the primary route M14.1 which is the pole of traffic network of Vukosavlje municipality.

Mentioned route through the municipality Vukosavlje extends with the length of 6 km and of qualitative road surface. The rest of road network includes the local and unclassified roads; outline of local roads is shown in the table no. 5.2.2.6.

Table 5.2.2.6.: Road network - local and unclassified roads

	Section	Asphalt	Macadam	Total
1.	Odžak-Potočani	4.50 km		4.50 km
2.	Odžak-Jazavac	2.50 km	1.20 km	3.70 km
3.	Odžak-Gnionica	4.80 km		4.80 km
4.	Odžak-Potočanski Ritovi	4.50 km		4.50 km
5.	Potočanski Ritovi-Kočević	3.50 km		3.50 km
6.	Tuk-Čopori	1.50 km	1.50 km	3.00 km
7.	Odžak-Čopori	2.50 km		2.50 km
8.	Jakeš-Modrički Lug	3.50 km	2.20 km	5.70 km
9.	Rupovi-Zeleni Vir			
10.	Pečnik-Modrički Lug	15.00 km		15.00 km
	TOTAL OF LOCAL ROADS	42.30 km	4.90 km	47.20 km

Small length and poor developed traffic network as well as relatively small number of registered vehicles in the area of Vukosavlje municipality made an impact on small number of traffic accidents.

Number and structure of registered vehicles in the area of Vukosavlje municipality was shown in the following table.

Table 5.2.2.7. Number of registered vehicles in the area of Modrica municipality in the years 2004 and 2005.

Type of vehicles	2004	2005
Bus	-	-
Motor cycle	10	5
Service vehicle	14	2
Passenger vehicle	441	373
Work vehicle	-	-
Special vehicle	-	-
Freight vehicle	28	16
Tractors	-	-

Table 5.2.2.8. Number of registered traffic accident in the area of municipality Vukosavlje

TA*/road category	2004. year			2005. year		
	Primary	Regional	Local and town streets	Primary	Regional	Local and town streets
TA with dead persons	0	0	0	0	0	0
TA with injured persons	2	0	1	1	0	1
TA only with material damage	3	0	3	2	0	4

* - Traffic accident

4.14.2. Telecommunications

Local automatic switchboard (LS) sited in the center of municipality presents telecommunication network system in the area of Vukosavlje municipality.

Optical cable connecting that LC with LC of Modrica crossing with planned the highway alignment of Corridor Vc as was shown on graphical supplement of the study.

Concerning the postal traffic, it is focused on the postal center in Vukosavlje.

4.14.3. Water supply and waste water disposition

Water supply of current consumers in the Vukosavlje municipality is performed from the source area in Modričko polje that is water supply system of Modrica. Main supply pipe and distribution network can not in qualitative way current requirements and especially planned requirements of population.

For the area of Vukosavlje municipality, perspective solution of water supply should be found in regional concept of municipalities of north Bosna central part.

Waste water drainage still was not solved with public sewage system. Consumers discharge the household waste waters depending on the site: in the nearest water flows (without treatment) or in individual septic tanks.

4.14.3. Municipality Modriča

4.14.3.1. Road network

Municipality Modrica is located on the banks of river Bosna in north part of Bosnia and Herzegovina. It is found on the junction of road directions east – west (Banja Luka – Bijeljina border) and north-south (north border - central part of BiH). In the area of Modrica municipality, there is crossing of many regional and primary routes. As the most significant crossing it can be distinguished the crossing of primary routes M17 and M14.1. Primary traffic network of Modrica was made of these two routes. The following table gives the outline of local roads in the area of Modrica municipality.

Table 5.2.3.7.: Road network - local and unclassified roads

Municipality Modriča	Section	Asphalt	Macadam	Total
1.	Jakešnica-Pečnik	2.00 km		2.00 km
2.	Put uz rijeku Ljubioču	5.10 km	12.90 km	18.00 km
3.	Jakešnica-Modrički Lug	4.00 km		4.00 km
4.	Dugo Polje-Vranjak		From primary route M17 to the river Bosna is macadam	10.00 km
5.	Botajica-Jošava	2.30 km	7.70 km	10.00 km
6.	Put uz Botajičku rijeku	5.00 km		5.00 km
7.	Prnjavor-Žabari	5.50 km		5.50 km
8.	Brezik-Vrbovački Lipik	11.00 km		11.00 km
9.	Prudovi-Čopori	13.50 km		13.50 km
	TOTAL OF LOCAL ROADS	18.40 km	21.60 km	40.00 km

Table 5.2.3.8.. Number of registered vehicles in the area of Modrica municipality in 2004 and 2005 year.

Type of vehicle	2004	2005
Bus	12	18
Motor cycle	38	44
Service vehicle	84	85
Passenger vehicle	4455	4152
Work vehicle	-	-
Special vehicle	-	-
Freight vehicle	372	356
Tractors	-	-

Table 5.2.3.9. Number of registered traffic accidents in the area of Modrica municipality in 2005 and 2006 year.

TA /road category	2004. year			2005. year		
	Primary	Regional	Local and town streets	Primary	Regional	Local and town streets
TA with death persons	0	0	0	0	0	0
TA with injured persons	24	6	17	22	3	9
TA only with material damage	89	9	50	64	8	58

- Traffic accidents

4.14.3.2. Electric power system

In the area of Modrica municipality, future alignment of the highway on Corridor Vc at few sites will be crossing 0, 4 and 10 kV ducts, while at one site passing below 110 kV long-distance

power line Modrica – Derventa. In wide area of the highway Vc, there is one 110/H kV electricity substation while it is as well planned the construction of new 110 kV long-distance power line of Modrica, next to the alignment of the highway on the right bank of river Bosna.

4.14.3.3. Telecommunications

It was installed the local ATC in Modrica that was connected to primary optical cable towards Brcko, that is towards Doboj. Postal traffic is run over the post offices in Modrica and Milosevac.

4.14.3.4. Water supply and disposition of waste waters

Main source area for the water supply of Modrica is located in Modricko polje (on about 2 km southeast from Modrica towards Gradacac). The source area is composed of 3 bored wells with depth from 28, 00 to 33, 00 m; total spring yield is estimated from 100 to 126 l/sec. Besides the urban area and suburban settlement of Modrica, the source area located in Modricko polje is used for the water supply of urban area suburban settlement of Vukosavlje municipality.

Besides the main spring in Modricko polje, in immediate zone of the highway alignment of Corridor Vc there are many local water works: waterworks of Modricki lug, then local waterworks (well) of the following villages such as: Jakes, Pecnik, Kuznjaca, Tarevci, Brvno, Babesnica, Karamanici, Botajica, Mala rijeka.

According to made studies for long-term water supply of Modrica municipality it was the guidance for the water resources use of regional character. In terms of that, it was previously planned the construction of impounding reservoir “Marica” on the river Usora in the territory of Teslic municipality. This system would include the municipalities of north Bosna. Alternative solutions are the water resources of underground waters in alluvial of the river Bosna on the part downstream from Modrica to Šamac (for the municipality’s Šamac, Modrica, Odzak and Gradacac).

Existing sewage system of Modrica is of very poor construction. It was only constructed the fecal sewage in the narrow area of town. Later on, additional 3 water flows of torrential character, as well the storm waters were connected on this system, causing the effusion from sewage system. Constructed sewage system has the profile Ø200 – 700 mm. Collected waste waters were discharged directly in the river Bosna. Town has not waste water treatment unit. Larger economic entity have constructed sewage systems, but without waste water treatment except of oil refinery Modrica having the waste water treatment unit.

Other settlements in most cases do not have any sewage system, but waste waters dispose in individual septic tanks or directly in nearest water flows.

4.14.4. Municipality Doboj

4.14.4.1 Road network

Municipality Doboj is located on the banks of river Bosna, on the junction of primary routes M4 and M17 present one of the most significant road directions in Bosnia and Herzegovina. The primary route M17 in the area of Doboj municipality was introduced through the section shown in the table below as well as PGDS for mentioned sections according to the counting results, conducted by Public Enterprise “Putevi Republike Srpske”, Banja Luka, as well as length per sections.

Table 5.2.4.7.: Pimary route M17

	Section	Length	PGDS(2003)	PGDS(2004)	PGDS(2005)
1.	Podnovlje - Šešljije	11	5282	5176	5042
2.	Šešljije - 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, besides the mentioned primary routes it was as well developed the network of regional roads, where mutually formed the primary traffic network of Doboj municipality. Regional road of R465 Doboj – Modrica has important role in flow collection from the right bank of the river Bosna and its connection with Modrica and with rest of road network. With regional roads R474-a, R482 and R472, it was carried out the connection of primary route M17 with the section of primary route M16.1 Klasnice –Derventa, the section of primary route M17.2 Derventa – Seslije as well as section of primary route M14.1 Derventa – Brod.

Table 5.2.4.8.: 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 Osinjom)-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-Putnikovo brdo-Miljkovac	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 OF LOCAL ROADS	205.00 km		205.00 km

Table 5.2.4.9. Number of registered vehicles in the area of Doboj municipality in 2004. And 2005 year.

Type of vehicles	2004	2005
Bus	40	39
Motor cycle	13	10
Service vehicle	84	63
Passenger vehicle	9078	8545
Work vehicle	25	24
Special vehicle	35	25
Freight vehicle	526	457
Tractors	36	6

Table 5.2.4.10 number of registered traffic accidents in the area of Doboj municipality in 2005 and 2006 year.

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

* - Traffic accident

4.14.4.2. Electric power system

In the area of Doboj municipality, future highway of Corridor Vc at few sites will be crossing 0, 4 and 10 kV ducts and at three sites crossing 110 kV transmission line. Future alignment of the

highway will be crossing the transmission line of Doboj – Derventa, Osjecani – Gradac and Doboj – Teslic. In Osjecani area it will be passing next to the power substation 110/H kV Osjecani (Doboj 3), while power substation 110/H kV Doboj 1 and Doboj 2 are found in wide impact zone.

Planned alignment of the highway will also crossing the current 35 kV d transmission line Miljkovac – Kotorsko and Miljkovac – Jelah. Mentioned 35 kV power substation trafostanice Miljkovac, Kotorsko and Jelah are found in wide impact zone of the highway of Corridor Vc.

Alignment of future highway Vc on south part of Doboj town will be crossing 400 kV transmission line Tuzla – Banjaluka as shown in graphical appendix.

4.14.4.3. Telecommunications

Network of telecommunication system in the area of Doboj municipality is presented with the regional automatic switchboard (ATC) located in town center and local ATC (Grades of RSS) in the settlements Rudanka, Kotorsko, Lipljaku.

In those settlements there are post offices for operation of postal traffic

4.14.4.4. Water supply and disposition of waste waters

Main source area for water supply of Doboj is at site Luke next to river Bosna where it was carried out replenishment with underground waters of well zone. The source area is found in the proximity of town center and industrial zone. It is composed of the following wells: 5 dug well of Ø2500 mm, the depth from 8,00 to 9,00 m; 3 dug well of Ø1000 mm, depth from 11,00 to 13,00 m; 3 bored well of Ø350 mm, depth from 10,00 to 15,00 m; 2 technological well of Ø350 mm, depth from 8,00 to 10,00 m; impregnated dug well of Ø1000 mm the depth of 9,00 m. Estimated total capacity of all wells is around 135 l/sec (around 140 l/sec in favorable hydro geological conditions). However, during summer months the replenishment of water bearing beds is reduced up to 30%. The previous analyses confirmed that safe maximum capacity during the droughty season is 80 – 90 l/sec. The source area of Luke is in the center of settlement area that is only partially connected to sewage system.

Other minor significant source area for water supply of Doboj is the source area of Rudanka. It is composed of seven drilled wells of total capacity of around 65 l/sec, while safe maximum capacity during the drought season is 45 – 50 l/sec.

Among other existing waterworks systems, there is significant source area of waterworks Osjecani (site "Bare" with one dug well in the first phase, the depth of around 10 m, capacity of around 20 l/sec) for water supply of settlements Osjecani, Brdani, Čivcije, Simici (totally around 4000 inhabitants). Larger local waterworks are the following: waterworks Kostajnica, waterworks Grapska, waterworks Kotorsko, waterworks Seplije and other local village waterworks.

Lot of water loss in existing waterworks even more complicate the problems of the provision of sufficient water amount for population and other needs.

Earlier studies for the area of Doboj, supported the option of using the water resources of regional character. In terms of that, it was planned the construction of impounding reservoir "Marica" on the river Usora on the territory of Teslic municipality, then the reservoir on the river Krivaji at Zavidovica and other minor reservoirs.

This regional waterworks would be connected with the systems of the source area (the reservoir of surface waters: Marica, Krajinci, Sibosnica, Drenova, Brestovo, Stoglav, Poljana, Sladna, Mrdići, Malivojevići, Maoča, Donji Islamovac, Vidara, and underground waters: the area of Rudanka-Kotorsko-Kožuh, Modričko-Odžački lug, the area of Vucilovac at Brčko, the area of Korace at Brod), pumping stations (Krajinci, Žepče, Mrkotić, Brestovo, Popići, Gračanica, Gornji

Moranjci, Sladna, Gradačac, Šamac, Orašje, Srebrenik, Prnjavor, Drenova), units for shaping (Krajinići, Marica, Brestovo, Drenova, Sladna, Šibošnica), main reservoir systems (Krajinići, Mrkotić, Doboј, Modriča, Gradačac, Brestovo, Popići), distributive reservoirs in the consumption centers, breaking reservoirs (Donja Bišnja, Gornji Maronjci), and primary and distribution pipelines. It would be connected to the municipalities of north part of Sjeverna Bosna.

Existing sewage system of Doboј was constructed as combined (mixed), common for both waste waters and storm waters. All waters in town were drained in two main sewers, and on one site discharged in the river Bosna without previous treatment. On the joint of main sewers, there is pump-over station which during the high water level of river Bosna performs the pumping over of the waste and surface waters.

Town has not the waste water treatment plant, although its construction has planned downstream from the settlement Kotorsko, and it would be of regional character for the largest part of the municipality Doboј.

Other settlements in most cases do not have any sewage network, but their waste waters dispose in individual septic tanks or directly in the nearest water flows.

4.14.5. Municipality Usora

4.14.5.1. Water supply and disposition of waste waters

The area of Usora municipality uses the water intake in alluvial of river Usora. In the area of settlement Alibegovac, there are two wells of capacity 10 l/sec, and in the area of settlement Ularica with capacity of existing well of 5 l/sec. The settlement Makljenovac has the water supply from the well of capacity 5 l/sec, while in the area of settlement in the local community Zabljak there is source area of 4 wells with total capacity 15 l/sec.

For permanent solution of water supply problem, there is no yield source area. Besides a limited water capacity, the huge problem for current springs presents the enforcement of sanitary control measures of the source area (both underground waters and surface flows for replenishment of alluvium).

According to previous studies for the area of Usora, it was supported the option of using the water resources of regional character. In terms of that, it was planned the construction of impounding reservoir "Marica" on the river Usora in the territory of Teslic municipality. Alternative solutions would be the water resources of river Krivaja with planned construction of impounding reservoir of Krjinici or Buk.

4.14.6. Municipality Doboј Jug

4.14.6.1. Water supply and disposition of waste water

The area of municipality Doboј – Jug uses the water intake in alluvium of river Usora and Bosna. Current water supply is composed of two separate (not connected) systems Matuzici and Krasevo. In the area of Matuzici settlement, current well capacity is 10 l/sec, reservoir capacity of 300 m³. Well capacity of the spring Krasevo is around 18 l/sec, total reservoir capacity is 350 m³.

According to previous studies for the area of Doboј - Jug, they supported the option of using the water resources of regional character. In terms of that, it was planned the construction of impounding reservoir "Marica" on the river Usora in the territory of Teslic municipality. On this system, it would be connected to the municipality of Sjeverna Bosna. Alternative solutions are the

water resources of river Krivaja with planned construction of impounding reservoir Krajinići or Buk.

Problem of waste water disposition was not solved in comprehensive and planning way. Partially constructed sewage systems have only municipal centers. These systems are of mixed type with discharge in the nearest receiving body water without previous treatment.

4.15. Mine pollution

Data about position and approximate size of mine-fields were taken from the documentation found in Spatial Plan of the highway on Corridor Vc, in the annex about the conditions of the use and protection of the area. The fields of potential mine pollution were defined according to the map of mine fields registered by Center for mine – MAC on the basements of the scale 1:100000 and 1:25000. For more detailed data about mines on the study area, it is necessary to prepare the special study. It is completely understandable that it is necessary to completely clear the mines within the study area of the highway that is to carry out clearing of all mine-fields. It should be especially emphasize that it takes to pay attention on this problem during the phase of construction works, as well as on the possibility of finding the mines on the places that are not marked on the plans and maps.

4.16. Emission and Air quality

Air pollution is the consequence of emission of pollutants from different sources. All particles which are not normal air particles are thought as polluters. This is changeable dimension in space and time, and it depends on the site of pollution, amount, speed and temperature of the particles coming out the sources (emission), about terrain configuration, vegetation cover, season and meteorological situation.

Deposited matters are all matters in solid, liquid or gas condition that are not compositional part of the atmosphere, and are deposited with on gravitation or precipitation washing out from the atmosphere on soil. Large particles are mostly found in deposited matters, larger from 20 to 40 μm . They are indicators of visible environment pollution (dust on the windows, laundry that is drying, automobiles and other surfaces, and on the plants they can make harder plant processes and penetrate in the plant) In terms of that, deposited matters disorder the environment quality and may indirectly unfavorably impact on people, but they are to large that people could inhale them.

Because of the complicated political situation appeared after the war, there have not been almost anything cooperation between Entities regarding the environment issues. There are no available data regarding the air quality in BiH. The most particles that pollute the air coming from the industrial activities, but also from transport. Before the war, the industry was the largest air polluter such as: bloomery Zenica, steam power plant in Kakanj, Tuzli, Ugnjeniku and Gacku, factory of detergent and fertilizers in Tuzla and many others. Most of industry stopped the work during the war period and this industry has not been reconstructed on pre-war level. Thanks to that, air pollution is much less than in pre-war period, though there is no accurate data about current air quality in BiH.

Both on the national and entity level, data about air quality are very poor. Control of air quality is done permanently or temporarily in less number of the municipalities (around 30%), although there is the necessity regarding the presence of local and outside polluters. Observation of the chimneys from the firebox of industrial facilities, town heating plants and individual firebox is done in around 10% of the municipalities (probably temporarily). Number and quality of big air polluters is applied to the structure of economy (ferrous and non-ferrous metallurgy, mining,

chemical industry). Consequences are much harder if it is about so called. "Dirty technologies". That requires to be approached to regular measurement of air pollution on the sites where there is higher emission of aero pollution or it is expected a larger impact of outside polluters. The measuring of the aero pollution is done continually, everyday, only in Banjaluka. Measuring of the the emitted gases from the vehicles is done in a very small number of the municipalities (10%) during the automobile inspection, and during vehicle operation the measuring is only done in two municipalities (Banja Luka and Prijedor).

Concerning the pollution (quality) of air in the area of the corridor of the future highway (the municipalities Modriča, Doboj, Odžak and Svilaj) from above mentioned reasons it must be stated that there are no indicators by which it is possible to determine real condition. It was conducted the questionnaire in Modrica where the inhabitants answered that the environment problem that bother them the most is air pollution.

Due to above mentioned condition any data about the air quality on the corridor of the highway Vc can be seen from the measuring of the condition i.e. air quality in Modrica (for the purpose of the bridge construction over the river Bosna) during the period 19.-20.11.2003. Sampling and air analysis was done by the Mining Institute from Zemun, according to valid standards and methods prescribed for used equipment. Also the volume of sampled air was corrected to standard conditions ($T = 25\text{ }^{\circ}\text{C}$ and $p = 1\text{ bar}$). There is no other data about air quality measuring. The makers of this study are aware of the fact that the strictly local data can not be applied for the whole intake area, but they give the framework picture of air pollution that can be applied (at least approx.) for estimate of air quality by the town settlements.

At site of Modrica, the measurement was done at two survey places. Selection of the survey places was done on the base of impact zone of future highway, and in the aim of overview of current air quality condition near the river Bosna. Measuring places are marked as MM-1 and MM-2.

Survey place MM-1 was at site of construction material storage, i.r. in the circle of the yard, and on about 40 m downstream from the bridge of the primary route Šamac – Šešljije. On the left and right side of survey place, viewing towards the bridge, there were pallet pieces with building products of the height up to 2 m, and on 20m on the left side it was prefabricated building of open storage.

Survey place MM-2 was in the yard of weekend house around 30 m remote from the left bank of the river Bosna and around 100 are downstream from the alignment of the future bridge. In the surrounding area of survey place in the direction of the alignment, it was located the facility serving for the needs of cattle fair. Surrounding terrain, except of the river bank was not overgrown with vegetation, the mostly meadows and fields.

Measuring results were given in the table T.4.3-02. Results of the analysis of deposited particles on the survey places were shown in the table T.4.3-01.

Table T.4.3-01: results of the analysis of deposited matter in Modrica

SURVEY PLACE	DEPOSITED MATTERS (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 T.4.3-02. Survey results of air quality in Modrica

PARAMETER	MEASURE UNIT	TIME OF SAMPLING	MM-1	MM-2	LIMIT VALUE OF THE EMISSION (GVI)	SOURCE
sulfur dioxide	µg/m ³	24 hours	12,2	< 5,0	125 150 365 100-150 80-120	TA luft, 2000 Off.Gaz.R. Serbia 54/92 EPA (NAAQS) EC, 1980 Regulation about recommended and limit values of air quality in Croatia, NN 101/96 and 2/97
nitrogen oxide	µg/m ³	24 hours	18,6	21,2	40 85 100 60	TA luft, 2000 Off.Gaz.R. Serbia 54/92 EPA (NAAQS) Regulation about recommended and limit values of air quality in Croatia, NN 101/96 and 2/97
Carbon monoxide	mg/m ³	24 hours	max. 0,8	max. 0,4	10 (30) 10 10 (40) 2	TA luft, 2000 Off.Gaz.R. Serbia 54/92 EPA (NAAQS) Regulation about recommended and limit values of air quality in Croatia, NN 101/96 and 2/97
soot	µg/m ³	24 hours	145,3	34,6	50 40-80	Off.Gaz.R. Serbia 54/92 Regulation about recommended and limit values of air quality in Croatia, NN 101/96 and 2/97
Suspended particles	µg/m ³	24 hours	55,0	32,3	120 150	Off.Gaz.R. Serbia 54/92 Regulation about recommended and limit values of air quality in Croatia, NN 101/96 and 2/97
lead	ng/m ³	24 hours	283,4	293,4	500 1000 1500 2000	TA luft, 2000 Off.Gaz.R. Serbia 54/92 EPA (NAAQS) Regulation about recommended and limit values of air quality in Croatia, NN 101/96 and 2/97
mercury	ng/m ³	24 hours	3,3	3,6	1000 1000	Off.Gaz.R. Serbia 54/92 Regulation about recommended and limit values of air quality in Croatia, NN 101/96 and 2/97
cadmium	ng/m ³	24 hours	13,4	18,0	10 40	Off.Gaz.R. Serbia 54/92 Regulation about recommended and limit values of air quality in Croatia, NN 101/96 and 2/97
mangan	ng/m ³	24 hours	210,0	137,8	1000 2000	Off.Gaz.R. Serbia 54/92 Regulation about recommended and limit values of air quality in Croatia, NN 101/96 and 2/97

There were used the following methods for determination of concentrations:

1. Analysis of sulfur dioxide (spectroscopy method with tetrachloride mercury and pararosaniline JUS ISO 6767:1998)

2. Analysis of nitrogen oxide (spectrophotometry method by Gris-Salcmanu JUS ISO 6768:1990)
3. Analysis of soot (reflectometry, recommended methods: guidelines SDČVJ 202, Union of the associations for clean air Yugoslavia)
4. Analysis of suspended particles (gravimetry VDI 2463)
5. Analysis of hard metals in suspended particles:
 - Lead (atomic absorption spectrometry, 12128-02-73T, Methods of air sampling and analysis, APHA intercos. comm. 1977.)
 - Mercury (atomic absorption spectrophotometry, 42242-01-74T, Methods of air sampling and analysis, APHA intercos. comm. 1977.)
 - Cadmium (atomic absorption spectrophotometry, 12110-02-73T, APHA intercos. comm 1977.)
 - Mangan (atomic absorption spectrophotometry, 121312-02-73T, Methods of air sampling and analysis, APHA intercos. comm. 1977.)
6. Deposited particles from the air (gravimetry BS 1747, VDI 2119)
7. Hard metals in the deposited particles: lead, cadmium, zinc (method of atomic absorption spectrometry)
8. Carbon monoxide (repeated short-term sampling with gas analyzer of the firm Dräger)

5. DESCRIPTION OF POTENTIAL MAJOR ENVIRONMENTAL IMPACT

5.1. Assessment of environmental impact – background

All systems of communications with their current characteristics represent a source of major environmental pollution. This emphasizes the importance of planning, design, construction and use of motorways as a function of environmental preservation and protection.

In line with this, we may claim that the planning and subsequent construction of high-capacity roads always gives rise to a number of conflicts between the motorway and the environment. The motorway Svilaj – Doboj is certainly one such communication.

The global assessment of the environmental impact of the motorway indicates three major lines of impact. The first line is typified by impact arising from the construction of the motorway, which is predominantly temporary by nature. It is results from human presence and the presence of machines, as well as from the technology and organization of construction works. As a rule, negative impact results from excavation/disposal, transport and laying of big quantities of construction materials, and permanent or temporary possession of space and other related activities.

Environmental impact arising from the physical existence of the motorway in space and its use in time is generally permanent by nature, and as such, it certainly represents the type of impact of great interest in terms of the relation between the motorway and the environment. In most cases this impact tends to deteriorate in both space and time, which is undoubtedly a recommendation for its timely management.

All processes within the complex relation between the motorway and the environment occur as a result of interdependence of multiple relations, which eventually results in a number of changes. These changes range from minor to radical, where individual elements lose their original features. A systematic approach to the above-mentioned relations through the analysis of individual criteria produces satisfactory outcomes in most cases, provided they are assessed and measured impartially and methods are used consistently with respect to their inherent hierarchy.

Each criterion may be crucial in certain circumstances; however, the practice to date has outlined the basic matrices of these relations, which does not guarantee that in the future, with greater knowledge and enhanced environmental awareness, these matrices will not undergo changes based on which we define most of the potential impact.

Respecting the specificities of the motorway route and local spatial relations, this research examines the principal criteria turned indicators for use in the process of quantification, whose main role will be to assist in the detailed quantification of future relations and to define their true nature. Based on the maximum permitted values of certain types of impact and their anticipated future values, it proposes adequate measures of environmental protection.

The analysis and evaluation of the current state of the environment, as well as the assessment of the potential impact of the motorway construction show that only one comprehensive analysis may provide unambiguous and objective data.

All experiences in this area indicate that today we may speak with great certainty about a particular matrix of impact, while taking into account its character as a category changeable in

space and time, where also the relative importance of certain types of impact and their absolute limits must always be observed in concrete spatial relations. This primarily means that all influences must be assessed using valid procedures and their relevance must be determined depending on concrete local relations.

In order to ensure an accurate assessment of all types of impact, it is necessary that each one of them be appointed a number of indicators in concrete conditions, which must be exact values easy to use in the process of defining the necessary measures of protection. One of the problems faced in the process of defining the relation between the motorway and the environment is that it is not possible to select exact indicators for certain factors, which means that some or all of the impact takes place in the area of subjective relations.

The definition of the specificities of certain influences (criteria) and their indicators is essentially in connection with the project stage for which the analyses are carried out. Each stage in the process of design and the preparation of plans relies on the characteristics of the info basis, which in turn defines all the important factors in terms of the extent and accuracy of the available information, limiting and affecting the possibility of assessment and the exactness of indicators.

Based on the facts and concrete site conditions determined prior to this research, the basic factors of impact (criteria) are defined.

The matrix of the analyzed criteria is the result of familiarity with issues characteristic of the relation between motorways and the environment. One thing is immediately obvious – all the criteria are not equally important, even more so, especially if we take into account concrete spatial relations in the examined area.

The factor of air pollution must be assessed given its possible impact along the relevant section of the planned motorway, primarily on the flora and, in part, also on the population and facilities.

The assessment of the factor of noise pollution will be used as a parameter to examine the current and future relations with the population inhabiting the studied area, ie the area along the planned motorway.

Water pollution is an important factor, especially in the light of the possible pollution of the Bosna River and its tributaries.

Soil pollution, land possession and the issues of accessibility are important factors in this situation, because the motorway will run across the land in the valley of the Bosna River, which is mainly used as farmland.

The details of spatial relations in the area of the analysed corridors condition the impact on flora and fauna, since the examination of the current situation has observed the existence of these resources in the area as well.

Other factors are relatively less important in terms of the current relations in the studied area. This lesser importance is apparent when it comes to two basic phenomena, which may be defined as: local spatial distribution of impact or low intensity along the analysed corridors. The microclimate and the issues related to resources and energy are local in character.

The motorway will affect the social sphere to a certain extent, especially in terms of the current situation in the valley of the Bosna River. The construction of the new motorway in this area will cause significant economic changes.

All this indicates that environmental relations and issues may be defined only if each of the above-mentioned factors is analysed in the context of concrete spatial relations and quantified to accurate indicators.

While respecting actual conditions, the properties of communications lines, use of land in the area of the corridor, principles determining the relevant links between most of the factors defining the relation between the motorway and the environment, exact indicators will be used to define the requirement for environmental protection.

5.2. Social impact – population and density

The impact the planned motorway will have on the social environment may only be assessed if we distinctly define individual social groups as users of space and the facilities in it, in relation to which it will be possible to examine this phenomenon. In this sense, we can single out two basic interest groups or populations in the actual context of the planned motorway. One group are motorway users, while the other is the inhabitants living along the motorway, as well as the owners of property to be affected by the construction.

The first social group comprising motorway users will enjoy a number of benefits, given the fact that the construction of the motorway will result in improved traffic safety, reduced fuel consumption (which will have a positive effect on a whole range of related global problems), reduced length of travel, improved connections in the broader area (with other positive effects as a result of this) and the creation of more favourable conditions for the development of the broader area.

The construction of the motorway is expected to increase human mobility, which will open possibilities to develop certain economic branches and consequently improve the social structure.

Following the construction of the motorway, the living conditions will become unfavourable for the people living in the immediate vicinity of the communications currently in use, since the impact of certain factors will become more significant if compared with the current situation. The construction will affect the economy favourably as a result of increased demand for services along the motorway.

Given the fact that the construction of the motorway will require the expropriation and demolition of the existent buildings in inhabited places, mainly residential structures, certain problems are bound to occur, especially if we know the construction will claim some farmland. There are effects which may result from the construction and have certain impact on the social sphere, and they are connected with the induced, uncontrolled development along the planned motorway, which would significantly disturb the current relations, making the phenomenon of uncontrolled construction even more negatively accute. This phenomenon may be expected in all inhabited places where there is unoccupied ground.

One individual factor may be separated as especially important in the construction of the motorway, and that is the permanent expropriation of farmland from its current owners. In terms of social impact, this problem is of great importance, and chapter 5.6 entitled 'Impact on soil and farmland' examines this issue in greater detail. The implementation of adequate measures may prevent the negative effects of farmland expropriation or the division of current lots into smaller ones, as well as the interruption of direct connections between lots.

5.2.1. Land expropriation

The problem of possession of the land needed for the construction of the motorway and other associate structures needed for the completion of the construction represents a parameter important for the definition of the relation between the motorway and the environment. The examination of this problem became crucial the moment it was finally understood that the soil covered by roads is a resource lost permanently, which will never be used for any other activity.

This claim and the fact that there is limited farmland led to the need to reconsider this indicator. In the process of defining the possible impact, land possession/expropriation must be examined from the ecological point of view and adequate measures must be undertaken to minimise its negative effects.

5.2.1.1. Land possession – calculation methods

The definition of the area of land needed for the construction of the motorway is a simple process, provided all elements of the cross section are defined in advance, the degree of comfort of the necessary facilities is ascertained, the positions and concepts of all crossings are defined and the topographic characteristics of the areas through which the motorway will pass are known. These data have been defined in the motorway project documentation. Based on everything that has been defined, methods have been selected to express this indicator quantitatively.

The land needed for the construction of the motorway may be divided into two basic categories. The first category is the land which will be expropriated permanently and the second is that which is most often expropriated temporarily during the construction. The land which will be expropriated permanently will cover the space needed for:

Roadbed:

- driving lanes
- stopping distances
- central reserve
- fast and slow lanes
- shoulders

Road base:

- cut and fill slopes
- drainage systems (canals)
- space for visibility splay assurance
- space containing various protective and supporting structures

Associate structures and support buildings:

- crosses with associate elements
- car parks and half-landings
- petrol stations
- road maintenance stops
- various associate roads and paths

Other

- road servitude within the expropriation belt

The data presented in the previous table show the possession of sites for the construction of the motorway is a factor of great significance in the described circumstances, primarily as the soil of

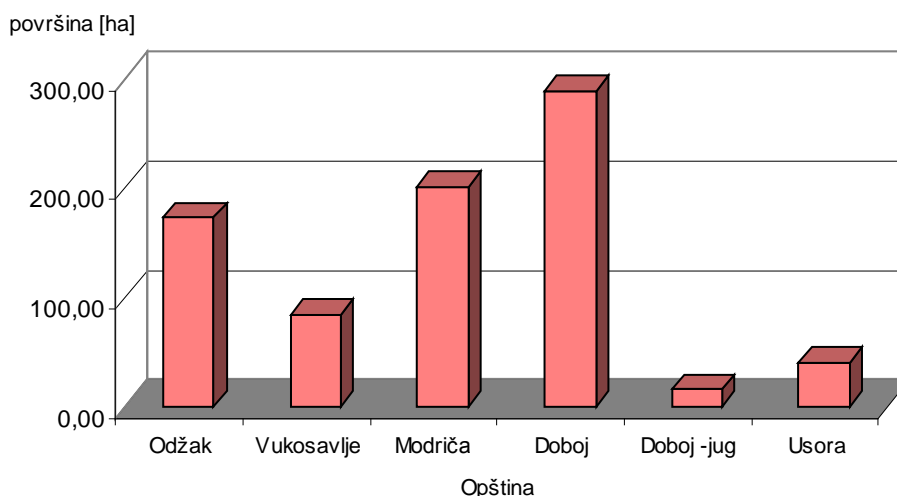
the valley of the Bosna River is highest quality plain farmland. There are no measures to remove this effect and this additionally aggravates the problem.

5.2.1.2. Expropriated land

The planned use will require a land belt approximately 100 m wide. The actual width of the motorway belt will be calculated following the preparation of the preliminary brief and the examination of relations on site. The belt width will be reduced to cca 30 meters at those parts of the motorway where viaducts and bridges will be built, while this evaluation/calculation excludes the strips where tunnels will be constructed.

Table 5.2-01. Total land to be expropriated for motorway belt 110 m wide

Number	Municipality	Expropriation belt [ha]	Municipality area
1	Odžak	172.9	21.52%
2	Vukosavlje	83.9	10.44%
3	Modriča	200.6	24.96%
4	Doboj	289.4	36.01%
5	Doboj – south	15.8	1.97%
6	Usora	40.97	5.10%
	Total	803.57	100.00%



Graph 5.2-01: Total land to be possessed for motorway belt

Based on the presented data, it may be concluded that a total of approx. 800 ha will be expropriated. This datum is very important given the fact this will be mainly farmland in the valley of the Bosna River.

The comparison of the data leads to the conclusion that the social environment will benefit from the construction of the motorway and this effect is far greater than the damage that will also occur as a result of the construction.

5.3. Microclimate

Changes to the microclimate in the areas of the motorway alignment resulting from its construction may be observed only in terms of strictly local characteristics. These microclimatic dispositions will result from the presence of facilities in space and be generated due to man-made structures, whose volume will cause effects likely to change the relatively stable microclimates.

It is possible to determine the concrete values of certain microclimatic elements resulting from the construction based on the known variables. The basic microclimatic variables which may be measured above and on the sides of the motorway (temperature, humidity, evaporation, radiation), provided this is beyond the zone of impact of major man-made facilities and structures, indicate stable patterns characteristic of those particular spaces.

In terms of microclimate, the space immediately above the motorway surface will suffer from increased temperature across the pavement, while this variable will reach stability as far as a few meters away from the motorway curbs. Evaporation and light radiation will undergo the same change, while air humidity will be affected by the inverse change, with the lowest values above the motorway surface. All these microclimatic changes will be spatially limited to the narrow belts on both sides of the motorway (approx. width of 10 meters), without any negative effects on the broader surroundings.

Other potential microclimatic changes on the local level may come as a result of man-made facilities and structures (fills, cuts, tunnels and other associated structures). If we consider the morphological characteristics along the alignment, the spatial characteristics of the alignment and the features of the local climate, where air flow is of particular importance, it is possible to conclude that certain influences may be predicted only around high fills and cuts as well as in the area of tunnel portals, which is especially the property of the last section in the zone of Doboj.

Given the facts presented above, it is possible to predict local influences whose impact will not be extremely negative. As there will be vegetation along all lots of the motorway and on its both sides, negative impact ought to be assessed primarily regarding the effects on the vegetation. Given the planned cross section and the width of the road servitude, the factors mentioned above will affect primarily these areas and there is no fear of extreme negative impact of microclimatic changes on the vegetation.

5.4. Impact on water

Depending on the manner of construction and use, motorways cause minor or major changes to the environment. Certain effects on water resources may be avoided in the stage of design by accepting suitable solutions: external and internal runoffs, building bridges over water currents with spans allowing flood flow, securing the superelevation of the lower bridge superstructure over stage of flood flow, flow control, horticultural intervention in bumper zones and the design of vertical barriers (safety fences) along the motorway at sites designated as sensitive from the aspect of water resources. Negative impact on the quality of ground and surface waters may be avoided by means of careful and controlled organization of building sites and application of protective measures during construction, and by means of internal drainage and processing of motorway wastewater as part of road and facility maintenance operations during use.

Particular danger may come from pollution in the event of accidents, especially those involving heavy and long vehicles transporting hazardous substances (traffic accidents, vehicle failures) due to unpredictable effects of weather and spatial factors.

The examination of the hydro-geological characteristics of the corridor has discovered and marked 11 sensitive sites along lot 1 alignment. Furthermore, in the sense of construction and use, the banks of the water currents along which the motorway will run and which it will cross, as well as springs in and outside public water supply systems are also considered sensitive.

These sensitive areas are presented graphically in the hydro-geological map, scale 1: 25.000, prepared as part of the technical study and lot 1 preliminary brief. Bearing in mind their importance and the potentially negative impact on them, it is necessary to conduct detailed hydro-geological research and present its result on a 1:5.000-scale map in the subsequent stages of brief preparation. Only a detailed hydro-geological examination of the alignment terrain will produce a reliable assessment of potentially negative effects on water resources.

The planned alignment of the motorway will be located within the proposed bumper zone III of Odžak waterworks source area. The alignment will affect the water source bumper zone in Kraševo (as stipulated by the Decision on Implementation of Spatial Plan of Tešanj Municipality), and in certain areas it will run through aquifers which are either currently in use or may be used for water supply in the future.

Following the description of the current situation and concrete conditions on site (hydro-geological, hydrological and hydrographic characteristics and others), it may be concluded that the area has considerable water resources, so it is essential to predict all potentially negative effects and define suitable measures for their prevention/minimization. With respect to the above said, the impact of the motorway on water resources will be examined from two aspects:

- Impact on water resources during motorway construction,
- Impact on water resources during motorway use.

5.4.1. Impact on water resources during construction phase

There is a number of activities during construction works which may have negative impact on the flow and quality of water. In that sense, great danger may come from:

Construction works (mining, deep excavation, devastation and removal of cap sheets, etc). This may result in disturbing the process of natural replenishment, while by removing cap sheets and creating new catchment areas, muddy water or water contaminated in other ways will quickly filter into the ground.

Building machines – potential hazard from leakage or accidental spillage of oil and oil derivatives, disposal of motor oils and similar waste liquids.

Uncontrolled disposal of excavated material and location of machinery parks or asphalt bases in the vicinity of surface and/or ground water resources.

Use of unsuitable building materials.

Uncontrolled sewage disposal at labour accommodation sites and potential minor pollution from food preparation and ablution facilities.

Given the spatial disposition of the planned alignment of the motorway, there may be considerable negative effects on surface and ground water resources as a result of the motorway construction.

The water sources of Modriča, Vukosavlje, Doboj and Doboj-South public water supply systems are located at a considerable distance from the alignment and no negative effects on them are expected.

The hydro-geological conditions and relations in the examined section of lot 1 and the alignment of the motorway in relation to the water source of Osječani and Usora Municipality water

supply systems are such that construction works in this area may cause considerable negative effects by muddying these water sources, disturbing the flow regime in case of massive excavations, and contaminating them with various hazardous substances used in construction and for the work of building machines. The water source of Odžak waterworks is located at a sufficient distance from the motorway. Since the alignment will pass through the proposed bumper zone III of Odžak water source area, construction works in this area may cause considerable negative impact. In designing and building the motorway, it is necessary to work in line with the restrictions specified for bumper zone III for water sources belonging to aquifers of intergranular porosity and plan facilities / structures which will comply with the regulations specified in the 'Codebook of terms and specifications for bumper zones and protective measures for water sources used for or planned for potable water consumption – October 2002'.

Since Kraševo water source is located on the right bank of the Usora River, this assessment does not predict any considerable environmental impact on it. The estimation is the same for the local sources registered in the area of municipality of Doboj-South.

Following the analysis of the hydro-geological conditions and the hypsometric position of water sources in relation to the alignment, the above-mentioned environmental impact during construction may be the most serious for the following water sources:

- Odžak water source (Odžak Municipality)
- Bare-Osječani water source (Doboj Municipality)
- Ularice water source (Usora Municipality)
- Makljenovac water source (Usora Municipality)
- Alibegovci water source (Usora Municipality)

These water sources can be seen on the map of restrictions for water resources (Supplement 12.3.5), and the collected data about water sources are presented in the questionnaires in Supplement 12.2.

In case a water source is muddied, which is an occurrence most likely to take place, it is necessary to emphasise that such occurrences are not permanent and may be alleviated, even disappear in time altogether, if proper measures and drainage are undertaken at the excavation site following the completion of construction works.

In order to prevent and minimize negative effects on water sources during construction works, it is necessary to undertake all proposed measures to prevent the possibility of erosion in the area of excavation as well as the leakage of oil and grease from building machines.

There is a possibility of considerable negative impact during the construction stage at all sites where the motorway crosses water currents, as well as where the alignment is located along the banks of water currents. This is particularly true of the crossings in the vicinity of water currents, especially those requiring extensive works and interventions. Construction works on such sites along the motorway may lead to the serious muddying of surface waters, their backfilling, even their contamination with various hazardous substances. It is possible to minimise negative effects on these sensitive areas if the proposed protective measures are adhered to.

The proposed alignment will run across or in the immediate vicinity of 11 sensitive areas, which might have considerable environmental impact on ground waters during the construction stage. One additional problem is the lack of reliable data about their depth and yield, which means that the assessment of possible impact of the motorway construction on them, but also the impact of ground waters on the motorway, must be taken with hesitation. Possible effects can only be considered in terms of the current use of ground waters for water supply, but also in the future,

especially if we take into account the increasingly acute lack of good-quality potable water, ie the need to assure safety standards. Given the current situation, this is a very sensible approach, especially as the possible outcome might be permanent. It is possible to minimise negative effects on these sensitive areas if the proposed protective measures are adhered to. However, it is still necessary to examine them in greater detail in the further stages of brief preparation (the main project) in the light of recognized potentially negative effects. Therefore, it is necessary to check the predicted effects on water resources based on the data which will be available after the completion of research operations, ie smaller scale (1:5.000) hydro-geological maps and cross sections of the narrower belt of the motorway.

Since details and specifications regarding water resources and facilities/structures on the motorway given in the preliminary brief were not available to the writer of this study, the assessment of impact during the construction stage is general and based on related experiences from technical literature. Actually, it may be said that this impact may be very serious unless environmentally acceptable practices are followed in the management of water resources. It is certainly necessary to comply with the water management specifications where rivers or streams are to be spanned with bridges (min. superelevation of 120 cm between 1/100 flood flow and lower part of bridge superstructure above stage of flow). Chapter 6.3.2 outlines the necessary measures of prevention ie minimization of impact.

5.4.2. Impact on water resources during motorway use

Road use and maintenance are always accompanied by pollution of roads themselves and the immediate strips of land along their sides, which has negative impact on water quality and may result in the following:

- Pollution of precipitation falling on roads due to:
 - leakage from engines and other parts requiring greasing (petrol, oil, motor oil, cooling and braking liquids),
 - traces and particles of tyres and fretting corrosion particles (asphalt and bitumen remains),
 - emission of exhaust gases and related particles (lead and its compounds, unburnt carbon oxides, nitric oxides, soot and tar). Combined with precipitation water, these pollutants may reach both surface and ground waters and contaminate them.
- Sudden pollution caused by traffic accidents. Accidents are followed by the spilling of hazardous substances, as the most frequent accidents are those involving the spillage of oil and its derivatives, which easily penetrate and diffuse in the ground. Due to the complexity of the process of water flow and the fact that water tends to stay in the ground, the pollution caused by oil derivatives is a long-lasting one. This pollution may be activated in various hydrological conditions.

It is necessary to say that the hazard of pollution of water resources near the motorway is directly linked to the number of vehicles using it. Given the anticipated daily traffic density of 20000 vehicles, it is possible to predict considerable impact on surface and ground waters.

The water sources of Modriča, Vukosavlje, Doboj and Doboj-South public water supply systems are located at a considerable distance from the alignment and no negative effects on them are expected.

Similar to the construction stage, the water sources of Osječani, Odžak and Usora Municipality water supply systems will be most seriously affected by the use of the motorway. This impact is

thereby assessed as significant and measures have been proposed accordingly for its prevention, ie minimization.

The water source Kraševo, which is located on the right bank of the Usora River, is not expected to suffer from considerable negative impact in this stage. The estimation is the same for the local sources registered in the area of municipality of Doboj-South.

- Similar to the construction stage, the following local water sources will receive negative environmental impact due to the use of the motorway:
- Odžak water source (Odžak Municipality)
- Bare-Osječani water source (Doboj Municipality)
- Ularice water source (Usora Municipality)
- Makljenovac water source (Usora Municipality)
- Alibegovci water source (Usora Municipality)

Considerable negative impact on the quality of water from use is also possible at all sites where the planned motorway will run across or along the banks of water currents.

Sensitive areas, such as aquifers, may be considerably affected during the use stage. Point 6.3.2 of this study proposes measure to help avoid or reduce the anticipated negative impact on the mentioned water resources during the use stage.

5.4.2.1. Basic characteristics of pollution sources

According to its duration, the process of pollution may be permanent, seasonal and incidental (accidental pollution).

Permanent (systematic) pollution is connected primarily to the extent, structure and characteristics of the traffic stream, characteristics of the communication and climate/weather conditions. Traffic activities result in the permanent settling of detrimental substances on the road surface and the associate structures of the cross section, which are washed away by precipitation. The substances which settle are primarily exhaust gases, petrol, oil and grease, tyre and road surface wearing, body wearing, etc.

Seasonal pollution is connected to individual seasons. One typical example of this sort of pollution is the use of salt for road maintenance in the winter or of pesticides for the cultivation of green spaces along the motorway during the vegetation period. This type of pollution is considered special due to the presence of a huge quantity of hazardous substances in a very short period of time.

Incidental (accidental) pollution is most frequently caused by traffic accidents. Accidents are followed by the spillage and diffusion of hazardous substances. 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. In such cases, environmental preservation requires treatment in the broader area.

5.4.2.2. Vrste, oblik prisustva i količina zagađujućih materija

Waters drained off roads contain various waste and hazardous substances, whose concentration frequently exceeds the maximum permitted for discharge into water currents. These are primarily components of petrol, such as hydrocarbons, organic and inorganic carbon, compounds containing nitrogen (nitrates, nitrites, ammonia), sulfates, chlorides, etc. Heavy

metals constitute another important group of elements, such as lead (as a component of petrol), cadmium, copper, zinc, mercury, iron and nickel.

Equally important are solid substances of various structures and characteristics present in the form of sedimentary, suspended or dissolved particles. Certain other materials may be found, whose presence is the result of the use of special substances against corrosion. Polyaromatic hydrocarbons (benzopyrene), which are the byproduct of incomplete combustion of fuel and used motor oil, make a special group of highly cancerogenic substances.

In order to determine indicators which will be used in the assessment of impact of the motorway, it is necessary to obtain reliable data regarding concentrations in road waters and the flow 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 these claims and based on certain foreign experiences, we have calculated the amount of pollutants in waters which will drain off the planned motorway by means of interpolation for various traffic loads. With this kind of analysis it is possible to establish some basic rules based on global parameters (traffic load, traffic structure, etc.). Table 5.4.1. presents the anticipated amounts of pollutants contained in waters which will drain off the motorway along lot 1.

Table 5.4.1. Estimated concentrations of pollutants in road waters

Substance	Unit	Lot Svilaj – Dobož South (Karuše)
Suspended substances	mg/l	100-150
Chlorides	mg/l	50-80
Sulfates	mg/l	0.04-0.07
Phosphorus – total	mg/l	0.4-0.8
Fuel	mg/l	0.005-0.008
Mineral oils	mg/l	0.004-0.007
Cadmium	mg/l	0.002-0.005
Chrome	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 and drained off road surface. The basic data which is particularly important for the calculation of the pollutant concentration may be summarized in the form of these conclusions:

- The biggest concentrations of pollutants were measured in water draining off roads during the winter, when use of grit or salt is most common.
- The concentration of most pollutants correlates directly with the duration of dry weather prior to precipitation and with traffic load. The biggest concentrations were measured in the first 5 to 10 minutes of precipitation, after which they drop abruptly.
- The concentration of suspended substances is proportional to the intensity of precipitation and the biggest 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 substances off the road during dry weather caused by airflow due to the passage of vehicles does not have an important effect in the sense of concentration decrease.

- The pollution of surface waters caused by the drainage from the motorway surface may be important, which is why it is necessary to conduct a detailed analysis and define possible measures of protection.
- Pollution caused by traffic accidents is a special problem and the previous statements do not refer to it. This issue is analysed separately in the chapter dealing with possible accidents.

5.4.3. Impact on water in accidents

In the event of accidents, especially those involving vehicles transporting hazardous loads, one possible danger is the spillage and diffusion of waste and hazardous substances along the motorway, possibly even into the narrow strip of land along it if there are no safety fences or concrete blocks (new jersey) as physical barriers to prevent the overturning of vehicles. The most frequent accidents are those involving the spillage of oil and its derivatives, who have a great capacity to diffuse into the ground. The probability of the mentioned impact is small; nonetheless, in case one such accident actually occurs, the consequences may be serious and long-lasting. The seriousness of this kind of impact is greater in areas where the motorway runs through aquifers, over and near local water sources, along the zones of protected waters, as well as at sites where the road runs across open water currents.

As consequences may be extremely serious in the event of accidents, along with prevention measures, it is necessary to prepare a plan for urgent action in the event of accident both during the construction and use stages.

5.5. Impact on air

Traffic causes air pollution and this is another factor defining the relation between the motorway and the environment. It may be assessed only if all relevant parameters are considered (meteorological, topographic, traffic-related, building-related, etc.).

If these factors are considered, this study may produce certain conclusions related to the issue of air pollution, which will allow a level of assessment corresponding to the amount of data which may be taken from the project and study documentation. These findings, calculation methods and functional laws create a methodological basis needed to determine the relevant parameters of air pollution, with the principal goal of obtaining relevant data to assess potential negative impact on people, vegetation and buildings along the studied sections of the motorway.

5.5.1. Concentration measurement

Research into the problem of air pollution has produced certain findings which may be said to represent a generally valid model used to determine/calculate the relevant indicators. In that sense, as a rule, it is possible to measure the emission of air pollutants in all periods sharing the same characteristics.

If we take into account the properties of the relevant parameters conditioning the concentration of air pollutants, we may conclude that such uniform properties may be obtained only if we resort to significant simplification. According to this, the majority of analyses to date have shown that the best measuring basis is obtained for mean annual values of relevant indicators understood as long-term concentrations. This facilitates planning, which principally relates to parameter MADT (mean annual daily traffic), as far as traffic is concerned. This study is based on indicators defined as mean annual values (long-term concentrations) and the 95th percentile value (maximum short-term concentration).

5.5.2. Air pollutants

To date, the examination of exhaust gases released as the byproducts of the work of motor engines has revealed several hundred hazardous organic and inorganic components. It is clear that it is not possible, nor is there such a need, to measure all these indicators. This is justified by the fact that we do not know how most of them are formed, and also, they are not equally harmful for the environment. In that sense, most analyses of air pollution today are based on several indicators which allow to obtain numerical data with satisfactory accuracy.

The long-standing practice of measuring carbon monoxide (CO) as the only relevant air pollutant in air pollution analysis is considered outdated. Along with carbon monoxide, it is very important to include the measuring of nitrogen oxides, sulfur oxides, carbon hydrogen, lead and soot. The increase in the number of vehicles with diesel engines leads to greater concentrations of nitrogen oxides, a trend likely to continue with the mass use of lead-free petrol. Research also indicates that, in comparison with carbon monoxide, the concentrations of nitrogen oxides reach or even exceed the maximum permitted values much more frequently.

For the purpose of this study, the following elements contributing to air pollution have been accepted as relevant for assessment: carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), hydrocarbon (C_xH_y), lead (Pb) and soot particles (CC).

5.5.3. Major air pollutants and their impact

Basically, the analysis of the negative impact of air pollutants needs to take into consideration a wide range of findings related to this area. The reason for this is simple – there is no agreement on the character of negative impact – 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 describing the character of this kind of impact, primarily related to people, animals, vegetation and materials.

Taking into consideration the nature of the road studied in this research and the character of individual spatial environments in its zone of impact, the conclusion is that it is necessary to describe in greater detail the impact of certain air pollutants.

In the context of this, it is necessary to emphasise the fact that there is very little research conducted today which examines the joint negative impact of various air pollutants in an integrated manner. The findings to date show that, in principle, the impacts of these factors add up, although there is also the possibility of increased impact (synergy), as well as the phenomenon of neutralization of individual factors.

5.5.3.1. Carbon monoxide

Primarily, carbon monoxide affects people as it combines with hemoglobin, eliminating oxygen and impeding its transport through the organism. Carbon monoxide has negative impact even when its concentrations are very low, as its tendency to combine with hemoglobin is 240 times greater than that of oxygen. When inhaled, its symptoms are usually disturbed balance, problems with vision, bad concentration, heavy respiration or headaches.

The general conclusion related to this compound is the widely accepted fact, where the concentration of CO in hemoglobin of 2% may be considered harmless, while concentrations higher than 2.5% are considered dangerous.

The impact of carbon monoxide on vegetation may be considered irrelevant. This conclusion is equally valid for building materials.

These findings show that the impact of carbon monoxide on people is the most serious and in that sense, it needs to be analysed together with other negative factors.

5.5.3.2. Oksidi azota

Dejstvo azotmonoksida na čoveka slično je dejstvu ugljenmonoksida, dolazi naime do istiskivanja kiseonika iz krvi čime je ugroženo snabdevanje tkiva. Velika koncentracija azotmonoksida u krvi izaziva smrt. Činjenica je međutim da su koncentracije azotmonoksida koje se pojavljuju u atmosferi jedva škodljive ali je njihov značaj kao aerizagađivača bitan prvenstveno zbog stvaranja azotdioksida (NO₂) koji je toksičniji i naročito štetan za disajne organe.

Iz navedenih konstatacija izvode se i granične vrednosti koje se zakonski propisuju.

Dejstvo azotnih oksida na biljke ispoljava se prvenstveno kroz uticaje azotdioksida. Wegovo štetno dejstvo ogleda se prvenstveno kroz voštani izgled lišća, nekrozu i prevremeno opadanje. S obzirom na ove uticaje u svetu se danas smatra da su sve vrste biljaka zaštićene od uticaja oksida azota za dugotrajne koncentracije od 0.03 mg/m³.

5.5.3.3. Nitrogen oxides

The effect of nitrogen monoxide on people is similar to that of carbon monoxide. It drives oxygen out of blood, which jeopardizes the nutrition of tissue. High concentrations of nitrogen monoxides cause death. The fact is the concentration of nitrogen monoxide in the atmosphere is generally low and thereby hardly ever dangerous, but as an air pollutant, it is important for the formation of nitrogen dioxide (NO₂), which is more toxic and very dangerous for respiratory organs.

In accordance with this, we have accepted the values permitted by law.

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 early falling. In terms of this kind of impact, the general view is that all types of plants are safe from the negative effects of nitrogen oxides whose long-term concentrations are 0.03 mg/m³.

5.5.3.4. Sulfur dioxide

In observing sulfur dioxide as an air pollutant, it is necessary to emphasise that traffic is its secondary source. Sulfur dioxide affects people by combining with fine dust and may damage mucous membrane (eyes) and airways.

Sulfur dioxide has a great negative impact on vegetation as it disintegrates chlorophyll and leads to the dying of certain types of tissue. Certain conifers have proved very sensitive to sulfur dioxide, as they are damaged by concentrations as low as 0.05 mg/m³. Sulfur dioxide has the greatest negative impact on buildings out of all air pollutants.

In contact with moisture, sulfur dioxide turns into sulfur acid and disintegrates organic substances. This type of reaction is possible when very small concentrations are present, and it is certainly necessary to focus on this issue when evaluating the historic and artistic value of buildings. The related effects deteriorate with the rise of temperature, humidity and intensity of

light.

There are no functions connecting these phenomena or occurrences, which is why it is very difficult to assess their negative impact.

5.5.3.5. Lead and its compounds

It is clear today that people take in much higher quantities of lead and its compounds through food than by inhaling them from the atmosphere. Permanent exposure to pollution caused by lead results in chronic poisoning, whose primary symptoms are loss of appetite, stomachache and digestive malfunction, fatigue, vertigo/dizziness, kidney damage and unconsciousness. However, the dilemma still lingers regarding the acceptable concentrations of lead in the atmosphere. This leads to the "temporary" character of maximum permitted concentrations of lead in some countries. As for its impact on vegetation, lead has low toxic value. The concentration of lead in plants correlates highly with the lead content in soil. However, the presence of lead in plants reduces their growth capacity and enzyme activity.

5.5.4. Established values

According to what was noted about the negative impact of individual air pollutants and their possible combined impact on people, plants, animals and materials, it is very important to pass legislation which will regulate this area.

Most foreign related legislation also defines the maximum values of air pollutants in relation to plants and materials. From the aspect of agricultural cultivation, the study uses experiences from foreign technical literature in the event of sharp negative impact of air pollution on plants. It is believed that all plants are safe from nitrogen oxides of 0.02 mg/m³ (long-term exposure) and 0.10 mg/m³ (short-term exposure).

As for sulfur dioxide, negative impact may be expected from the concentration of 0.6 mg/m³, whereas especially sensitive plants require the maximum value of 0.25 mg/m³. The stated values refer to concentrations present in the short term.

5.5.5. Assessment of air-pollution emissions

Regardless of the difficulties present in the process of measuring/determining air pollution parameters and the lack of standard procedures, it is possible to obtain useful and sufficiently accurate data to assess potentially negative impact, even with so many question marks.

However, it is necessary to say that in the process of quantification of air pollution parameters caused by traffic, we may opt for more or less elaborate research/examination, which primarily depends on the number of factors included in the it.

The process of design may lead to the decision to resort to greater or lesser simplification. In cases when air pollution analyses will be used as the basis for the assessment of negative environmental impact, which is certainly the aim of this study, their presentation has to indicate key problems with no hesitation or doubt. In that sense, operating with emissions while resorting to their relative value and unification has proved useful, usually through mean annual values in mg/m³.

With respect to the above-stated findings and facts related to air pollution indicators, major factors, the possibility of their quantification, concrete conditions as presented in the study, as well as the level of analysis defined in the planning and design stages, the assessment of the

emission of air pollutants uses mean annual values as relevant and the 95th percentile value as an indicator of anticipated short-term concentrations.

5.5.6.1. Measuring/assessment methods

The concentrations of air pollutants for the typical cross section of the motorway were calculated using a computer program based on the model created in line with the specifications for the calculation of air pollution on roads (Merkblatt über Luftverunreinigungen an Strassen, MLuS-90). The parameters of air pollutants in the form of mean annual values and the 95th percentile value were calculated based on exponentially expressed determinist rules:

$$K_i(d) = K^*i \times g_i(d) \times m_i(d) \times f_{si} \times f_w \quad \text{mg/m}^3$$

where:

K^*i – standard concentration of an individual component (i) at the motorway edge,
 $g_i(d)$ – function of concentration change depending on the distance,
 $m_i(d)$ – function defining the transformation of NO to NO₂,
 f_{si} – function which specifies traffic features,
 f_w – function which defines wind impact.

Possible variations to the concentrations of air pollutants as a function of distance allowing the possibility of analysis for the impact zone is calculated as:

$$g_i(d) = \exp \left(a_{0i} \frac{d}{100} + a_{1i} \arctan \frac{d}{100} \right)$$

where:

d – orthogonal distance from the motorway edge to the emission point,
 a_{0i}, a_{1i} – coefficients

As NO turns into NO₂ with the increased distance from the pollution source, the correction function $m_i(d) = f(b, d, n)$ is introduced in the calculation of the concentration of nitrogen oxide. The impact of meteorological factors on the concentration of air pollutants is introduced in the calculation by means of function $f_{nj} = f(u)$, where (u) is the speed of wind at the emission point.

The result of the calculation is mean annual values and 95th percentils for all noted components of exhaust gases. Relevant concentrations needed for this part of the research were defined at various distances from the motorway in order to take into account the impact of meteorological factors.

5.5.6.2. Calculation and analysis results

Based on the calculated concentrations of air pollutants along individual sections of the motorway, data have been obtained representing relevant air pollution indicators. The data were obtained with respect to meteorological conditions, spatial dispositions and the speed of the most frequent types of wind. These relevant air pollution indicators are given in table T.5.5-01. Based on the data obtained in the analysis and the maximum/minimum values common in such cases, we come to the following conclusions:

The maximum values of relevant mean annual concentrations were exceeded within distances shorter than 30 meters from the motorway edge. From the aspect of air pollution, this is

primarily a result of air pollution, traffic load and structure-free curbs, except in approach cuttings.

Table T.5.5-01: Relevant concentrations of pollutants

Communication: Vc Motorway							
Distance [m]	0	25	50	75	100	200	300
CO _{sv}	1.3920	0.684	0.3614	0.211	0.140	0.054	0.0360
CO _{max}	5.1200	2.6700	1.4900	0.920	0.630	0.2684	0.1830
C _x H _y _{sv}	0.1354	0.0662	0.034	0.0205	0.0135	0.0053	0.0034
C _x H _y _{max}	0.4961	0.2581	0.143	0.0890	0.060	0.0258	0.0176
NO _{sv}	0.220	0.0954	0.0450	0.023	0.0144	0.0040	0.0020
NO _{max}	0.790	0.3644	0.1814	0.1012	0.0630	0.0194	0.0100
NO ₂ _{sv}	0.061	0.0501	0.0352	0.0254	0.0195	0.0103	0.0078
NO ₂ _{max}	0.2227	0.1915	0.1420	0.1077	0.0856	0.0494	0.0386
Pb _{sv}	0.00092	0.00043	0.00022	0.00012	0.00008	0.00004	0.00002
Pb _{max}	0.00335	0.00172	0.00096	0.00060	0.00040	0.00017	0.00012
SO ₂ _{sv}	0.026	0.013	0.0074	0.0043	0.0028	0.0011	0.0009
SO ₂ _{max}	0.1102	0.0547	0.0293	0.0176	0.0118	0.0050	0.0038
CC _{sv}	0.0084	0.0042	0.0022	0.0012	0.0009	0.0004	0.0003
CC _{max}	0.035	0.0172	0.0092	0.0055	0.0037	0.0016	0.0011

Based on the previous conclusions, it is evident the negative impact of air pollution on people, animals and buildings is not particularly important in the examined area within the given period. As for the impact of various air pollutants on the vegetation, this factor is important from the aspect of soil properties in the immediate vicinity of the motorway. The obtained results show that negative effects may be expected only in the immediate vicinity of the motorway.

Based on all the analyses, we may draw a general conclusion that the problem of air pollution will not be very serious in the motorway corridor, and given the modernization of vehicles in the future and serious restrictions from the aspect of the quality of exhaust gases, it is realistic to expect smaller concentrations of pollutants, regardless of the increase in the traffic load.

5.6. Impact on soil and agricultural land

The project of road construction, in its section LOT 1, will to a significant degree disturb the existing environmental balance, established in this area primarily thanks to human activities over a long period of time.

5.6.1. Sources of damaging and pollution

a) Land damaging

The areas of agricultural and other land that will be impacted by the construction of the highway could be divided in the following three strips:

- The narrowest strip is up to 60 m wide (30 m on each side of the road axis, to the embankment or slope) will be fully «attacked» either by the route itself, or support facilities and heavy machinery during the construction. It means that approximately 375,80 ha of land along the LOT 1 section of the route, will be attacked in a most direct way. This is not a minor loss, nor is it the only loss caused by the construction of the highway and its infrastructural and support facilities.
- Somewhat broader strip is up to 200 m in diameter (100 m on each side of the road axis). Along with the aforementioned one, it is considered to be the strip of direct impact of the highway traffic. Most of it is owned either by the road concessionaires or state. This wide strip is usually expropriated or purchased if required. Most of the protection measures and actions are related to this strip. The area of the strip is 1252,68 ha.
- The board strip is considered to be 500 m in diameter (250 m on each side of the road axis in continuation of the previous one). This strip includes the land areas suffering from direct physical damaging and loss of soil; areas along the highway being under both direct and indirect influence of traffic (0 + 30 + 70 + 150 m on each side, measured from the road axis). If we presume that the total width of the area exposed to direct damaging and pollutants, as well as indirect impact of the highway traffic is 500 m, than a total area of land exposed to these impacts will amount of 3131,70 ha.

b) Land pollution

Since the major part of the highway route section LOT 1 goes through agricultural areas of high use-value category land, it will be necessary to undertake special soil protection measures and establish full control over the key traffic generated pollutants.

The shorter the route (more tunnels and viaducts), the lesser the loss of soil through change of use is. From the agricultural point of view, it is logical to request that deep arable land be avoided to the maximum extent possible.

While selecting the route for the highway it is certainly necessary to respect its basic function and purpose, which is - efficient transportation. This requirement is often in conflict with the requirement to keep the **fragmentation of production plots** at the lowest possible level. This is hard, yet not impossible to achieve. This is feasible in the part of the sector situated in the slope foot by orienting the route along the margin, thus avoiding the traversing of major production lots. In this way, at least three significant effects could be achieved:

- more valuable soils are preserved from change of use
- fragmentation of land lots is prevented
- the road route is elevated relative to the land in the fields and valleys, where air circulation is more frequent
- there is less fog and foggy days on the highway itself.

Agro-ecosystem represent very complex relations between agro - biotop – agricultural habitat (which is defined by soil properties and climate) and agricultural living association – agro - biocenoses, whose key members are crops and domestic animals. The basic regulatory role in these complex relations lies with the humans. Only a stable agro-ecosystem provides stable and high production of quality food. Any **immission of harmful matters** into agricultural land

jeopardizes its function. Traffic is a considerable source of harmful immissions. Based on the basic significance of harmful traffic emissions, they can be divided in four groups:

- Emission of solid particles - dust
- Emission of liquid matters
- Emission of gases
- Emission of salt for melting snow.

Solid particles are emitted from the highway as fine dust and widely spread by wind. Major harmful matters that are in the shape of dust being emitted off the roads are lead and soot, while Oelischlager (1972.) listed even 26 elements which include zinc, phosphorus, chrome, nickel, copper, molybdenum, arsenic, cadmium and mercury. Lead originates from exhaust gases, and cadmium from vehicles' tires. It is a significant component of dust and soot, which in addition to that, adsorbs various gas pollutants.

Distinction is made between large and tiny dust particles. Large particle dust is usually sedimented on green leaves in the vicinity of the road, while finer dust is dispersed by wind to more distant areas as dust suspension or aerosol. Sedimentation of dust on plants reduces the penetration of light and intensity of photosynthesis. Additionally, the dust sediment on the back side of leaves precludes normal transpiration causing physiological disorders. This results in reduced growth of the plant. According to the current researches, soot emitted from car engines shows no harmful impact on plants.

Emission of liquid matters, all liquids dripping out of car engines: fuel (petrol and diesel), motor oils, oil from gear-box and brakes, windshield washing liquids and anti-freezing products for the radiator liquid. Some of the stated liquids contain heavy metals: lead, cadmium, copper, nickel, vanadium and molybdenum. A total quantity of these substances depends primarily on the traffic intensity, i.e. number of moving vehicles. Cold engines emit significantly bigger quantities than warmed up engines in the optimal operation regime.

Gaseous component of emission represents a mixture of the engine exhaust gases. These emissions contain some of some already known, as well as a number of yet unknown organic compounds, and less unorganic compounds. The former include: carbon monoxide, carbon dioxide, ethylene, sulphuric dioxide, and the latter include polycyclic aromatic hydrocarbons - PAH_s and benzopyrene.

Industrial salt is used to melt the snow on the road surface. As snow is a regular phenomenon on this road section, there is a direct danger from salt for the agricultural land. In case of contamination, it would reflect in the shape of destruction – peptisation and formation of crust. Additionally, chlorine would damage all sensitive crops. The protective actions, which should be foreseen anyway, could protect the agricultural ecosystem from the negative impact of salt. The problem here is the contamination of soil by heavy metals, which are being washed into the water and through the cultivated plants included into both animal and human food chain. This is a focal and most pressing issue of modern ecology, especially agro-ecology.

The highest degree of contamination does not necessarily have to occur in direct vicinity of the road (except, of course, the closest – marginal part), but lies somewhat further out. This depends on the way of dispersion of pollutants and given local conditions.

5.6.2. Estimated concentration of heavy metals

Heavy metals and polycyclic aromatic hydrocarbons - PAH_s are the most dangerous pollutants produced in traffic, and they are accumulated near the road. However, PAH such as benzopyrene can be transformed into less dangerous component parts in a relatively short time,

unlike heavy metals which remain unchanged in the environment for a very long time. Following their dispersion into environment, they can be transported by water and wind to considerable distances, accumulated in sediments and through plants enters the animal and human food chain. Especially water is endangered in zones of sediments where heavy metals are accumulated.

In the eighties, a lot of research was done on land pollution in narrow embankments along the highways, where lead petrols posed a complex environmental problem (Mander, 1983, 1985a, 1985b). Recently, more than 80% of vehicles have engines that burn lead-free fuel. In comparison to 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 concentration in soil around the highway route continues to be a major problem. Pollution sources important for waters, most commonly originate from the area of shoulders and embankments along the road. The situation is similar in marginal agricultural areas. This should be taken into consideration while undertaking protection actions, maintenance or rehabilitation of the sites where the level of pollution is high. Although a number of heavy metals can be found in environment, the most frequently accumulated along the roads are lead (Pb), cadmium (Cd) and zinc (Zn).

Thanks to extensive use of lead-free petrol, the lead pollution is considerably reduced. Unlike lead, cadmium (Cd) is mainly a product of diesel fuel, and level of cadmium pollution is being maintained at the same level as in the past, and even shows descending trend. Zinc (Zn) is ten times less dangerous for living organisms than lead and cadmium; it originates from car tyres and gets spread with the dust along the roads. Of course, over time, zinc can accumulate and its concentration in soil can reach a critical level. The metals differ from each other based on their solubility and movability in the soil. In comparison with lead and zinc, cadmium has the highest level of movability in the soil. Acidulous reaction increases moving capability of heavy metals. At pH reaction below 4, leaching of heavy metals is twice as big 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. With regard to the acidulous sulfuric deposition which is being emitted primarily by vehicles burning diesel fuel, as well as emission of nitrogen gases, the roads and marginal areas along the road surface (grassing shoulders and embankments), are always acidulous.

Many researches also indicated that addition of salts preventing the formation of ice on the roads (NaCl and KCl in particular) 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 shoulders and embankments along the road. The use of reinforced concrete in construction of bridges, viaducts and tunnels may during the construction result in increased leaching of cadmium. Although no surveys on leaching of heavy metals from roads and their transportation into the watercourses, underground waters or accumulations have never been conducted in BiH, certain researches suggest that this factor could play a significant role in the accumulation of heavy metals in river sediments (Sults, 1997.).

The indicators of the assessed environment impact of traffic are given through the example of presence of average content of heavy metals in the soil (mg kg^{-1}) of shoulders and embankment along the road, a 3 m strip, according to the Mander 1983, 1985b, (table 5).

Estimated average concentration of heavy metals ($\text{mg kg}^{-1} \text{ god}^{-1}$) in soil (shoulder or embankment) in a 3 m strip along the asphalt

Table 5.

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, which are calculated using the following formula:

$$\text{MHM} = 2 \cdot w \cdot L \cdot d \cdot \text{BD} \cdot (\text{CHM (0-20)} + \text{CHM (20-50)}) \cdot \text{HM} / 1000$$

Where:

- **MHM** = estimated quantity of heavy metals in the upper stratum (50 cm shoulder or embankment in kg),
- **w** = width of strip (shoulder or embankment from asphalt, 3 m),
- **L** = length of the strip along the highway in m,
- **d** = depth of embankment, 0,5 m
- **BD** = volume density $1,6 \text{ g cm}^{-3}$,
- **CHM(0-20)**= average concentration of each heavy metal in the surface layer (0-20 cm) shoulder 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 value of Pb, Cd i Zn amounts to 165, 14 i 145 mg/ kg^{-1}*),
- **CHM (20-50)** = average value of the concentration of each heavy metal in deeper layers (20-50) of shoulder or embankment assessed as 20% of the quantity contained 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, we calculated the average concentration of heavy metals (Pb, Cd and Zn) in a 3m strip off the road edge (shoulder or embankment strip), while traffic intensity was taken over from the study dubbed „ Pre-feasibility Study-Lot 5 Final Report “ for the year 2015.

Table 6 shows estimated accumulation of three major heavy metals in a 3 m strip on each side of the road surface, both by sections and total length of the route, which require planning of protective and remedial actions.

Total quantity of Pb, Cd and Zn in the treated zone along the entire length of the highway route amounts to 9,27; 5,59 and 9,27 tons, respectively. This is certainly a rough estimate, however, it indicates potential danger of contamination of the highway margin areas. The situation could get even more complex at certain sections with higher traffic intensity level, such as 3, 4 and 5 in Table 6, or at exit, pull-over, intersection points, gas stations etc., whose exact locations have not yet been determined and therefore couldn't be treated as stationary in this study. It is very likely that we will face a conflict situation unless comprehensive protection actions are undertaken on margin areas involved in agricultural production.

Estimated quantity of heavy metals (in tons) in a 3 m strip of land (sholder or embankment) along the future highway Vc – LOT 1 by sections

Table 6

	Section	Length in m	Intensity* of traffic vehicles/day	Pb (t)	Cd (t)	Zn (t)
1	Svilaj - Odžak	10 891	1464	1,22	0,75	1,22
2	Odžak - Vukosavlje	6 398	1403	0,67	0,42	0,67
3	Vukosavlje - Podnovlje	16 178	2579	3,19	1,93	3,19
4	Podnovlje - Johovac	13 157	2081	2,09	1,26	2,09
5	Johovac - Rudanka	6 192	2081	1,02	0,59	1,02
6	Rudanka - Karuše	9 818	1433	1,09	0,66	1,09
<i>Total:</i>		<i>62 634</i>	<i>1840</i>	<i>9,27</i>	<i>5,59</i>	<i>9,27</i>

*Traffic on the highway in 2015

According to the RS Official Gazette, the Table 7 provides the maximal allowed quantities for some heavy elements in soil affected by potential pollutants.

**Maximal allowed concentration (MAC*)
of some heavy metals in soil**

Table 7

#	Element	MAC*
1	Ag	50
7	Cu	100
8	Cr	100
10	Ni	50
12	Zn	300
15	Pb	100

*RS Official Gazette No. 23 of 18 March 1994

Yet, we have to point out that the accessibility of heavy metals to the plants depends on the soil condition, especially pH reaction, therefore, the penetration of heavy metals into the food chains can be prevented through the interventions involving the change of pH reaction of soil.

Table 8 shows an example of the maximal allowed content of heavy metals and other potentially harmful materials, which is harmonized with the countries of Alpine-Adriatic regional association, whose member should become our country as well, being the first step toward other integration processes.

**Maximal allowed content of heavy metals in agricultural soil
(in mg/kg soil)* extracted in aqua regia**

Table 8

Element	Mechanical properties light soils, stony soils and soils poor in humus	Mechanical heavy soils and soils rich with 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
(PAH)***	2	2

* In carbonate soils, with over 2% of CaCO₃, content can be higher by 25%

** Figures pertain only to the soil of plough-lands, gardens, meadows and pastures

*** PAH – polycyclic aromatic hydrocarbons

5.7. Impact on flora

The direct impact zone of lot 1 of the motorway Vc Svilaj – Doboj-South (Karuse), whose total area is 19 255 ha, covers 10 524 ha of agricultural soil (54.4%), 2 213 ha of woods (11.7%), 653 ha of water (3.4%), and 5 865 ha of other types of space (30.4%). This clearly shows that agricultural soil is the dominant category of land, ie impact on flora. Based on the cultivation method used across the direct impact zone, it is defined as presented in the following table.

Table 5.7-01 Total area (method of soil cultivation) within the zone of impact

Agricultural soil function (cultivation method)	Area [ha]	%
1. Tillage	3 993	38
2. Mixed farming	4 399	41,8
3. Orchards	15	0,1
4. Pastures	72	0,7
5. Mostly agricultural with vegetative growth	2 046	19,4
Total	10 524	100

Based on the analysed impact within the area of air, water and soil pollution and area possession, the same conclusions can easily be drawn regarding the possible impact on flora in the area through which the planned motorway alignment will pass.

Facts discovered within the current state show that, considering local conditions and flora diversity in the area, only limited impacts are to be expected. Those are in fact findings that the area interesting for analysis does not have high potential of an ecosystem and there are no specific lairs of rare or protected species.

The impact of air pollution on the most sensitive species is spatially limited to a narrow corridor along the motorway, since those are concentrations that the allowed limit values, in regard to possible negative impact, reach at about 50 metres from the motorway edge for most components. This is a result, as already concluded in the chapter on air pollution, of traffic load and pollutants transmission terms on motorways without edging construction.

Soil pollution impact on flora in the motorway area is also spatially limited to the area along the motorway edge and in the drainage ditches. Certain impacts, within the area closest to the motorway, can be expected only through effects of putting salt on the ground for winter maintenance.

The main impact on flora within the examined area is apparent in already analysed area occupancy effect. This impact is apparent along the entire route because it is mostly passing through areas under the plough.

Considering defined areas under vegetation of certain quality, which is defined within the chapter on characteristics of the current state, it is necessary to emphasize the fact that the analysed alignment enters these ecosystems minimally.

At this level of analysis, procedure of calculating the impacts on flora is only possible through defining areas with complete loss of vegetation, areas with changed vegetation and areas covered with autochthonous vegetation under certain impacts. Complete loss of vegetation will happen to areas within the road construction and embankments, which is about 170 ha.

Areas within the main body of the road that are to be under the process of planting greenery upon the construction, as a part of road corridor arrangement (embankment slope, ditches), as well as areas expropriated as required for the road construction, are those that will be covered with changed vegetation and they are under the main negative impact of the road. These areas are comprised of 375ha.

Based on analysis of impacts on soil and agricultural land the apparent conclusion is that the area of 1252.7 ha will be under various degrees of impact, from complete loss of vegetation to changed vegetation and vegetation under increased pollutants concentrations.

Areas covered with vegetation out of the expropriation zone that will be under indirect impact of concentrations amounts to 1900 ha. A part of these areas will be exposed to direct impact of motorway as well. Regarding the mentioned data on directly and indirectly endangered land, a final evaluation of impact on flora in the area of about 3100 ha can be made.

Concerning the fact that in the largest part of the areas through which the motorway passes certain species ecosystems exist, impact in the field of flora is basically reduced to the negative impact regarding the possibility to grow certain species along the planned motorway.

5.8. Impact on fauna

The need to explore all the negative impacts resulting from the construction of the planned motorway requires examination of possible negative impacts on fauna. Those are a result of some already evaluated criteria (noise, air pollution, water and soil pollution, land occupancy, accessibility, etc.) that exercise their impact regarding the existing lairs, but are also a result of certain specific criteria typical of fauna in an area. Those impacts are primarily apparent when it comes to intersection of traditional (usual) roads representing a formed network typical of every area and possible accidents (car hitting an animal) inevitable in such cases.

Field research of planned motorway corridor made in order to define possible negative impact on fauna showed that in the largest part of the area important negative impact is not likely to happen.

Especially important factor that needs to be emphasized is that the spatial and exploitative elements of the planned motorway contribute to possible negative impact because the motorway in question is a road with relatively heavy traffic load, great roadbed width and edging that has a great effect on spatial arrangement.

There are many facilities on the route for possible future construction of bridges, channels and tile drains. Current state research did not register any usual routes of animals' movement that could be a basis for formation of special constructions for the free movement of animals.

Impact of the planned motorway on fauna of the rivers should be seen as an impact without high negative effects, regarding the quality of water current in the Bosna River.

Current state analysis showed that in the wider area there are no lairs of rare and protected species and that, in that regard, negative impact is not to be expected. Concerning the spatial position of the existing lairs and spatial position of analysed corridors the obvious conclusion is that high negative impact is not likely to occur.

5.9 Impact on landscape

Problems of visual pollution viewed as criterion of relationship between the motorway and the environment are relevant and crucial since the moment it has become clear that the visual landscape characteristics are a qualitative index that has an effect on the quality of the project; or they become apparent as an element of degradation of usual and arranged relations.

Every research in this field is related to a stage of project documentation creation process, because the possibility to evaluate some of the indexes as characteristics of visual pollution problems depends greatly on the level of information. In order to make a transition from descriptive evaluation of impact in this field to quantitative methods that include a complex valorisation of the area, it is necessary to take a series of specific procedures of analysis, which requires graphic and visual information at a high technological level.

When it comes to specific research all data are in accordance with the basic proportion, R=1:25000, since bases of this proportion have been used for validation of basic relations, which determines all possible evaluation procedures and by itself a level of accuracy of the index results. Concerning the previous notes, problems of visual pollution have been examined at two basic levels. The first one comprises problems of spatial relations of the route itself and elements of its projections homogeneity included in the so called geometric modelling, and the second level includes the relation between the alignment, as a construction, and the space viewed in terms of defining the impact on the landscape.

5.9.1 Geometric alignment modelling

The geometric modelling means the process of project elements' harmonious combining, which main goal is to achieve a spatial image of the road that visually gives a positive impression and a sense of security to drivers. Since the drivers' visual field includes several geometric objects at the same time and they together define the spatial current of the route, it is necessary to take optical characteristics of each project element into consideration. Harmonious relations can be

achieved only with harmonious road route elements in the situational plan, longitudinal and cross-section profile.

Evaluation of relations in the field of geometric modelling at this level has been made using the information out of the draft project. Analysis of the used situational and levelling plans elements, as well as their interrelationship, has given the conclusion that criteria of homogeneity are mostly satisfied. Shortcomings in the field of landscape planning are apparent only in places of forced spatial planning of motorway route in Doboj region, resulting from complying with the local spatial plans.

5.9.2 Landscape properties

In order to evaluate relation between the planned route and the landscape methodology that has been applied uses separation method whose results are individual components (morphology, vegetation, surface water, facilities and general image). Those components does not have the same characteristics in terms of characteristics of the area through which the planned and analysed route is to be constructed, but certain degree of potential exists, which requires the appropriate analysis.

The zone of changed landscape characteristics can be defined based on medical threshold of visibility, applying the standard measuring visual angle of 10^0 as a measure for maximum altitudinal difference of the construction profile in relation to the landscape line. This kind of relationship means that width of the possibly endangered landscape zone is $600 H$ (H stands for maximum altitudinal difference in a cross-section profile).

Based on spatial relations of the planned motorway (maximum height of the embankment and channels) it is possible to say that the high width of this zone is about 2000 through 10000 metres. Therefore, the highest re-levelling at a cross-section profile should be visible at a distance of even 10 kilometres. Based on the previous examination it is apparent that under specific conditions high embankments in the Bosna River region have dominant characteristics, as well as some of the objects.

Since change of morphological characteristics is being considered as a dominant change of a landscape, this index has been evaluated by means of calculating a coefficient of landscape "violation" defined as:

$$O = \sum_{k=1}^{k=n} \left(\frac{P_n + P_{n-1}}{2} \right) \cdot d_p \cdot \frac{K}{100}$$

where:

O – is a coefficient of landscape "violation"

P – is "landscape profile" of the route

d_p – is profile distance

K – is a coefficient of landscape threatening in function from the road class to terrain category

Based on results it is possible to calculate the index to planned motorway impact on the landscape. Coefficient of landscape "violation" for certain sections is between 3480 and 4850, which can be seen as an important impact. This result is a direct consequence of high embankments along the Bosna River valley. The presented data show that, in morphological terms, the planned motorway alignment will "burden" the landscape and that with that regard certain protection measures have to be undertaken.

The planned motorway impact on landscape characteristics in terms of vegetation can be evaluated based on elements presented in the chapter on forestry characteristics. All elements

that could have been gathered so far do not give enough grounds for evaluation based on this parameter.

Impact of surface water on landscape elements also represents an important fact, primarily due to the fact that the route is almost in a direct contact with the riverbed of the Bosna River. Construction of the planned motorway visual characteristics of this landscape element may be threatened to a great extent, especially if the visual contact of the surrounding settlements with the water current disappears. Construction of the planned motorway will also create conditions for positive effects comprised in the fact that the construction will give some new views to those who are a part of the traffic, different view of the landscape in the Bosna River zone.

Out of objects planned for construction in the function of the analysed route, there are no important ones that will, in terms of visual aspect, enrich the landscape, apart from the positive visual characteristics that are to be expected in relation to bridge constructions over the Bosna River.

The landscape's general appearance has to be defined as a special parameter for the landscape evaluation. In the procedure of evaluation of this type, concerning the importance of subjective evaluations, interest landscape parts have been the first to define, followed by their evaluation. Evaluation of landscape characteristics within the scope of current state has not discovered any important potential, since it is mostly about various species' ecosystems.

Final positions in regard to the impact of the planned motorway on the landscape and its characteristics as part of the spatial section comprising the analysed corridors are possible to systematise within the facts that negative impact can be expected due to the need to build high embankments in the Bosna River valley.

5.10 Impact on nature preserves and cultral and historial heritage

Definition of the planned motorway impact on natural and cultural heritage includes all the possible effects related to protected natural and cultural properties or objects within the scope of natural and cultural heritage not categorised in this way but deserving special protection measures due to their characteristics. The analysis of the current state has established that there are no protected natural properties that could be exposed to negative effects.

Negative effects are not to be expected in the field of impact on the historical heritage either, since there are 12 objects in that category that are in the area of research and their locations give positive research results. Regardless of all stated facts regarding cultural and historical heritage in the analysed area, it is possible that during the construction work on the land in the area some archaeological remains may be found not yet discovered. In such case, it is necessary to notify the competitive Institute for protection of cultural heritage and take all measures to preserve discovered archaeological remains specified in the chapter on protection measures.

5.11 Impact on woods and hunting

Planned route is going to, inevitably, physically separate populations of already mentioned species, that is, it is going to restrict free migration of game. Apart from that, the planned route will certainly cause some damage to game due to traffic, pollution and disturbance, and will make it harder to raise, protect and use game, and in certain parts, it will make it completely impossible. This is especially apparent in the route starting section area, which is partly hilly, partly plain area, being the best lair for dwelling and raising of small game (sheep and goats), and in hills and mountains area, where big game dwells (horses and cows).

5.11.1 Aspects of forestry

In the area of Svilaj – Vukosavlje section the route contacts plains and ridges with discontinuous alder trees forests, together with willow and poplar trees. Discontinuity of this woods fragments emphasise even more the importance of minimising disturbance in the eco-ambient in order to preserve biodiversity of the system and hydrological functions of individual trees and their communities. From that point of view, it is strongly recommended that, to the greatest extent possible, the existing fragments of ecologic-vegetative communities should be preserved.

Along the section Vukosavlje – Podnovlje, the route partly goes through the urban area of Modrica and partly follows the Bosna River current, making occasional contacts with the willow and poplar woods, as well as with fragments and individual alder trees along the riverside. English oak and eastern hornbeam trees are on the slopes near the riverbanks where the route makes contact with it. Since the location Betnja has a wider gap between the edge and the edging woods, English oak and eastern hornbeam communities, their protective function remains intact.

In section Podnovlje - Kotorsko the route lies in the lowland costal area along the Bosna River. In that area there are trees of alder, poplar and willow, while there are no important contacts with the larger areas covered with woods, although located at the edge of the lowlands where there are mountain forests of English oak and eastern hornbeam. The most apparent impact the route has is on the individual trees along the riverside and small groups of trees in contact with the Bosna River at the section Rastoka-Prnjavor field. Through the section Kotorsko – Rudanka, the route passes through the lowland riverside area of the Bosna River and through vegetation of the lowlands.

After the route crosses the Bosna River in Rudanka, it penetrates greatly into the woods, first into beech woods and than into English oak and eastern hornbeam woods. The route intersects with the woods ecosystems in this section and thus has an impact on the way of planting and using these woods. There are two tunnels in this section, of 20 km total length.

5.11.2. Hunting

Section Svilaj – Potocani is in the zone of the former hunting ground called “Mera”, with very favourable lair conditions for sheep and goats. In this part of the route, there are areas „Bare” and „Potocanski ritovi”, which are very important lairs of swamp birds and also places where they make their nests. The channel „Svilaj – Potocani,” is also an area of an important impact, since it is also a suitable place for making the swamp birds’ nests and for gathering of game during the drought season. The route in the mentioned section passes through the best game lairs and it will have an impact on hunting and wild life preservation in this part. The route does not directly jeopardise the hunting facilities of greater importance in this section (pheasant farms, hunters’ logs, etc.).

The section Vukosavlje – Podnovlje, from the aspect of hunting, suffered a small loss of game lairs, due to avoiding Tarevacko polje, but it penetrated to a smaller extent Vranjacko and Kutlovacko polje (high-quality lairs of sheep and goats). Since the route is placed along the existing railroad, it minimised impact on free migration of game and performance of work in the field of wild life preservation and hunting.

The selection of route in the section Podnovlje – Osjecani Gornji did not give many alternatives, so it was necessary to pass through the more important lairs of swamp birds in the closer area of the Bosna River. This riverside area is important for the dwelling and breeding of wetland

birds, as well as for hunting (organisation being more difficult and almost impossible to hunt game in this section, due to the danger for the traffic). Local hunting organisations in this area, wild life preservation facilities (Ritesicko and Majevacko polje) are in danger since the route will divide the area. After it crosses the Bosna River, the route passes through Prnjavor Polje and further to Jabucnik, Osjecani Gornji, where it causes minor loss of game lairs.

In the section Ocjecani Gornji – Trnopolje, when the route passes onto the right coast of Bosna, impact on areas of Stavci and Zavucenice has been avoided. Those areas represent high-quality lairs of sheep and goats and swamp birds, and by being further from the Bosna River, impact on hunting and wild life preservation has been significantly reduced.

In the section Kotorsko – Rudanka, the route goes along the Bosna River and penetrates the area that is important for dwelling and reproduction of swamp birds, as well as for hunting itself (more difficult organisation and almost impossible hunting in this section, due to the danger for the traffic).

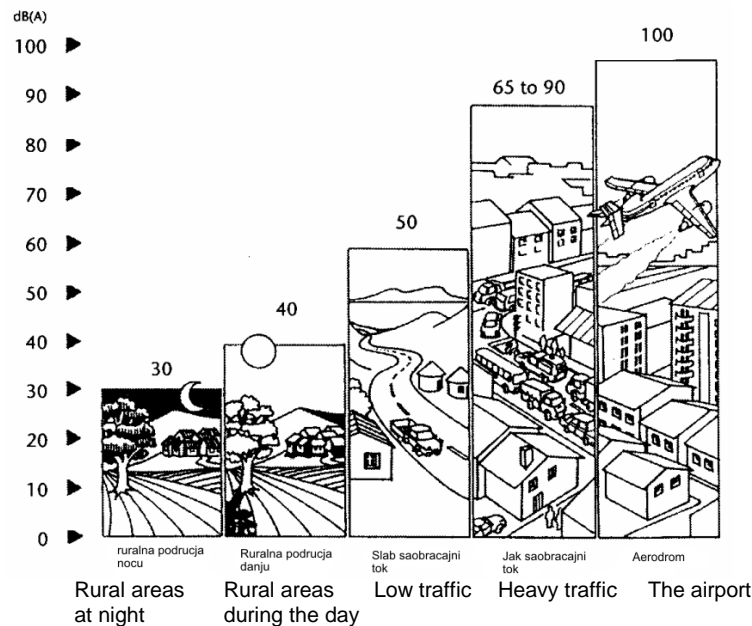
Rudanka zone, with regard to the route and planned fork in the road, will suffer the biggest loss of lairs and places for making swamp birds' nests. The route section in the area of Susnjari, Mala Bukovica and Prisada will cause some loss of lairs and restrict free migration of game, which is more apparent in this area (roe deer and wild boar), therefore possible danger for game and traffic is bigger there. Placing the route along already built road communication facilities makes better communication and migration of game.

5.12. Impact of noise

One of the most important impacts caused by traffic is exposing the people who live in settlements close to the route to traffic noise. Research made in European Community has discovered that a large percentage of population feels uncomfortable due to the noise that road traffic makes.

Measurement unit for measuring the noise level is decibel (dB), which is based on logarithmic table. From practical point of view, this means that, for example, the intensity of a doubled source (e.g. doubled traffic load) will appear as an increase of +3 dB. On the other hand, from the receptor's point of view, subjective impression of human beings that the noise has doubled its strength requires an increase of about +10 dB. In general, any change less than 1 dB is not considered as important.

The problem of traffic noise impact is usually being solved by applying the measures used in the stage project, construction stage and stage of exploitation of the roads.



Since human beings are sensitive to noise, depending on its frequency, there is a convention to use the curve of adjusting the frequency (curve A) in order to obtain the measure for the noise level independent of its frequency (marked as dB (A)).

Examples of noise levels of usual sounds in the environment are:

- Ambulance siren at distance of three metres 140 dB (A)
- Plane taking off at 100 metres 110 - 120 dB (A)
- Pneumatic hammer unit 90 - 110 dB (A)
- A restaurant full of guests (inside) 65 - 75 dB (A)
- Bureau with lots of officers (inside) 60 - 65 dB (A)
- Normal conversation 40 - 60 dB (A)
- Silent living room 30 - 40 dB (A)
- Silent bedroom at night 20 - 30 dB (A)
- Silent garden 30 dB (A)

5.12.1. Sources of noise at the motorway

Noise on roads has four main sources: (a) motor vehicles, (b) friction between vehicles and the road surface, (c) behaviour of drivers and (d) activities on construction and maintenance. *Motor vehicles noise* occurs due to work of engines, transmission, exhaust pipes, suspension systems, and it is biggest during the acceleration of motor vehicles on the slopes, when using engine brake system, on the roads in a poor state and in "stop and go" traffic conditions. Poor maintenance of motor vehicles contributes to increase in the noise level emission on the roads. *Road noise* occurs due to friction between contact points on the road and motor vehicles' tyres and it increases the total level of the traffic noise. The level also depends on the type and state of tyres and the road surface). Resistance noise is the highest at higher speed and stopping (braking) of motor vehicles. *Behaviour of drivers* increases the noise when they use sirens, play loud music, suddenly stop, and go. *Construction and maintenance* basically use heavy mechanic tools that during the operational stage of the work increase the noise level at the construction site.

The most important factors of spreading the noise are:

- Source type (linear or dotted)
- Distance from the source
- Atmospheric absorption
- Wind
- Temperature and temperature gradient
- Barriers or buildings
- Soil absorption
- Reflection
- Humidity
- Precipitation

In order to obtain representative measurement results, these factors have to be taken into consideration. Conditions for each of the mentioned factors are usually regulated.

5.12.2. Noise impact

Noise originating on the roads has an impact on the environment through which the road passes and it contributes to degradation of the quality of life and disturbs the wild life. *Quality of life* decreases due to exposure to noise in both psychological and physiological aspect. Continuous exposure to noise can be a cause for nausea, create communication problems and lead to increased level of stress, as well as to related impact on health. Noise can cause occasional or permanent hearing impediments, disturb sleeping and decrease learning abilities of children. *Vibrations* that occur out of traffic resonance can have negative impact on objects close to the road. This is very important when it comes to historical and cultural objects that are not designed to suffer such impact. *Wild life disturbance* occurs due to the fear animals have when they have to cross the road full of traffic. Out of this reason, the roads become barriers to wild life migrations from one area to another.

5.12.3. Current and future impact of noise on existing road network

If daily traffic load is between 4.000 and 20.000 vehicles in 2013, traffic noise impact in settlements along the existing road network (road sections M5 and M17) can be seen as unequal and in certain parts high. Endangered residential facilities are located along the roads M5 and M17 on almost 60% of the road route, especially in settlements located directly along the motorway. The existing road passes the settlements closely or goes right through them. Motorway construction at lot 1 will lead to re-distribution of traffic elements between the existing road network and the new one and cause decrease in the level of noise in settled zones along the route of the network without investments.

Motorway construction will be useful for the noise situation in most of the existing sections. With projected increase in traffic load of 62% by 2013, noise level will also increase for about +2.0 dB (A) apart from the motorway construction.

Upon motorway construction, traffic load on the existing roads is planned to be decreased in relation to the current state, in certain parts for even 400%, which means that the noise level will also decrease for -6.0 dB (A).

5.12.4. Ecological standards for noise impact

The Government of Bosna and Herzegovina has not specified standards for noise yet. Therefore, standards that will be applied for the motorway lot 1 are set by Sarajevo Canton. As relevant regulations the following is applied in RS: Rulebook on allowed levels of sound and noise intensity from 1989 (Official Gazette of SRBiH, 29 December 1989) in Table T.5.12-01, that is, the Act on noise and quality of air, Official Gazette of Sarajevo Canton, No 95/99, 28 May 1999, as in Table T.5.12-02.

Table 5.12-01: Allowed level of external noise in accordance with Republic of Srpska regulations

Area	Area function	Maximum allowed level of the external noise (dBA)			
		Equivalent levels Leq		Maximum levels	
		Day	Night	L ₁₀	L ₁
I	Hospitals, rehabilitation	45	40	55	60
II	Tourist, recreational, recovering	50	40	60	65
III	Residential, educational and health institutions, public green and recreational areas	55	45	65	70
IV	Trade, business, residential and residential along the road corridors, storage houses with no heavy transport	60	50	70	75
V	Business, administrative, trading, handicraft services, services (utilities)	65	60	75	80
VI	Industrial, warehouse, service and traffic areas with no residential parts	70	70	80	85

Note: 1) in terms of this rulebook, daytime starts at 06.00 a.m. and finishes at 10.00 p.m., while night starts at 10.00 p.m. and finishes at 06.00 a.m. 2) maximum levels L₁₀ and L₁ are those noise levels that are exceeded in duration of 10%, that is, 1% of the total measurement time, i.e. day or night period.

Table 5.12-2: Allowed external noise levels in accordance with regulations of Bosna and Herzegovina

Area	Area function	External noise standard in dB (A)		
		During the day	At night	Maximum time
I	Hospitals	45	40	60
II	Tourist and recreational areas	50	40	65
III	Residential and educational areas only	55	45	70
IV	Mixed residential and economic areas close to road	60	50	75
V	Mostly economic, administrative, business and trade centres, public facilities	65	60	80
VI	Industrial zones, warehouses, road network are uninhabited	70	70	85

Since rural areas along the route are of a mixed character, i.e. both residential and economic function, hereinafter the zone IV category will be used for settlements along the motorway. Due to that, in this study, noise standards being applied for evaluation of noise impact amount to 60 dB (A) during the day and 50 dB (A) at night. In cases where an object or objects belong to groups I, II or III, the allowed noise level has been determined for the appropriate zone category.

Applied standards of 60/50 dB (A) can be compared to those applied according to WHO regulations (World Health Organisation) and regulations of EC countries.

5.12.5. Impact of noise with no noise protection measures

Motorway traffic will cause noise emissions at very high levels, due to the planned PGDS. Noise levels at night will exceed standard value of 50 dB (A) in areas close to the motorway. Out of this reason, the noise will have a negative impact on the settlements located along the planned route.

In order to identify threatened areas a research of the noise modelling has been made using the software "SoundPLAN" (Version 6.1), which is used as standard software for measuring noise in Germany and other countries of EC. Basic conditions used are as follows:

- ☐ Projection of traffic load for the detour in 2013 according to data specified in the Traffic study – final report, given in Chapter 4 of this study.
- Specifications of the motorway are taken out of the Draft solution (for example: motorway cross-section profile, planned speed etc.). ☐
- Concerning the road, asphalt concrete is going to be used.
- Calculation method is taken out of "Guidelines for controlling the noise caused by road traffic" – RLS 90, issued by the German Ministry of Transport (1990).
- ☐ Settlements sketches have been gathered from various sources: e.g. topographic maps and satellite images from 2005.

In order to evaluate projected noise impact, noise levels at night are used as criteria since the noise standard at night is more restrictive than standard noise level during the day. Contour lines of noise at night are displayed on noise maps. Results show the impact of noise on objects 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.

Noise map without protection measures has defined a possible length of the protection acoustic wall in settled areas threatened by the impact of noise, because the noise level is higher than noise standard at night. Noise map without protection measures has been made based on calculation that analyses the situation of motorway construction in 2D.

Motorway characteristics include definition of day and night periods¹⁰ and standard being used in noise level calculation. PGDS has been taken from Traffic study, as well as relations between day and night traffic and percentage of goods vehicles participating in the traffic. Motorway profile has been set in Draft project. Elaborated calculation of the noise levels and protection measures for LOT1 will be made based on the Draft project for lot 1 as part of Draft project on noise protection.

¹⁰ RLS daytime is 06-22h, nighttime 22-06h

5.13 Impact of vibrations

Vibrations are another factor defining the relation between the motorway and the environment and are generated as a result of the oscillatory movement of vehicles participating in traffic. Given the restrictions in terms of its spatial impact, the significance of this factor is lesser in comparison with noise and air pollution, although in certain situations it can become more relevant in the sense of negative environmental impact. With regards to this, the problem of vibrations is focused on in order to determine reliable indicators and assess potential negative effects.

Vehicle oscillations resulting from movement across uneven road surfaces cause vertical dynamic reactions on the contact surface between tyres and the road, generating vibrations in the ground which move upwards in the form of surface waves, with negative impact on both people and building. The generated vibrations essentially represent the result of the vibrating of the three principal systems, which may be defined as:

- the system of every individual vehicle as a whole, whose own frequencies, depending on the make of vehicle, range between 1 and 10 Hz,
- the system of elastically suspended elements (wheels, axes...) with their own frequencies ranging between 10 and 20 Hz,
- individual structural systems oscillating at much higher frequencies.

The principal type of vibrations generated by continental traffic consists of that created by the oscillatory movement of each individual vehicle as a whole.

The primary kind of negative impact of vibrations on buildings is material fatigue, which eventually leads to the shortening of life span. The effects of vibrations on man are recognised as a direct mechanical influence of fluctuating acceleration on the movable parts of the human body and through various secondary biological and psychological effects due to the irritation and damage caused to nervous receptors.

With respect to the noted facts, the importance of loop roads and the possible negative effects which may appear in use, considerable focus has been placed on the problems of emission, transmission and imission in line with the knowledge about this phenomenon and its relevance in concrete conditions. In order to assess the negative impact of vibrations on people and buildings, reliable indicators have been selected and calculated using characteristic objects which may be expected to receive such impact.

5.13.1 Calculated values

Each study of the problem of vibrations caused by traffic has to find its final interpretation in the current legislation defining the maximum allowed levels of certain indicators. The issue of vibrations caused by traffic is regulated by general regulations in the field of vibrations and their impact on people and buildings.

Since there is no law on the national level to regulate these issues, we used international standards ISO 2631 and DIN 4150 for the purpose of this study. Standard 2631 is probably the most acceptable document currently in effect which regulates the general issue of vibrations.

Standard DIN 4150 allows an objective assessment of the impact of vibrations caused by traffic on buildings and people. This standard defines the curves of the permitted levels of vibrations (acceleration, speed and movement). This standard is special because it covers a wide range of

vibration sources, including those resulting from traffic. Given the nature of this research and the requirements to evaluate the impact on people and buildings as the basis for the assessment, we have adopted maximum values as defined by standard DIN 4150 presented in table T. 5.13-01.

Table T.5.13-01: Values of VC according to DIN 4150

Use of space	Time	VC values	
		Steady vibrations	Infrequent vibrations
Habitation (single purpose) General habitation Weekend houses civil engineering structures	day	0.2 (0.15)	4
	night	0.15 (0.1)	0.15
Rural zones Mixed zones central zones	day	0.30 (0.2)	8
	night	0.20	0.20
Business zones (including offices)	day	0.40	12
	night	0.3	0.3
Industrial zones	day	0.6	12
	night	0.4	0.4
Other zones Special uses	day	0.1 to 0.6	4 to 12
	night	0.1 to 0.4	0.15 to 0.4

The conclusion about the impact of traffic-generated vibrations on people and buildings will be made with respect to previously defined maximum values and indicators calculated for the typical cross sections and as a function of concrete conditions on site characterising the nature of emission and transmission.

5.13.2. Basic calculation methods

In order to obtain an objective assessment of the negative impact of vibrations generated by traffic, it is necessary to obtain indicators which will allow one such assessment as a function of concrete spatial characteristics. As a reliable indicator for all analyses in this study we have adopted the speed of vibrations (mm/sec), which is the function of movement in time. The intensity of vibrations depends on the properties of the traffic, road surface, soil properties expressed through the damping coefficient and other specific spatial relations on the way of transmission between the source and the recipient. The general model used to calculate these indicators is the speed of vibrations on the edge of the external traffic lane in the following form:

$$V = a W^b \quad (\text{mm/sec})$$

where:

V – speed of vibrations mm/sec

W – traffic properties

a, b – constant values depending on road evenness

The intensity of vibrations drops with the growth of distance and may be expressed with the following formula:

$$V = (V_0 / \sqrt{d}) \cdot e^{-\alpha d}$$

where:

V_0 – speed of vibrations at the motorway edge

d - distance

α - damping coefficient

For this particular calculation coefficients a and b were taken as values characteristic of roads whose evenness corresponds to the standard for the surfaces of flexible roads in the category of primary routes. Damping coefficients may vary as a function of soil properties.

5.13.3. Impact values

Using the right program package, the vibration speed has been calculated for the typical cross section of the motorway and for various distance from the motorway edge. Coefficient KV has been calculated using the obtained data (DIN 4150) which may be used as direct evidence of impact. The data obtained in the calculations using relevant parameters are given in table T.5.13-01.

Table 5.13-01: Calculation results for vibrations on motorway Svilaj – Doboj South

Communication:	Corridor Vc motorway						
Value of parameter KV calculated in accordance with standard DIN4150							
distance [m]	0	25	50	75	100	200	300
V [mm/sec]	2.367	0.241	0.087	0.036	0.016	0.001	0
KV	1.504	0.153	0.055	0.023	0.010	0	0

5.13.4. Results of calculations and analyses

Based on the data obtained in the examination of the problem of vibrations, we may reach some conclusions about the potentially negative impact on the area within the zone of the planned motorway. In terms of its nature, this negative impact is observed for people and buildings. The assessment of the negative impact was carried out using VC (DIN 4150), and in that sense it is possible to conclude the following:

- The obtained values of VC were exceeded only at the motorway edge; the values obtained for greater distances are lower than the maximum permitted ones.
- The impact of vibrations on buildings and the environment is insignificant and no damages are expected in the forthcoming planning period caused by vibrations.

5.14. Impact on existing infrastructure

5.14.1. The route impact on settled areas and road network

Motorway of Corridor Vc represents a central transportation corridor through Bosna and Herzegovina from north to south border with Republic of Croatia and is in our country the spine of road traffic system. The corridor mostly follows the valleys of Bosnian and Herzegovinian rivers, where it collides with the existing network of main, regional and local roads, as well as with main railway Modrica – Doboj and Doboj – Sarajevo. The road network in the corridor area

will not significantly change, but the construction of the motorway will unload it of transit and target traffic because it will be redirected towards the motorway.

Table 5.14.-01: Outline of main and regional road network for the area of direct impact on municipalities

Municipality	Main roads length (km)	Length of main roads in direct impact zone (km)	Regional roads length (km)	Length of regional roads in direct impact zone (km)	Total network (km)	Total network in direct impact zone (km)
Odzak	22.5	16.1	31.3	15.8	53.8	31.9
Vukosavlje	6.4	4.4	0.0	0.0	6.4	4.4
Modrica	37.1	18.33	17.5	17.5	54.6	35.8
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
	113.1	78.12	165.3	56.6	278.4	134.7

Municipality of Odzak

Motorway route goes along the western part of municipality areas close to the River Sava (border with Republic of Croatia) between Svilaj and Novi Grad to the entity border with Republic of Srpska. The route goes through unsettled areas and passes the channel Svilaj – Potocani to the place Vrbovacki Lipik. From that point it goes to the entity border through the uninhabited areas. Motorway route that goes through the municipality of Odzak does not endanger spatial development of inhabited areas.

Main road M14.1 goes 16.1 km through the area of Odzak municipality and direct impact zone. Out of regional roads in direct impact zone, through the municipality of Odzak, there is a regional road R464a that goes 15.1 km through it. Main road M14.1 is in direct impact zone through the municipality of Vukosavlje, too, for 4.4 km.

Municipality of Vukosavlje

Further from the entity border motorway goes mostly through uninhabited areas to settlements Tuk and Jezero and it goes between them making no threats to their spatial development. From these settlements, the route goes further to the South through uninhabited areas all the way to the newly built residential area Jakes. Colliding with the eastern part of the settlement, the route goes further towards the Bosna River where it crosses over to territory of municipality of Modrica.

In this section, (from the entity border to the Bosna River) the route intersects three local roads and main road M-17.

Municipality of Modrica

Motorway route follows the corridor of the existing railway in the area of municipality of Modrica, through the space planned for a new railway route, it fits into it not colliding with the newly built residential area Dobor, with about 500 residential objects. From the railway station Vranjak, motorway route crosses the Bosna River and branches off the corridor of the railway. Further to border with municipality of Doboj, the route goes through uninhabited areas crossing the Bosna River in two more places.

Motorway route through the municipality of Modrica does not endanger the spatial development of inhabited areas except the settlement Dobor, therefore the route has been laid along the existing railway, which has enabled redirection of the town towards the river and placement of the motorway within the corridor that railway has been exploiting for a long time.

Main road M17 (E73) goes 11.2 km through the area of municipality of Modrica, which is the biggest part of the main roads in direct impact zone in this area, and a smaller one is main road M14.1, which makes 18.3 km of main roads in direct impact zone. Out of regional roads in direct impact zone through the municipality of Modrica, there is a regional road R465 that goes 17.5 km through it.

Municipality of Doboj

Motorway route in municipality of Doboj is laid between main road M17 Bosanski Samac – Doboj and the Bosna River, and it goes through uninhabited areas in this section. South of settlement Majevac, the route crosses the Bosna River and goes along the railway corridor and main road M-17 to the railway station Grapska, where it again crosses the Bosna River. In this section, the route mostly goes through uninhabited areas and it collides with settlements Kozuh, Osjecani, Trnjani and Grapska.

Main road M17 (E73) goes through the area of municipality of Doboj, which is the biggest part of 35.7 km of main roads network in direct impact zone in this area, and a smaller one is 4.9 km of main road M4. Main road M4 passes through the municipality Usora in one part, for 2.6 km, which zone is in direct impact zone in its full length.

Upon crossing the Bosna River (off the railway station Grapska), the route goes into a tunnel just off the settlement Plocnik, it goes out of the tunnel at settlement Prisade and goes into the tunnel again to the Entity border.

Motorway route through the municipality of Doboj does not endanger spatial development of settlements that it collides or by which it passes by.

Municipality of Usora

Motorway route is laid through a part of area at the border with Municipality of Tesanj, along the left coast of the River Tesanjka. With regard to the settlements Brkovici and Tokme, the motorway goes east of these settlements, close by the border with Municipality of Tesanj and does not endanger their spatial development.

Municipality of Doboj-Jug

From the Entity border, the route goes for a while through this municipality and through uninhabited areas.

5.14.2. Impact on water management

Direct impact zone area of the motorway construction mostly belongs to river basin of the River Sava, that is, tributaries of the Bosna River. A smaller part in the areas of Municipality of Usora and Municipality of Doboj – jug, belongs to the River Usora river basin (which is a tributary of the Bosna River).

From the water management aspect, the lower course of the Bosna River (from Doboj to the place where it flows into the River Sava) in current situation is being used as a source of underground water (alluvium exploited from the Bosna River) in water supply systems of the settlements next to it.

From the aspect of waterpower potential, the course of the Bosna River is being relatively rarely examined, primarily due to the fact that the river valley has been completely urbanised. That was also the reason to build thermal power plants (TE Kakanj) instead of hydroelectric power plants. In the lower course, downstream from Doboj, construction of smaller embankment stairs without a significant accumulation of water has been analysed. Urbanisation process and traffic infrastructure construction (roads and railways) has limited the construction of bigger objects for water utilisation and use of energy potential from this stream.

From the aspect of water power utilisation, in the area of the Bosna River downstream from Doboj, there is an interesting construction of 4 pipe hydroelectric power plants that produce total power of 51.6 MW, that is, 312.6 GWh of electrical power: HE Doboj, HE Kotorско, HE Micica and HE Modrica. In lower course of the River Usora smaller pipe hydroelectric power plants could also be built: HE Kovanici, HE Jelici, HE Rosulje.

Considering all relevant factors a general conclusion can be made that motorway construction can only have positive impact in the field of water management.

5.14.3. Impact of the route on water supply and water infrastructure

Motorway route has satisfied the set criteria since it does not go through areas of existing or planned zones of drinking water springs, planned accumulation and those of important channels for land development/reclamation.

Apart from that, special attention has been paid to an impact of the motorway on primary objects of towns' water supply and sewerage systems (the existing and planned main pipelines, collectors, tanks, waste water treatment plants).

The apparent thing is that the motorway crosses supply pipelines of smaller capacity, which shows the need to apply certain technical solutions in terms of dislocation of these pipelines through de-levelling passages planned for dislocation of local roads.

5.14.4. Impact of the route on electric power system

5.14.4.1. Production capacity

There are no production electric power plants in the section of the route Vc that goes through municipalities of Odzak, Vukosavlje, Modrica and Doboj. Power consumers in those areas are connected to electric power system of RS, that is, BiH. In order to supply consumers with electric power, 110/h kV power transformer stations have been built in this part of the road Vc in Odzak, Modrica, Osjecani and Doboj 1 and 2.

The existing 110/h kV power transformer station in Osjecani is next to the planned route of Vc road, while in other towns existing power transformer stations are further away from the planned route Vc. Planned route of Vc motorway in the areas of Odzak, Modrica and Doboj will intersect in more places the existing electric power network of voltage level between 0.4 and 400.

5.14.4.2. Intersection of the alignment of the motorway Vc with 110 kV lines

Planned route of the motorway Vc in municipalities of Odzak, Modrica and Doboj will go under the existing 110 kV lines: Gradacac – Modrica – Derventa, Doboj – Osjecani – Derventa and Doboj – Teslic.

5.14.4.3. Intersection of the alignment of the motorway Vc with 35 kV lines

Planned motorway Vc route will go under 35 kV trunk route in the area of Doboj electricity distribution (company “Elektro distribucija”): Miljkovac – Bukovica and Miljkovac – Jelac. The intersection of motorway Vc route and the existing 35 kV trunk route will be carried out by installing iron lattice-type straining posts at an appropriate distance from the motorway on both sides, so that the lines will be elevated above the motorway at a height required by the relevant regulations.

5.14.4.4. Intersection of the alignment of the motorway Vc with medium voltage lines

It is certain that the planned motorway Vc route is going to go through inhabited areas in distributional regions of: Odzak, Modrica and Doboj. Therefore, the future Vc road route will collide with distribution 10 (20) kV network, that is, Vc motorway route will intersect main and branching lines of 10 (20) kV.

5.14.4.5. Intersection of the alignment of the motorway Vc with low voltage grid

Planned Vc motorway route will intersect a low voltage network in the areas it goes through. Since relevant regulations do not allow installation of a low voltage network neither over nor under a motorway, the existing low voltage network has to be removed from the planned motorway route. Having in mind that construction of motorway must not leave the current consumers without the electricity, new power distribution transformers will be built on both sides of the planned motorway route, connecting 20(10) kV trunks and a new low voltage network for objects left without electric power during the motorway Vc construction.

- According to the main project of the motorway and state on the field, detailed conditions of intersection of the planned motorway Vc route and the existing electric power network of 0.4 through 400 kV will be given simultaneously with motorway conditions.
- Creation of city planning and technical conditions on the spot will include scanning of the existing power networks and, just in case, intersection of Vc motorway with power lines, upon which a detailed city planning and technical conditions will be given and detailed intersection conditions defined.

5.14.5. Impact on gas transportation system

There are no gas transportation installations in the monitored area that the motorway route goes through. Spatial plan of Republic of Srpska projects installation of gas pipes in its northern parts (Semberija, Posavina, Lijevce-polje, Knez-polje). Realisation of this project has already begun and it plans construction of a main gas-pipeline from Prnjavor Macvanski (place of connection to the gas-pipeline system of Serbia) to Novi Grad (with main measuring-regulating stations at the entrance into all towns), and construction of distribution systems in towns included in the project of installing a gas-pipeline.

The mentioned project also plans construction of a branch gas-pipeline from Kutlovac to Doboj, which can be seen in the graphic enclosure. Gas-pipeline route, in the area through which the motorway route is going, has been taken from the Study of the “Sava” gas-pipeline route and it represents a draft route that needs to be in accordance with the adopted motorway route.

5.14.6. Impact on telecommunication system

Planned Vc motorway route will intersect the optical cable in following sections: west of Odzak (settlement Potocani), area between Vukosavlje and Modrica and in settlement Rudanka, as drawn in the graphic enclosure.

Cables are laid along the road zone directly into the ground – a ditch 60 to 80 cm deep.

Creation of city planning and technical conditions on the spot will include scanning of the existing telecommunication network and, just in case, intersection of the motorway with telecommunication cables. After that, detailed technical and city planning conditions will be given and detailed intersection conditions defined. Apart from all the above mentioned, the graphic enclosure shows locations of regional and local telephone exchanges. It also shows locations of postal offices and postal centres.

5.15. Accidental impact

Problems of accidents is one of the more important criteria used to describe impact of the planned motorway on the environment. Detailed research of those problems is necessary within the scope of traffic related research. Based on gathered data and knowledge in this field, an estimation can be made, regarding the motorway profile typical of the section Svilaj – Karuse, of about 0.3 accidents per motorway kilometre in a year of the planned period. If the presumption is applied to the entire motorway section from Svilaj to Karuse, it is possible to expect about 20 accidents a year.

According to the above mentioned estimation, it is apparent that a sufficient level of traffic safety can be reached on the planned motorway and that, in those terms, impact on the environment is within limits acceptable for this kind of object.

6.0 DESCRIPTION OF ACTIONS AIMED AT MITIGATION OF NEGATIVE IMPACTS ON ENVIRONMENT

Given the previously elaborated conclusions, protection measures will have to be taken for certain effects in order to reduce the possible negative consequences within acceptable limits.

Taking account of the previous remarks, the data obtained as part of the analysis of effects as well as local spatial conditions that significantly determine the possible actions, measures of the environment protection are systematized within a few basic groups:

- general measures of protection of the living environment,
- technical protection measures,

Administrative measures related to the exploitation of the highway.

6.1 General actions for mitigation of negative impact on environment

The complex of general measures of protection of the environment include general knowledge in this field that are in line with the general strategy and the local spatial conditions and characteristics of the concerned highway.

- All activities proclaimed within the general development policy at the level of the BiH Federation and the Republic of Srpska, and that were made concrete through the highest plan documents should be taken account of in the sense of rational management of the environment for the concrete investment venture;
- As part of the general development policy, consistent observance of the regulations should be ensured, that is of wider importance in the sense of limit values of certain influences as well as the regulations on characteristics of the rolling pool in terms of the level of noise and quality of exhaust gases;
- Ensure pre-conditions for constant monitoring of the situation of the environment in the area of the planned highway by providing data obtained through measurements;
- Ensure pre-conditions for continuous maintenance of the highway;
- Ensure timely plans for maintenance of the road during winter months, while particularly considering the possibility to minimize the use of sodium chloride.

6.2. Special actions for mitigating the negative environment impacts

Given all the conclusions that are obtained in the phase of analysis of effects, and primarily in the sense of applying adequate protection measures, it is necessary also to define certain procedures that must be implemented in the object exploitation stage. These measures imply the following activities:

- Planned highway should be equipped with an appropriate horizontal and vertical signalization that includes all forms of necessary bans and information. The area close

to the banks of the Bosna river should be supplied with necessary information signs due to the danger of possible pollution caused by accidents,

- For the procedures of winter maintenance it is necessary to design special operational plans taking primarily account of the protection of waters and soil, and then of global problems of protection of the environment;
- In case of breakdowns of vehicles carrying hazardous cargo in powder or granulated condition, traffic is stopped, and the request is sent to the specialized service that should carry out removing of the hazardous cargo and repair of the carriageway. Spilled powder or granulated material must be removed from the carriageway only mechanically (by putting it back into new appropriate packaging, cleaning, vacuum cleaning etc.) without rinsing with water.
- If there is a breakdown of vehicles carrying liquid hazardous matters, the traffic is immediately stopped and the responsible service is alerted, and specialized teams for the repair of the breakdown are engaged. The spilled matter is removed from the carriageway with special sorbets. If the liquid got outside the profile thus contaminating the soil, the repair is done by its removing. All matters gathered in this way are treated applying the special procedures of regeneration or are taken to the depots that are designated for those purposes.

Measures anticipated as part of the previously defined procedures represent the obligation that must be complied with in order for the effects of the road to be reduced within acceptable limits.

6.3 Technical actions for mitigation of negative impact on environment

The complex of technical measures for protection of the environment includes all those measures that are necessary to bring the quantified negative effects within permitted limits, and also to take certain measures in order to minimize certain effects in the process of building and exploitation. Given the fact that as part of the Evaluation the individual effects have been dealt with in detail, protection measures are systematized separately for each effect.

6.3.1 Population

6.3.1.1 Possession of sites

To reduce the negative effects in the earliest project phases, it should be determined an approximate number of property, the houses, shops and activities located along the alignment that may be effected by property possession. Such procedure offers the first indication about the scope of possible problems related to land possession and resettlement.

Wherever are obvious the smaller impacts, further analyze should determine the category of people, land, activity and possibility of simple measures for mitigation and avoidance of these effects. For example: Can simple modifications of the position of planned highway reduce the negative impact?

Evaluation of temporary financial loss or the costs of temporary dislocation will be necessary for those objects that may be dislocated in the immediate zone. On the other side, for those objects that will have to be dislocated from this area or suffer the great losses it will be needed to evaluate the costs of dislocation or new opening of the ones. For agricultural producers, economic losses can include the value of crops in the fields and loss of profit because of the lack of information about the new economic conditions. Possession of land and dislocation has

as well impact on both population and objects that will not be dislocated. They have to face with problems of abundance of the properties and reduction of land price.

In some non-registered activities it is not easy to determine who will be affected or what will be the possible long-terms effects. Many markets or small catering objects along the road are not officially registered and very often do not have the documentation about ownership, rent or lasting of rent. Special problem is found in the fact that very often the planned compensation measures not cover the damaged ones especially if the alternative funds are of better quality than the lost ones, so they are then more attractive to other impact groups. Example of possible impacts and actions for their rehabilitation was given in the table T.6.3.1-01.

Table T.6.3.1-01 Patterns of possible impacts and actions for their rehabilitation

Consequences	Actions
Taken house and all land	Dislocation of owner, construct the house and give the on new place
Taken house and some land (land that kept is not for use)	Dislocation of owner, construct the house and give the land on new place
Taken house and some land (land that kept is for use)	Reconstructs the house on kept land, compensate the loss of land
Taken house, the land kept	Reconstruct the house on the remaining land
Taken house owner without land	Reconstruct the house on the new site in the same or new area as the owner wishes
Taken house, the owner is occupier	Assistance in finding the new home in old or new area depending on his/her wish
Taken house illegal construction	Assistance in finding the new home in old or new area depending on his/her wish
Taken land but not the house	Provide the land within reasonable distance from the house in other case dislocate the owner, provide the house or land in the new area
Taken some land (kept land can not be used), House kept	Give the land within reasonable distance from the house if possible
Taken some land (kept land can be used), house kept	Compensate lost land
Lost of income that earned at home (temporarily), but not the house	Reconstruction of the house by the wish of owner, compensate lost income during the process of dislocation
Lost the work he performed at home or work	No action
Lost business location, tenant of illegal user	Provide the alternative location with equal or better access, services and work potential.

6.3.1.2 Social impact

In concrete conditions, it can be clearly identified two basic social groups that are under the highway impact. One group is the road beneficiaries, and the other group is population along the road, as well as the owners of property that are under the impact of planned construction.

With construction of planned road, it is expected the increase of mobility of wide area population, and in that way the creation of options for development of certain activities for improve of social structure.

In terms of mitigation of impacts within this sphere, it should be provided to current owners of property that under the most favorable conditions start the works in certain zones of new highway. More detailed options within the impact zone were shown within the chapter about land possession.

In situation, when the alignment is found in rarely inhabited area, part of problems is minimized but it can appear the impacts coming from exposure to the social contacts of much higher level (practically of international significance) from which it can come out the significant problems at communities that are by now lived in traditional environment.

Part of these problems must be solved in the period up to the construction of highway, before all on the level of contact with these communities and solving of basic problems that will occur during and after the construction of planned highway.

Part of problems in social area will be as well present in the construction phase of works, and it should be trying that stationary objects of construction site are not located, to avoid possible problems between workers engaged on road realization and local population.

The owners of land where it will be constructed the planned road are the interest group that the most losing in current circumstances regardless the compensation that belong to them after expropriation. Models of impact and compensation for such cases are detailed reconsidered within the chapter about land possession.

Financial compensation for expropriation and demolished objects should be delivered on the base of contract about investment of funds to avoid the cases that received money is spent and created social cases about which the society must take care in the following period.

Comparison of construction effects in both cases leads to knowledge about benefit for social environment in case of planned road construction. Project certainly should be realized only if the benefits are multiplying higher those losses that as well appear as consequence of construction.

Effects that may turn up as consequence of construction, and which may have certain impact in social field are as well related to the possible induced, non-controlled development along the planned road with which it will be significantly disturbed the existing relations.

With construction of planned road, it should be expected as well certain positive effects related to possible increase of property values as well as positive effects in terms of job creation of local labor.

6.3.2. Waters

6.3.2.1. Measures for prevention and mitigation of negative impact on waters during preparation and construction of the highway

6.3.2.1.1. During higher design phases

In higher phases of project design, it is necessary to prepare the main design of drainage from road base and associate outer waters, with detail hydrological and hydraulic estimate, as well as the drafts of objects for collection, transport and disposition. Project of drainage must contain at least the following:

- Objects for waste water treatment from highway in some way may be located within the area defined as sensitive within this Study, but before final choice of object disposition it

should be consulted the detail hydro geological basement of narrow belt around the highway in the scale 1:5.000. It is necessary to pay attention to that that objects not set up in aquifer area where determined high level of underground waters to avoid the disturbance of hydraulic regime of underground flowing, disturbance of replenishment of aquifer and similar.

- In the drainage project, it is needed to foresee the closed system of drainage, with interseptor for oil and fat, and if needed with further water treatment that will achieve the water quality in accordance with regulations. (use "Rule book about conditions for waste water outlet in surface waters, that is Rule book about conditions for discharge of waste waters in the public sewage, Off.Gaz. of RS, no: 44/01").
- Construction of planned objects for waste water treatment must guarantee the impermeability, that is it should be avoided the seepage of waste waters in the underground. Access to the objects of internal drainage, i.e. separators and lagoons to solve in efficient way with option of car access (type of tank for waste water collection).

In the higher phases of project design it is necessary to prepare the main design of the drainage of communal and storm waste waters for all associate structure. Project should provide the following:

- For all associate and service objects it should be solved the issue of drainage and waste water treatment. On the sites where possible, waste waters should be led to already existing sewage systems in surrounding settlements. On the sites where it is not possible, the fecal waters of associate service objects should outlet in own sewage system with constructed appropriate treatment unit before its outlet in the receiving body or soil. Storm waters from these objects treat as on the highway itself. Respect of limiting emission in waste waters should be adjusted to relevant regulations. It is necessary to provide the respect of limiting values defined in the " Rule book about conditions for discharge of waste waters in the surface waters, Off.Gaz. of RS, no: 44/01, and Rule book about conditions for discharge of waste waters for the area of towns and settlements where there is no public sewage Off.Gaz. of RS, no: 68/01.

In higher phases of project design, it is needed to prepare the Project of the organization of construction site and construction dynamics for each subsection on LOT 1. Project must contain the following:

- Borders of construction site, need to be set up, having in mind the following: technical criteria for organization of construction site, the need of sensitive area protection from erosion, waste and land material, seepage of oil and similar (surface waters, springs, agricultural land, and other values recorded with this study).
- The most favorable site of gravel pit and material dumps. During the selection of material it is needed to avoid their settlement in the sensitive area.
- The way of sanitation and recultivation of gravel pit and dumps.
- The most favorable locations for workshops, mechanization base, asphalt, storage of fuel and oils for construction equipment. O avoid the placing in the zones of unacceptable and high water risk defined in terms of hydro geological aspect and on the base of research works.
- Transport routes.
- Planned system of the drainage of waste and storm waters from construction site.
- With work plan, and detail analyze of technological processes it should be completely avoided the option of partial, and especially complete shoaling of watercourse bed (all watercourses that alignment intersects or passing near by are detailed described within drainage pattern).
- Sanation plan.
- Plan of landscape development.
- Plan of urgent interventions in case of accidents.

On all places where the highway passing the watercourses, in the zones where alignment settled along the bank of watercourse, as well as passing through the zone of sanitary protection of the springs of drinking water, it is obligatory to design safety fence or sand-cement blocks (new jersey) for physical prevention of roll-over vehicle from the highway.

In the phase of design, it should be avoided all possible collision with existing water management objects in the study area of corridor Vc, and there where it is not possible to avoid this collision and give adequate technical designs.

Project of watercourse regulation that implies environmental acceptable constructions and criteria should be the avoidance of dislocation of natural river bed i.e. designs of culvert through road base of highway where conditions allowed.

On design of river bed dislocation to change principles of environmental sound practices.

6.3.2.1.2. During the construction phase

- special manner of mining taking care not to disrupt the underground flows of water,
- depositing of removed humus in places where its contamination is not possible,
- relocating the excess material and the location of depots of excess material,
- selection of material for building of the embankment that is physically and chemically stable and does not jeopardize underground waters.
- planning of the work conduct, and with a detailed elaboration of technological procedures, the possibility of partial, and especially total covering of the bed should be completely avoided.
- by the project of work organization and arranging of the construction site, the measures of plan and safe collection of all waste matters should be foreseen, as well as of their transporting and depositing on the sanitary depot. At the same time, those who infringe the established rules of conduct should be subjected to disciplinary measures. It can be expected that during construction contractors will find in several places either registered or unregistered (wild) depots of different waste. All these locations should, depending on the type of waste, be repaired according to the special projects.
- special, used waters from the construction site should be caught in safe sewage systems, collected in appropriate reservoirs and filtered in the prescribed manner (either on site, or at a distant location) before they are let into the water streams.
- by technical measures – making of underground drainage systems – lead the cut stream of underground waters underneath the road base / road belt.
- location of workshops and warehouses of oils and lubricants for the construction machines,
- location of the facilities on the construction site of accommodation of people (fecal waters),
- in all alternatives technologies of performing works should be maintained stable/natural hydrological regimen of swamps and marshes, in the first place by preventing the outflow of water / drying out.

6.3.2.2. Measures of the mitigation of negative impact in the use phase

These measures relate to the manner and scope of maintenance of the highway drainage system, selection of appropriate localities of the maintenance service facilities, and selection of material used in this way:

- passing regulations stipulating the scope and time intervals of control procedures, cleaning, and if necessary repairs of facilities for drainage of downfall waters as well as facilities for their filtering,

- selection of appropriate locations and methods of storing chemicals used during the highway maintenance and maintenance of the surrounding ambiance (salt, fertilizers, pesticides etc.),
- organization of the service of regular control and maintenance of the highway and related facilities,
- use the salt for melting and other chemicals, to the smallest possible degree.

It is important to make the operational plan of procedures for possible accident situations as early as during the stage of building of the highway, and at the level of the municipality of cantons organize and equip the appropriate intervention service.

6.3.2.3. Administrative water protection measures

The complex of administrative measures of protection includes a range of activities in the sense of administrative regulating of certain phenomena that, unless regulated in time, may cause certain negative impacts that are hard to bring within acceptable limits. These protection measures include the following activities:

Provide instruments within the authorizations issued by responsible institutions (relevant ministries of water management) in order to carry out permanent control during performance of works, in the sense of possible effects on waters;

Provide instruments on the necessity of professional improvement of experts in the field of exploitation of road from the point of view of environment management in concrete spatial circumstances.

6.3.3. Air

The analysis of air pollution shows that special protection measures are not necessary in terms of the analyzed conditions for the concerned highway, given the fact that the limit values are exceeded in close distances from the edge of the highway.

6.3.4. Soil

6.3.4.1. General actions for mitigation of negative impact on environment

The above described characteristics of the area that the route of the future Corridor Vc, going from Svilaj to Karuša near Dobož, to include: relief, litological properties, climate, vegetation and anthropogenic influence, indicate diversity of the soils. Based on data obtained from the Basic pedologic map in scale of M 1: 50000 as well as from some additional researches and reconnaissance of the terrain, there was developed a protection category map in scale of 1: 25 000 and up to 500 m in diameter, for both the entire length of the LOT 1 highway corridor and each individual section. The map is a constituent part of the annexes to this report. The basic spacial unit of this map is the soil type, or even its sub-type, and in some cases the variety which usually depends on mother material upon which the soil had been formed, or the process that was dominant during its formation. A total of 24 mapped units were identified. Such diversity certainly makes the engineering process more difficult, particularly the execution of the protection measures recommended by the final study. However, the nature of the soil is such and it makes this ecosystem one of the most complex ones in general. And yet, this study provides a simplified approach in projecting the soil protection measures grouped in different categories by the level and necessity of application of the individual measures.

Land reflects like a mirror and collects like a battery the historic flow of environmental activities incorporating them into its properties. The soil represents the most natural laboratory in which all incoming substances are being transformed in a natural way protecting thus the waters running through the soil from contamination to a certain degree. However, to date experience has proved that this particular capability of the soil, given the ever growing pollutant pressures, is yet limited. It was expected that the soil would manage to process or maintain the herbicides, pesticides, nitrogen fertilizers and other introduced contamination sources, but that was not the case. Therefore, we already have the underground waters heavily contaminated in many world regions. This issue deserves serious consideration, especially when it comes to the contamination of soils in ecologically sensitive zones such as the river valleys and underground aquifer, which is the case with this highway route.

All predictable impacts on agricultural land and agro-ecological systems along the Corridor Vc from Svilaj to Karuše near Doboj were analysed particularly from the aspect of change of use of the land, fragmentation of land plots and emission of harmful materials into soil. There is a distinction between the emission of solid and liquid matters, gasses, and even snow melting salts on the road.

With regard to geo-morphological situation, soil type affiliation, depth, (skeletal), physical and chemical properties that have influence on the soil fertility, all the soils found in the area of up to 500 m off the main road axis, have been categorized in four categories (levels) based on required protection measures and the following general criteria:

a) **I category – overall protection**, encompasses fertile, deep, most valuable soils along the route, with favourable 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 arable land in production of vegetables, fruit and even for green-houses. These soils require an overall and thorough protection. At the points where the highway route goes across these soils, it is necessary to apply a closed drainage system to collect the water coming from the road surface, construct viaducts to avoid damaging of the land, and, certainly, apply the wind-protection strips with carefully selected varieties, in order to collect the emitted pollutants within a narrow zone along the road, i.e. within the highway perimeter.

b) **II category – high protection**, encompasses the soils having most favorable physical and chemical properties, high fertility, yet limited to smaller areas, with minor disadvantages that could be easily removed by some melioration actions. They usually come as arable land, abandoned arable land or abandoned meadows, mainly on the rolling parts of the terrain. A part of these soils is being used as pastures. All soils in this category could be used in extensive production of a range of crops and vegetables.

c) **III category – selective protection**, encompasses primarily the soils covered by dense or less dense underbrush, where in sinkholes of karst, small valley or cut some deeper soils are found that are suitable for extensive growth of mainly fruit and vegetables. This category includes bare regions, i.e. shallow skeletal soils on steep inclinations, exposed to water erosion. These locations exposed to erosion require selective protection from erosion, feasible through grassing, i.e. protection by suitable vegetation cover.

This category also includes the protected soils covered by forest. In case that the highway route crosses such areas, it is necessary to ensure that the damaging of land by construction work is made with utter caution, in order to avoid creation of water erosion spots.

d) **IV class - protected (forest) soils** encompass the soils covered by reasonable forest cover. In case that the highway route crosses such areas, it is necessary to ensure that the damages caused by construction work are done with utter caution, so that formation of water and wind erosion spots is avoided. We would particularly like to emphasize the wind erosion issue, which is prone to a very fast progress on the “inclined” locations exposed to the northern winds, unless wire net or some other protection means is erected.

6.3.4.2. Special actions for mitigating the negative environment impacts

Physical, chemical and biological soil properties have a huge impact on the penetration of pollutants into the soil, mechanism and power of their connecting, transformation and loss of heavy metals. It has to be pointed out that the two major mechanisms of soil decontamination are: biological - through connecting into organic mass of the plant, micro or macro fauna, and leaching. Both mechanisms are risky for the environment. By connecting to plants, heavy metals enter the animal and/or human food chain, while leaching brings them into the underground waters and aquatic ecosystems.

All the sections involve different pedo-systemic units and, therefore, different protection categories (levels). Certainly, the first and second protection categories are the most important ones, since they encompass arable, deep, most valuable soils with favorable physical and chemical properties. In third and fourth protection category, the focus should be placed on protection from erosion and physical embankment of the road banks in order to prevent landslides and other negative environmental impacts.

As for the LOT 1 section of the corridor, which is the subject of this study, we recommend a concept of protection of agricultural production area – soil, i.e., agricultural ecosystem, that would be based on the following principles:

- Effective protection of all valuable agricultural lands from coars dust
- Limit dispersion of the fine dust and aerosol to the narrowest area possible, while avoiding pollution of more valuable agro-biotope

a) Dust protection of soils

Efficient dust protection can be accomplished if dispersion of the fine dust and aerosol is limited to the narrowest area possible, while avoiding the pollution of more valuable agro-biotope. Additionally, an intensive “circulation” of organic matter should be ensured within the highway fenced area, through frequent mowing and taking the plant mass away. Out of this area – on agricultural lands, especially those on which the harmful impacts cannot be reduced to an acceptable level by any of the above mentioned actions, it is necessary to undertake the actions to reduce the mobility of heavy metals and ensures their binding. This primarily refers to calcification and humification of agricultural soils, and instead of calcification it is possible to apply the matters that facilitate binding of heavy metals into less accessible compounds.

b) Level of the route relative to environment

In terms of monitoring the emission of harmful matters and its directing, it is very important to select a proper level of the route relative to the environment. The route at the environment level is the least suitable from the contamination point of view. Should a noise protection wall be erected on such route, it would also provide protection from emission; however, it would contribute to the increase of pollution on the very road. The route that is elevated relative to the surrounding terrain causes wide dispersion of pollutants. The viaducts and bridges have the

same effect. Direct planting, as well as other kinds of barriers along this section of the route, provide a good protection from contamination.

The route below the level of the surrounding terrain or profound or concave level route must result in increased concentration of pollutants on the very road, if the dominant air circulation follows the route direction, which could be considered while designing the route.

c) Biological measures – protective plantation

The plantations aimed at protecting the agricultural land and thus water, are placed along the road, either on one or both sides of the route where the soils we want to protect are located. By directed plantation and maintenance of trees and bushes, purification – filtration of the emitted particles is accomplished. During the winter time, when there is no green leaves, the dust pollution is 5-7 times bigger than during the summer time, when the leaf mass is fully developed. The impact of protective plantations is manifold:

- Reduces concentration of harmful matters in the air and soil; for this purpose, the plantations are required to have appropriate permeability
- Increases humidity of the air through evaporation and transpiration of water – cooled moist air enables adhesion of the fine dust particles and aerosol
- Absorbs dust and gasses on the leaf surface – depending on the size of the leaf, its roughness and stickiness. When raining, the absorbed matters are being leached (cca 90 %), so the leaves are ready to perform the same role again.

d) Selection of varieties for wind-protection zones

This is the most important and most delicate issue which requires an overall solution through a separate project. In selection of varieties suitable for protection zones, many criteria are used. Firstly, the requirements of a plant itself have to be honoured, i.e. the selected plants should have properties that correspond to the properties of soil and agro-ecological requirement of the environment. The best choice is indigenous plants, regardless of whether they are grasses, bushes or forest seedlings. In designing and growing an efficient protective plantation, it is necessary to consider the following facts:

1. Generally speaking, conifers are more efficient as filters, but on the sections that will have the traffic peak in summer (see the study on traffic frequency) more suitable are deciduous seedlings.
2. Dense forests conduct the air mass vertically upwards, with prior purification through the tree crown, so that a purified air mass comes into the atmosphere.
3. Thinned – permeable forest plantations or story-like planted hedges divide the main air current into a number of reduced speed currents, which facilitate disposal of pollutants in the leaf mass, thus making it less dense and protecting the surrounding agricultural area.
4. The dust particles originating from the highway are being deposited on the grass covered surfaces. High grasses have better filtration capability than the lower ones. This is also a good protection measure for the surrounding agricultural land.
5. The filtration effect of the protective plantations is based on reduced wind speed. Too dense plantations are not suitable since they prevent surge of emissions and thus their thinning. More permeable plantations are much better.
6. The best solution includes a dense plantation next to the road and a permeable plantation next to it. Such a mixed plantation is also efficient in terms of noise protection.

The above listed approaches should be applied while developing the project documentation in any concrete situation in the field, with regard to the constellation of factors and environment the route goes through. As the majority of the highway route crosses the areas that require the application of the I- category protection measures – overall protection, it will be necessary to apply a combination of biological protective measures and construction of facilities for collection (drainage) and purification of waste waters, construction of sedimentary tanks, ponds etc.

6.3.4.2.1. The areas of specific pedo-systemic units by use-value and protection categories

From Tables 9-15 it is visible which soil types belong to which use-value category and protection category as well, by individual sections, based on criteria and properties of the stated pedo-systemic units described in chapters 4.6.3 and 4.6.4. Also attached in this annex is a well laid out map of soil types on the section, as well as a map of protection categories for both the entire route of the highway LOT 1 and each section.

SECTION 1: Svilaj – Odžak km 0+000 to km 10+891, L = 10.891 m

Table 9

#	Pedo-systemic units	Area in ha	Use-value category	Protection category
8	Alluvial carbonate gleyic soils	13,40	II	I
18	Gray-brown (meadow) carbonate soils with poor drainage	21,20	III	II
20	Gray-brown meadow carbonate-free, sporadically gleyic soils	131,40	III	II
23	Podzolic Pseudogeys soil of valleys	226,40	IV	III
24	Epigley noncarbonated clay soils	152,15	IV	III
	Total	544,55		

SECTION 2: Odžak – Vukosavlje km 10+891 to km 17+289, L = 6.398 m

Table 10

#	Pedo-systemic units	Area in ha	Use-value category	Protection category
9	Alluvial carbonate loamy soil	104,05	II	I
19	Gray-brown meadow carbonate-free soils	38,55	III	II
21	Gray-brown meadow degraded soils	28,85	III	II
23	Podzolic Pseudogeys soil of valleys	148,45	IV	III
	Total	319,90		

SECTION 3: Vukosavlje – Podnovlje km 17+289 to km 33+467, L = 16.178 m

Table 11

#	Pedo-systemic units	Area in ha	Use-value category	Protection category
2	Dystric cambisols- shallow and medium deep soils on schist's	22,80	V	IV
6	Dystric cambisols- degraded, gleyic soils on clays	23,75	IV	III
9	Alluvial carbonate loamy soil	402,85	II	I

11	Alluvial carbonate soil on sands	226,50	II	I
15	Aluvijal-delluvial soil	133,00	III	II
	Total	808,90		

SECTION 4: Podnovlje – Johovac
km 33+467 to km 46+624, L = 13.157 m

Table 12

#	Pedo-systemic units	Area in ha	Use-value category	Protection category
9	Alluvial carbonate loamy soil	128,20	II	I
11	Alluvial carbonate soil on sands	135,90	II	I
13	Alluvial carbonate soil on gravels	88,85	II	I
14	Alluvial carbonate sandy soils on gravels	85,70	II	I
16	Brown (meadow) carbonate soils	66,85	II	I
17	Brown (meadow) carbonate- free soils	16,15	III	II
20	Gray-brown meadow carbonate-free, sporadically gleyic soils	122,80	III	II
22	Gray-brown meadow degraded little gleyic soils	13,40	IV	III
	Total	657,85		

SECTION 5: Johovac - Rudanka
km 46+624 to km 52+816, L = 6.192 m

Table 13

#	Pedo-systemic units	Area in ha	Use-value category	Protection category
3	Dystric cambisols- soils on shale's	17,20	IV	III
4	Dystric cambisols- podzolic soils on clays	10,35	IV	III
10	Alluvial carbonate sandy soil	141,15	II	I
12	Alluvial carbonate sandy soils on sand	64,80	II	I
14	Alluvial carbonate sandy soils on gravels	58,90	II	I
17	Brown (meadow) carbonate- free soils	17,20	III	II
	Total	309,60		

SECTION 6: Rudanka – Karuše
km 52+816 to km 62+634, L = 9.818 m

Table 14

#	Pedo-systemic units	Area in ha	Use-value category	Protection category
1	Dystric cambisols- medium deep soils on schist's	14,10	V	IV
3	Dystric cambisols- soils on shale's	119,45	IV	III
4	Dystric cambisols- podzolic soils on clays	57,45	IV	III
5	Dystric cambisols- degraded soils on clays	99,60	IV	III
7	Eutric cambisols – Brown carbonate soils on marls	14,90	V	IV
10	Alluvial carbonate sandy soil	185,40	II	I
	Total	490,90		

Overview of areas by protection actions by sections

Table 15

Section	Chainage	Area in ha				Ukupno
		I	II	III	IV	
Svilaj - Odžak	0+000 – 10+891	13,40	152,60	378,55	-	544,55
Odžak - Vukosavlje	10+891 – 17+289	104,05	67,40	148,45	-	319,90
Vukosavlje - Podnovlje	17+289 – 33+467	629,35	133,00	23,75	22,80	808,90
Podnovlje - Johovac	33+467 – 46+624	505,50	138,95	13,40	-	657,85
Johovac - Rudanka	46+624 – 52+816	264,85	17,20	27,55	-	309,60
Rudanka - Karuše	52+816 – 62+634	185,40	-	276,50	29,00	490,90
Total		1.702,55	509,15	868,20	51,80	3.131,70

Besides the mentioned tables, in the annex it was given the map of all soil types on the section as well as the map of protection categories both for the overall alignment of the highway of LOT 1 and for each section individually.

6.3.3. Measures during the construction and exploitation

In the situation of presumed concept of drainage for the planned highway, the pollution resulting from run-off water from the road and deposition of exhaust gasses represent the the most significant drivers. Based on todate information on could claim, with great certainty, that these phenomena would lead to increased pollution of the land immediate to the highway body, as well as in short distance on each side. The intensity of these pollutions is in direct and functional relation with the traffic intensity. In terms of time, the pollutions can be continuous, sesonal or accidental.

Continuous (systematic) pollution are a result of the exploitation of the highway. They are cumulative and can be succesfully surveyed through a systematic monitoring of the land along the highway.

Seasonal pollution is related to a certain period of the year. Typical example of this type of pollution is the use of snow melting salt during the winter months, or pesticides to prevent weeds during their vegetation period. The former type of pollution after a certain period of time causes significant increase in the salinity of the soil along the road, and thus the soil changes its initial properties to a considerable degree.

Accidental pollution usually occurs as a consequence of either minor or major damages of the vehicles transporting hazardous materials. Most commonly, these are petroleum and its derivates, although damaging of the vehicles transporting extremely dangerous substances is not rare. What poses a specific problem in this case is the fact that in such pollutions, only removal of contaminated soil and its transportation and storing at a location where it would not jeopardize the environment, is considered appropriate.

The water course interrupted by the construction of the road has to be properly rehabilitated and re-routed, through the construction of collecting canals, interception drains, captation and other kinds of facilities, which is a well known practice in civil engineering. By doing this, excessive erosion will be prevented. In order to prevent destructive rain erosion caused by cutting of the wood, it is necessary to compensate it by planting new trees and stabilizing the terrain by sowing grasses on the slopes, falls, road shoulders and embankments.

The water running off the thoroughfares into the watercourses and underground waters, which are very often sources of fresh water, represents a serious problem. In this respect, the land along the highway route, especially those of I and II protection categories, requires building of

an efficient drainage system consisting of discharge canals along the cross-section of the catchment section, properly placed in order to collect all waste waters and conduct them to the collection basin located at the lowest possible level, and as far away from the eventual settlements or agricultural land used in crop production as possible. The waste water coming off the highway must not flow directly into the rivers and smaller watercourses, but to previously build collective basins or natural marshes where it will deposit pollutants and thus keep them in limited space. These natural marshes are usually remote from the watercourses; they lay on impermeable clay, so there is no danger of pollutants being leached into underground waters, which, yet has to be previously examined. Generally, marshes have good buffer properties. According to a number of surveyors, marsh ecosystems are capable of sanitizing the contaminated water from many components. In addition, the heavy metals are being accumulated in marshlands. In some countries, artificial marshes are being successfully used in treating the run-off waters from the roads and urban areas. Some surveys indicate that 80% of metals (Zn, Cu, Pb) entering these marshes is being absorbed into sediments and accumulated within water plants (Dumbeck et al., 1998). For example, the root of aquatic macrophyte, especially *Phragmites australis*, is capable of accumulating huge quantities of lead, zinc and copper. The marsh grasses also show a high buffer efficacy reaching 60-85% of incoming Pb, Cd, Zn and Cu.

6.3.4. Measures during the construction and exploitation

The entire route of the LOT 1 section is placed in rural and agricultural zones and passes by a number of villages and settlements scattered along the route. While selecting the final position of the route, an attempt was made to avoid any direct contact with the inhabited places to the most possible extent. In the project zone, the most important sector is agriculture. The project potentially causes negative impact on environment, as a result of its physical facilities, construction activities, use of by-passes and access roads for exiting and entering the highway. The primary impact of the project relates to the traffic noise, emission of air pollutants, lack of previous treatment of the run-off waters and their penetration into the surface and underground waters, change of land use, permanent loss of land and negative impact on the ownership, to include housing facilities, flooding in lower plane, land drainage, loss of habitat functions, disturbed biodiversity, damaged landscape, etc

a) Measures during the construction

The measures recommended for the period of construction are basically the measures included in good civil engineering practice. The construction sites should be limited to the smallest area possible in order to reduce construction caused loss and damaging of the land.

On the areas that would be permanently covered by asphalt or infrastructure facilities, selective removal of the fertile humus soil from the surface should be carried out, and that soil should be deposited and preserved for remedying and landscaping the affected areas. This refers primarily to the soils in II use-value category, which are the best and most fertile ones. The depth of removed soil should range from 25 to 35 cm, depending on the quality of the surface layer. By doing this, permanent loss of soil due to road construction would be at least partly compensated. The construction of road shoulders, embankments and surrounding damaged inclined areas, has to be carried out in compliance with the technical regulations as well as biological requirements.

Turfs or protected net (fence) should be placed wherever required in order to protect the area from rain drop blows and erosion taking away not only dirt but the sown seeds as well. Maintenance during the entire period after the construction is compulsory, as without human presence the rehabilitation process is doomed.

The construction sites should be properly marked so that the surrounding land is not damaged by machinery. Establishment of the construction sites off the road body is not desirable, especially if the soil is prone to compaction, or has heavy mechanical composition. If there is no choice left, the use of geo-textile is strongly recommended.

Cuts on the slopes crossed by the highway route are potentially dangerous in terms of excessive erosion and landslides. This should be taken into consideration and adequate actions to mitigate the consequences should be undertaken.

The accessibility and use of land on both sides of the road, given the interrupted estates and owners being cut-off from their land, will also be a huge problem. Because of this, it is necessary to keep the existing access roads, build the provisional ones for as long as the new ones providing unimpeded access to the land plots and estates have been built. The crossings from one side of the highway to the other should be placed at reasonable distances and they should be natural-traditional, so that the farmers are not forced to drive their tractors, link road and other transportation means across the highway in order to get to their plot which is only a few hundreds of meters away on the other side. The field access roads leading to the crossing points, which would be mainly underpas, have to be made in accordance with the valid regulations within the area of field road construction.

The expropriation and financial compensation have to comply with the current legislation of BiH/RS/FBiH, and have to be based on a detailed property register form. Otherwise, knowing the economic situation of the population and significance of agricultural activities for the survival of the population, loss of gardens, plots and arable land would be unfair, with far-reaching economic and social consequences.

The process of preparation, construction and maintenance of the highway should be runned and planned in cooperation with the local community, so that everyone benefits from this investment. One should be especially cautious when the land owned by religious communities is involved.

For the littered top layer of soil required to make road shoulders, embankments and falles, quality soil should be provided, while the depth of the littered layer foreseen for grass sowing is 20-30 cm, embankments 30-40 cm, and for planting of bushes and other bigger plants 50-60 cm.

b) Measures during the exploitation

The project will significantly change the landscape, as the highway will not always be at the same elevation as the surrounding terrain. Even in flat parts of the terrain it will be elevated to a high embankment, since it passes through potentially flood areas. The road will also pose a view barrier. The visual perception will be disturbed also by noise protection walls (2-4), embankments, tree-lines etc. Bridges, viaducts and highway entries and exits will also contribute to a changed landscape. Actually, an entirely new architecture will be created. Many areas will be exposed to erosion. The facilities build to protect the land, agriculture, collection and treatment of waste waters, are some of the issues that require consideration. Damaged landscape can be mitigated by green landscaping designs which would incorporate the construction facilities into the landscape. Planted vegetation requires continuous care. The areas foreseen for planting would require proper preparations, seeds of adequate indigenous grasses, bushes and trees should be provided and prepared for planting. This includes the following:

1. In grass sowing we need to take care of the preparation, depth of littered, application of organic, but also mineral fertilizers (NPK), cultivation depending on relief characteristics, inclination and other factors. In selection of grass varieties, we should take into consideration the climatic conditions, characteristics of land, relief, botanical compatibility of the mixed varieties, etc. The grasses should be relatively resistant to industrial salts being dispersed in winter time, as well as to weeds, eventual application of herbicides, etc. In case of a sloping terrain, grasses with medium deep root are most suitable, rather horizontal than Za nagib najbolje su trave sa korijenom srednje dubine, radije horizontalnog nego vertical growth of the root and of longer vegetation period, in order to provide a better soil cover over a longer period of time, as well as better protection from rain drop strikes and erosion. The grass covers are being damaged over time, therefore they require regular replanting and maintenance, especially in the first years following the sowing, if we want to achieve their true efficiency in environment protection.
2. In planting the bushes and lower plants attention should be paid to the actual requirement and reason for planting such type of vegetation on a particular location, as well as to natural properties of the ambience and other characteristics and effects accomplished by this activity. The objective is to provide protection from erosion of soil, as well as consolidation of the deeper soil layers. While selecting these plants, one should take care that the root system has to be very robust and strong, with rich bush crown covering the largest area possible. The bushes should not grow too fast, but at medium rate or slow, as we want to avoid the «wall effect» which disturbs the drivers and reduces visibility. They should be highly resistant to parasites, as well as to winter solutions (salts) falling on them. We should also use the plants that can tolerate pruning without any serious consequences for their further growth; they can be planted in rows or in smaller groups with interspace covered by grass. Sometimes a smaller net is placed in such kind of hedge. This type of vegetation is usually planted on areas difficult for grasses to cover.
3. Afforestation is carried out on the most exposed slopes, steep inclinations, potential landslides and cuts, near the tunnels etc. Most commonly used are the forest seedlings capable of stabilizing the soil and improving the landscape value. While doing this, it is important to make a proper botanical selection of species and harmonize the outer look of the plant with the root development suitable for previously determined requirement for soil stabilization. The soil must be previously well prepared.

6.3.5. Flora and fauna

Reduction in the construction phase

- In order to avoid the unnecessary loss of biotope, the construction site must cover the smallest possible surface area, especially in sections that are of major significance for plant and animal life. Materials can be stored only within the construction site. The areas of greater environmental significance must be protected by fence during construction. Machines and vehicles used for construction should not move outside the construction site because they might tamp the soil. The biotope structures removed during construction should be restored after the construction works are finished.
- The utmost caution must be exercised when conducting construction works in the vicinity of watercourses so as to avoid blocking or disrupting surface or ground waters. This helps preserve the existing marshland and aquatic vegetation and ornithological population.

- Removal of trees and shrubs must be done during winter so as to avoid the egg-laying season which lasts between 1 March and 30 September. The biotopes that were removed during construction should be restored after the construction works are finished.
- When building a road, great care should be taken to ensure that the landscape is not compromised, especially where there are lakes. In other words, degradation of space after excavation and construction of embankments should be reduced to minimum and must be easily correctable.
- Any contractors should take upon themselves the obligation to collect and dispose of solid waste of any kind immediately after the construction works are finished on the particular section of the road. One should ensure that the collection and transport of solid waste from the workers' accommodation area as well as the parking and car maintenance area.

Reduction of impact created by road base

- Most of the impact created by the trunk of the road is inevitable. (The study contains references to places where most of the impact occurs: non-environmentally-friendly design of bridges, crossroads in river valleys, vicinity of a road, river, etc.) When designing, great care should be taken to avoid removal of wild trees such as Lombardy poplar, poplar (tamarisk) and willow.
- Analysis by sections in terms of what species are endangered and what species require protection. If these species grow in the road construction area, they need to be replanted into areas with similar conditions.

Measures to reduce the impact created by traffic

- Continuous monitoring of the number and types of birds killed along the road, consultations and appropriate protective measures aimed at risk reduction should be implemented at affected sections of the road.
- In case of a high number of amphibians killed along particular sections of the road, it is necessary to consult relevant experts with the aim of finding effective solution to the problem.
- Bridges should have high fences in order to prevent birds (whether individual or in flocks) from smashing into with vehicles, particularly during migration seasons.
- Potentially rich biotopes should not be planted in the vicinity of the road as this area is characterised by high traffic load and might have a negative impact on fauna. Birds will be attracted to hedges and will use these along-the-road biotope structures as new habitats. The planting of trees and shrubbery should therefore be reduced to minimum – enough for landscape and prevention of erosion, but not for creation of new biotopes. Planting vegetation in cuttings is not so problematic since trees and shrubs are located above the road, which prevents birds from colliding with vehicles.

6.3.6. Landscape

In the context of the defined potentials, one should also look for appropriate measures for protection, reduction of impact or compensation while keeping in mind that it is impossible to build a road without exerting certain impact on landscape.

Efforts in the design process must be aimed at reducing the existing measures, while taking account of the following:

- Elements of design geometry must be in line with the principle of homogeneity and must fit in with the local morphological characteristics.
- Slopes of cuttings and embankments should be variable and should fit in with the local morphological characteristics.
- Bridges, viaducts and tunnels, rather than cuttings and embankments, can be used in places where the road goes across steep hillsides, as they help preserve the visual and physical continuity of the landscape.
- View from the road can be specially emphasised by purposefully shaping the elements of the situational and levelling plan.

Especially significant effects can be achieved by greening the areas through which the road passes. In doing so, one should ensure that:

- the road fits in with the local vegetation (trees, shrubs, hedges, rows of trees),
- the plants are replanted with the aim of fitting them into the existing landscape,
- the chosen species are representative of the road category and function,
- the planted vegetation does not obstruct the view and that the plants are not planted just to fill up space,
- the planted vegetation demarcates and underlines various sections of landscape along the road,
- the vegetation dictates different traffic conditions (changes in the situational plan),
- attention is paid to the use of local materials for construction of buildings and facilities along the route.

Maintenance of the constructed road can have a significant impact on landscape and visual characteristics of the road. Visual pollution can be reduced if various protective and supporting structures are built (various constructions for noise protection), special punitive measures are introduced, advertising system along the road is regulated by law, etc.

Negative impact on the landscape can be compensated to a certain degree by afforestation of the area with the aim of making up for the trees that had to be cut down during construction as well as by rehabilitation of the affected area.

6.3.7. Protected nature areas

Assessing the impact of the planned road in terms of natural heritage requires an analysis of natural structures usually defined as national parks, nature reserves, scientific and research nature reserves, areas with special natural characteristics, characteristic landscapes, special nature reserves, and monuments of nature.

The said areas require a certain level of public care and as such are protected by relevant laws. As these areas represent natural rarities, the basic postulate to be taken into account is that roads should be built at a reasonable distance from them with the aim of avoiding adverse effects.

There are no protected nature areas along the analysed section of the road, i.e. there is no need for additional protection measures and this problem is therefore not discussed.

6.3.8. Cultural and historical heritage

Analysis of the current situation and likely impacts shows that there are archaeological sites along the analysed section of the road whose location is not precisely determined, which might cause certain conflicts. In view of the aforementioned facts, protection of potential sites would be conducted in three phases which will be implemented one after another as the situation unfolds.

Phase I – consists of trial excavations at the identified archaeological sites for the purpose of determining which culture these sites belong to, carrying out stratigraphy of archaeological strata, chronological determination, preservation of cultural strata and archaeological remains found at the sites. Research in this phase should be conducted before the construction works begin.

Phase II – based on the results of archaeological research conducted during Phase I, plan would be developed to conduct protective archaeological excavations in those sections of the site which will be exposed to risk due to construction. If research in Phase I finds that there are no preserved cultural strata or that the road in question does not pass through the identified archaeological site, research in Phase II will not be conducted.

Phase III – consists of monitoring carried out by expert services, i.e. control of the ground works conducted along the line marked out for construction with mandatory protective archaeological excavations if unknown archaeological sites are found during ground works.

6.3.9. Noise

6.3.9.1. Potential alleviation measures

One of the main goals of noise assessment is to examine the effect of alleviation measures aimed at reducing the impact of noise on the objects surrounding the motorway. Reduction of noise can be achieved in the following ways:

- Reduction of noise transmission by putting up noise barriers (obstacles).
- Reduction of noise emission at its source (vehicles, surface of the motorway track).
- Reduction of noise impact in residential areas by installing sound-insulating windows in individual dwellings.

The implementation sequence of these measures is as follows: first, instalment of noise barriers; second, elimination of the source of noise; and third, elimination of noise at the receiving end.

One of the most important alleviation measures is the construction of sound barriers. Given that the motorway on Lot 1 is for the most part built on the embankment, it would be more appropriate to use thin noise-prevention walls (e.g. panels) rather than wide sloped embankments that are aimed at preventing sound propagation.



Figure 6.3.9-01: Road on an embankment without noise protection measures – cross-sectional view with isophones (noise contour plots)

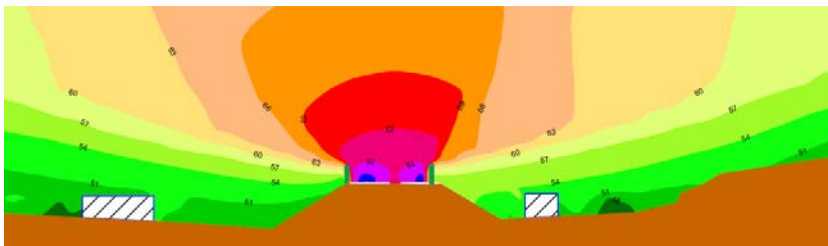


Figure 6.3.9-02: Road on an embankment with noise protection panel – cross-sectional view with isophones

Terrain configuration has a decisive effect on noise protection by means of protective panels. Figure 6.3.9-04 shows a cross section of the motorway with an object on the right that is taller than the motorway itself. The Figure shows that the projected 5m height of the protective acoustic wall is not sufficient to achieve the expected standard, while on the left of the motorway, where the object is below the motorway level, even 2m height was enough to meet the standard permitted noise level of 60 dB(A) during the daytime. Passive measures are recommended for objects that cannot be fully protected by means of protective acoustic walls.

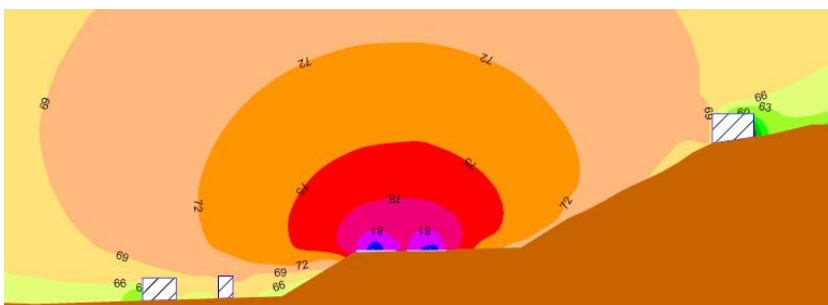


Figure 6.3.9-04: Road in a cutting with noise protection measures – cross-sectional view with isophones

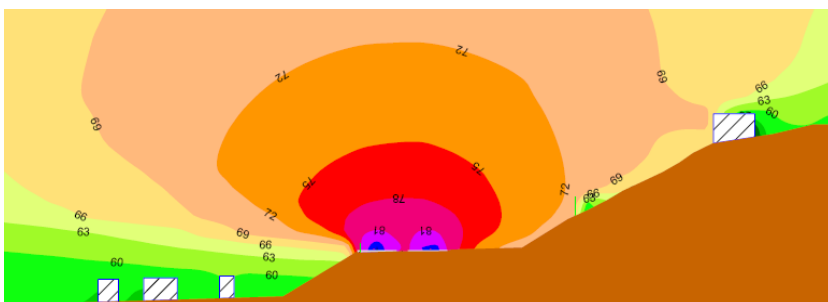


Figure 6.3.9-04: Road in a cutting with noise protection measures – cross-sectional view with isophones

Measures to reduce noise at its source include “silent asphalt” which reduces noise, local speed limitation, and optimised vehicles. The latter is beyond the scope of influence of road construction and depends on technological advances in vehicle manufacture in terms of noise emission and wheel design. Given that the general purpose of a motorway is to ensure fluid traffic flow, speed limit is not a practicable measure unless there other acceptable measures.

Restrictive speed limits can reduce noise emission, e.g. down to 2 dB(A) if the speed of light vehicles is limited to 80 kph instead of 120 kph and the speed of heavy vehicles is limited to 60 kph instead of 80 kph.

Construction of a special type of roadway, the so-called “drained asphalt”, which provides smooth surface and thus reduces emission of noise from wheels, is a significantly more costly alternative to standard roadway made of asphalt-concrete.

Generally, this is a much more costly alternative to the instalment of sound barriers. Further, one can consider changing the roadway (e.g. during road maintenance) as one of the alleviation measures aimed at reducing future negative impacts generated by the increased traffic flow.

As far as areas with low density of residential buildings or individual detached houses outside rural areas are concerned, instalment of noise-protection walls is not always economically justified since the number of buildings protected in this way is out of proportion to the extent and cost of their construction. Instalment of sound-insulating windows (passive noise protection) is recommended for dispersed houses in exposed areas. Passive noise protection is also a preferred option for the buildings located higher on the slopes relative to the motorway, where even higher noise protection walls could not provide effective noise protection because noise propagates in the upward direction. Instalment of sound-insulating windows is also recommended if the achievement of standards is not guaranteed by the implementation of protection measures along the motorway.

6.3.9.2. Determination of the appropriate height of 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 in the night-time. The determined alleviation measures are presented aggregately in the Table below ... The average wall height of 3 m was adopted for calculation of noise levels. The analysis used the bases of the improved alignment solutions from the preliminary brief prepared as 2D. The estimated wall height is satisfactory in most cases given that the motorway is largely set upon the embankment. The apartment buildings located higher on the slopes relative to the motorway, above the effective height of the noise protection wall, especially those located next to the motorway itself, would require noise protection walls 5 m to 10 m tall, which would not be a reasonable and cost-effective solution and would prevent visual contact of the people living in such buildings with the environment. Sound-insulating windows (passive measures) should be installed in these buildings instead.

Table 6.3.9-01: The identified noise alleviation measures

Section	CHAINAGE (km)	Wall No.	Right wall ¹¹		Left wall		Wall area (m ²)	Recommended number of objects for passive protection
			Wall height (m)	Wall length (m)	Wall height (m)	Wall length (m)		
Section I 0+000-10+890 km	09+559-10+002	1	3	443	--	--	1329	3
	09+982-09+581	2	--	--	3	401	1203	
Section II 10+890-17+289 km	11+120-11+533	1	3	413	--	--	1239	5
	12+895-13+301	2	3	406	--	--	1218	
	15+755-16+671	2	3	916	--	--	2748	
	11+137-11+574	4	--	--	3	437	1311	
Section III 17+289-33+466	17+469-19+596	1	3	2127	--	--	6381	9
	21+506-22+237	2	3	731	--	--	2193	
	27+815-29+163	3	3	1348	--	--	4044	
	30+421-30+834	4	3	413	--	--	1239	
	31+094-31+767	5	3	673	--	--	2019	
	17+290-18+985	6	--	--	3	1695	5085	
	19+878-20+792	7	--	--	3	914	2742	
	21+382-22+503	8	--	--	3	1121	3363	
Section IV 33+466-46+624	33+466-33+740	1	3	274	--	--	822	7
	39+798-40+109	2	--	--	3	311	933	
	40+689-41+236	3	--	--	3	547	1641	
	43+534-44+083	4	--	--	3	549	1647	
	45+995-46+470	5	--	--	3	475	1425	
Section V 46+624-56+457	48+864-49+260	1	3	396	--	--	1188	6
	52+268-52+841	2	3	573	--	--	1719	
	46+962-47+847	3	--	--	3	885	2655	
	47+272-50+685	4	--	--	3	3413	10239	
	51+503-51+845	5	--	--	3	342	1026	
Section VI 56+457-66+276	58+234-58+835	1	3	601	--	--	1803	15
	59+443-59+784	2	3	351	--	--	1053	
	61+831-62+751	3	3	920	--	--	2760	
	63+693-64+521	4	3	828	--	--	2484	
	65+876-66+276	5	3	400	--	--	1200	
	58+230-58+710	6	--	--	3	480	1440	
	59+493-59+849	7	--	--	3	356	1068	
	60+467-60+886	8	--	--	3	419	1257	
	61+657-62+695	9	--	--	3	1038	3114	
	64+257-64+456	10	--	--	3	199	597	
	65+308-66+276	11	--	--	3	968	2904	

6.3.9.3. Impact of the future traffic growth

The estimated growth of traffic load will require stricter alleviation measures mentioned above. This will also depend on the real traffic growth rate. Supposing no progress is made in terms of noise reduction on roads or in vehicles, the estimated noise level will have risen by 1.3 dB(A) by 2012 and by 6 dB(A) by 2042. Additional noise protection measures might be needed where residential areas are located near the motorway. In addition to lengthening the noise protection

¹¹ The direction follows the road chainage.

walls, other abovementioned alleviation measures might be implemented with the aim of meeting applicable noise control standards. One of the justifiable measures would be to improve the roadway surface structure in certain sections as part of the general road repairs by resurfacing the roadway with noise-reducing “drained asphalt”, which would reduce noise emission by 2-3 dB(A), which would in most sections of the road serve as a countermeasure against increase in noise that would result from the increased traffic load. However, if the future negative impact created by noise is to be alleviated, instalment of sound-insulating windows might be required.

6.3.9.4. Construction noise

Sources of construction noise include construction works in construction sites (heavy construction machines, mining in tunnel construction sites, etc.) as well as noise created by the traffic of construction vehicles and machines.

Currently, no information is available about the areas where the construction works will take place, equipment and dynamic of works, so it is not possible to estimate noise emission from the prospective construction sites and impact of noise on nearby communities.

There are no detailed plans for construction works that would contain transport routes, so it is impossible to accurately predict the extent of traffic on these routes. However, as far as noise alleviation is concerned, the contractors will be required to use state-of-the-art equipment with installed silencers as well as to keep usual working hours during the daytime (exceptions are allowed for construction of objects such as tunnels). However, the best option is to use equipment that conforms to the requirements of Directive 2000/14/EC, which regulates sound power levels of equipment used outdoors; e.g. equipment identified by the EU Declaration on Conformity. Use of noisy equipment in residential areas in particular should be restricted to minimum and/or improvised shields should be used, e.g. by placing equipment behind sound barriers, piles of material, containers and the like which might serve as protection from noise.

All construction machines and vehicles used for construction of the motorway must have sound insulated engines and other fits that produce noise.

In case mining is used for excavations through rock formations, it is necessary to choose the explosive with minimum detrimental effect on the environment; apply the technique of millisecond activation of explosive charge with directed explosion effect with the aim of reducing the effect of dynamic impact superposition (vibrations, seismic disturbances), noise and dust emission. Alternatively, one can employ excavation technique by using hydraulic hammers, excavators, moles, etc.

- It is necessary to require the contractors to conform to the general requirements of noise alleviation measures such as utilisation of state-of-the-art equipment with installed silencers and keeping usual working hours during the daytime (exceptions are allowed for construction of objects such as tunnels). The best option is to use equipment that conforms to the requirements of Directive 2000/14/EC, which governs sound power levels of equipment used outdoors; e.g. equipment identified by the EU Declaration on Conformity. Use of noisy equipment in residential areas in particular should be restricted to minimum and/or improvised shields should be used, e.g. by placing equipment behind sound barriers, piles of material, containers and the like which might serve as protection from noise.

6.3.11 Infrastructure

Electric energy

- Intersection of the planned Vc motorway route with 110 kV overhead power lines

All intersections of the future motorway Vc route with the said 110 kV long-distance power lines should be constructed in accordance with the regulations contained in “Official Gazette of SFRY”, nos. 65/88, 4/74, 13/98 and “Official Gazette of FRY” no. 61/95. Wherever the existing power lines intersect the route of the future motorway Vc, power-line poles should be adapted to conform with the relevant regulations and placed at a prescribed distance from the motorway.

Vertical distance between power lines and the surface of the motorway should be adapted to conform to the said regulations contained in Chapter VIII, Articles 100-102, which specify that the minimum safe distance between the lowest-hanging power line and the motorway is 8 m (Articles 124-129), and the minimum safe distance between the power-line pole and the edge of the motorway is 40 m (Article 125).

The existing power-line poles must be mechanically and electrically reinforced in accordance with the regulations contained in Chapter V, Articles 41-42, 45-46 and 45-53 of the said Technical Regulations contained in the “Official Gazette of SFRY” no. 65/88 and “Official Gazette of FRY” no. 61/95. At intersections between the motorway alignment and a transmission line, double suspension will be conducted and strain reduced on angle poles to the standard value (75% of the usual tensile strength) as stipulated in Article 126 of the stated regulation.

As far as the static at the point of intersection is concerned, power-line poles at the intersection of the motorway and power lines must meet the requirements contained in the said rulebook, Chapter II, Articles 3-11.

Power-line cables at the point of intersection must meet the requirements contained in Chapter III, Articles 12-23 as well as JUS N.C1 351/85 and JUS N.C1 702/85.

The grounding of long-distance power-line poles and protective lightning rod of the power line should be conducted in accordance with Articles 92-95 of the abovementioned regulations contained in the “Official Gazette of SFRY” no. 65/88.

- Intersection of the Vc motorway route with 35 kV overhead power lines

The planned Vc motorway alignment that runs through the territory covered by the Electric Energy Distribution Company in Doboj (*Elektrodistribucija Doboj*) will intersect the 35 kV power lines Miljkovac – Bukovica and Miljkovac – Jelah. The said intersections of the Vc motorway route with the existing 35 kV overhead power lines should be conducted by placing at a prescribed distance from the motorway the appropriate latticed iron poles to serve as anchors on either side of the road, which will raise the power lines at the required height above the motorway.

Guides must be additionally reinforced both mechanically and electrically on the newly erected poles at intersections of transmission lines and Vc motorway. Anchoring force, grounding, vertical and horizontal distance between the poles and the motorway should be conducted in

accordance with the requirements that apply to 110 kV power lines ("Official Gazette of SFRY" no. 65/88 and "Official Gazette of FRY" no. 61/95).

- Intersection of the Vc motorway route with medium-voltage power lines

It is known that the planned route of the Vc motorway will run through residential districts in distribution areas Odžak, Modriča and Doboј. Consequently, the future route of the Vc motorway will run through the 10 (20) kV distribution network, i.e. the route of the Vc motorway will intersect the 10 (20) kV backbone and split power lines.

According to the abovementioned codebook of the "Official Gazette of SFRY" no. 65/88 and "Official Gazette of FRY" no. 61/95, no overhead 10 (20) kV power lines can be constructed above motorways. Accordingly, all 10 (20) kV power lines will be displaced, ie coated, in case of their intersection with the alignment of Vc motorway.

The problem of intersections will be resolved by interpolating angle poles at a certain distance on both sides of the motorway and into the existent 20(10) kV transmission lines, and by laying high voltage cables between two angle poles. High-voltage 10(20) kV cables due for installation below the motorway alignment will be placed in underground power cable ducts, which will be completed prior to the construction of the motorway at intersection points. The capacity of power cable ducts below the motorway will hold space for at least two additional pipes than is needed.

The minimum distance between angle poles and the motorway edge will be 40 m, as stipulated in Article 125 of the mentioned regulation. 10, ie 20 transmission angle poles will be earthed and cathodic diverters will be installed.

- Intersection of motorway alignment with low-voltage grid

The alignment of the motorway Vc and the low-voltage grid is likely to intersect in habitations. No regulations allow the construction of low-voltage grids below or above motorways; therefore, low-voltage transmission lines currently in use will be removed where intersecting the proposed alignment. As no users may be deprived power supply due to the construction of the motorway, new power substations, 20(10) kV connections to mains and the new low-voltage grid will be installed/constructed on both sides of the planned alignment for the buildings which stop receiving electrical power during the construction of the motorway Vc.

- Detailed terms and conditions under which the alignment of the motorway Vc may intersect with the 0,4 to 400 kV power grid will be prepared in parallel with the terms and conditions for the motorway in accordance with the main design of the motorway and the situation in the field.
- The position of transmission lines and associate structures will be recorded during the field preparation of spatial and technical specifications. Detailed spatial and technical terms and conditions will be prepared for every intersection of the motorway Vc and transmission lines and detailed terms and conditions under which intersection will be permitted will be specified.

Telecommunications

Planned alignment of highway Vc will be crossing with optical cable on the following points: west from Odzak (settlement Potocani), in the area between Vukosavlja and Modrica and in the settlement Rudanka, as marked in graphical annex.

Cables were laid along the road belt directly in the land – trench on the depth from 60 to 80 cm.

On the places of crossing of mentioned telecommunication ducts with future alignment of highway Vc it is to be expected that it will appear the necessity for reconstruction of telecommunication network for meeting of technical regulations.

During the preparation of urbanism-technical terms on the very place, it will be carried out the survey of existing telecommunication network and for the case of crossing the highway Vc with telecommunication cables it will be prepared detailed urbanism-technical terms and prescribed detailed terms of crossing.

7. ALTERNATIVE SOLUTIONS AND DESCRIPTION OF REASONS WHY IT WAS SELECTED THE GIVEN ROUTE IN TERMS OF ENVIRONMENTAL PROTECTION

Alternative routes evaluation constitutes a process of documented evaluation of different alternative routes in order to compare them and choose the optimal one. For proper implementation of the evaluation process it is necessary to possess documented information, goals and criteria based on which the evaluation is to be done.

The main condition for the evaluation is that the alternative routes are defined on the same detail level where all criteria and its indicators are defined on the basis of the same conditions and verified lawfulness

Specifics of the evaluation process for the needs of study analysis of environmental protection related problems reflect primarily to the simplicity of the main goal, which is expressed in all-impacts-minimum principle. This goal will be achieved only if all realistic alternative routes are compared according to the defined criteria (impacts) and the optimal one is selected.

Given the fact that the evaluation procedure is done on Technical study level, as well as the fact that the available information level obtained through the Evaluation of the Impacts is made relative by the fact that all analyzed alternative routes are relatively situated into the same corridor, the variants evaluation process is done in two basic steps

- The first step implies systematization of all limitations obtained through the analysis of the current situation and presented in the form of the appropriate graphic documentation on the present characteristics level for all essential indicators. This analysis has resulted in a synthetic limitations' map, which is graded through three basic categories of suitability for the construction of the highway from the point of view of possible environmental impacts. Categories are defined as convenient (suitable), conditionally suitable and unsuitable. The methodology of synthetic map's forming has in this way disregarded relative importance of the individual indicators, that is the synthesis principle is significantly simplified in the sense that the a spatial unit turns suitable only if all indicators are suitable or it is unsuitable if only one indicator is unsuitable and conditionally suitable if only one indicator is conditionally suitable.

First step in evaluation of those proposed alternative routes that have the direct connection with absolute limitations, and after that evaluation of other alternative routes according to the elements mentioned in protocol 2¹²:

- A. Technical-exploitation characteristics, determine the conditions, exploitation costs, traveling costs, accident and maintenance costs;
- B. Construction costs, which have a relevant impact on rent ability and economic-financial feasibility of the project;
- C. Spatial-environment characteristics which impact on acceptability and project realization in terms of spatial use, environment and socio-economic environment impact, and
- D. Timing and construction conditions, which also have a significant impact on final judgment about suitability of project.

Each of mentioned criteria includes less or more parameters –criteria of lower rank (sub criteria) for appraisal of alternatives in terms of basic criteria. Spatial-planning characteristics foresee the acceptance and implementation of project in terms of spatial use, and environment and socio-economic impact and in recent time present more significant factor in making decision about

¹² Protocol about the coordinated methodology for triage of alternative routes on the level of all four design lot.

investments. Sustainable development principle more and more respect mentioned factors composed of care about environment and development in accordance with minimum environment disturbance. This criteria is divided in two criteria. On the base of mentioned it was carried out the evaluation of alternative routes on individual relations, by the side of multidisciplinary expert team with application of secret evaluation and it was selected the most optimal alignment of highway.

8. DIFFICULTIES DURING THE PREPARATION OF EIA

The greatest difficulty in preparation of EIA for the specialists for water resources presented the impossibility of insight in Decision of waste water drainage from surface of the highway. However, the concept of EIA preparation parallel with Preliminary design provided to the designers of EIA the insight in work versions of adopted alignment of highway, with partially marked objects per individual sections. In accordance with that, the Study designers did not have any insight in the decision about drainage, waste water treatment, and the sites of waste water outlet from traffic surface

Having in mind, the lack of mentioned information, this impact assessment during the phase of construction and use can only be given generally, on the base of literature. In many situation, it occurred the problem of data lack, and necessity for conduct of more detailed survey of particular water phenomena in higher phases of project design, having in mind both their potential negative impact on the highway, and potential negative impact of the highway on the ones.

Also, one of the problems is the lack of detailed hydrological map of narrow belt around the highway received on the base of research works. Objects for waste water treatment can be located within the area defined as sensitive within this Study,, but before final selection of object disposition, it should be consulted the detailed hydro geological basement of narrow belt around the highway in the scale 1:5.000. It is needed to pay attention that the objects not set up in aquifer area where determined high levels of underground water to avoid disturbance of hydraulically regime of underground water flow and similar. Having in mind all above mentioned, it is necessary to perform control of assumed water impact on the base of data that will be received after completion of survey works, and hydro geological maps and longitudinal profiles of narrow belt of the highway in detailed scale (1:5.000).

9. TRANSBOUNDARY IMPACT

Section of LOT 1: Svilaj –Doboj jug (Karuse) passes through the area of Federation of BiH and Republic of Srpska. Taking into consideration the spatial dimension of this section, there is risk and probability that project may have impact on water resources in the area of another country, i.e. transboundary on waters in Republic of Croatia.

Designed alignment of highway on this section is almost with all length laid in the valley of river Bosna, where on more places intersects or it is laid along the left or right bank. River Bosna empties in the river Sava which presents territorial border between the Republic of Croatia and BiH. In terms of that, in case of accidental situation there are possible the transboundary impacts in form of transport pollution in the river Sava in the neighboring country.

Accidental situations especially occur in the case of roll-over of vehicles in the proximity of watercourse, which transport the dangerous matters. In that case, it may occur the water pollution because of the seepage of dangerous matters, that may transport from the area of one entity to the area of other entity (if pollution came in river Bosna), and depending on the line of specific factors, it may reach the area of other country (river Sava).

Risks of dangerous cargo accidents can be defined if it is known the transport structure and basic data about traffic accidents on the study section. On the base of these data, it is possible to determine the probability of possible accident and in accordance with that undertake the special protection measures. In terms of data availability about the number of accidents on planned highway, it can be concluded that probability of possible accident with dangerous matters is very low, but it is possible that is why it is necessary to undertake water protection measures of possible entrance of dangerous matters in the area of other entity (Republic of Srpska) and the other country (Republic of Croatia).

Hazardous matters imply all those matters that have very toxic, oxidizing, explosive, eco-toxic, flammable, self-combustible and other properties dangerous for the life of the people and the environment. Every road has a certain role in transport of hazardous materials considering its position in the network, and possible consequences are especially emphasized in biologically valuable areas and in the places of concentration of the traffic flow, which is evidently the characteristic of the planned highway. Given the characteristics of transport conducted over the planned communication, the following hazardous matters can be expected:

- Flammable liquids – petrol and diesel fuel, transported on cisterns as well as different oils (machine, engine, reduction, hydraulic, emulsion), transported in different packaging,
- Compressed gases - propane, butane, packed in special containers made of steel,
- Oxidizing matters – chlorides, peroxides, transported on cisterns,
- Rusting or corroding matters – sulfur, hydrochloride and nitrogen acid transported on cisterns or in balloons,
- Poisonous and contagious matters – pesticides, herbicides packed in sacks and small carton boxes.

Matters that do not fall in the mentioned groups and that while transported may occur as polluters in case of accidents, are the foodstuffs transported in commercial network, agricultural products, industrial final consumer goods, construction material, textile industry products, technical ware etc.

Having in mind all above mentioned, it should be applied all available measures for reduction of probability of accidental situation.

With monitoring of water quality along the planned highway, and provision of conditions for timely undertaking of additional protection measures, it is possible to prevent transport of water pollution. It is especially necessary to introduce the system of urgent informing of responsible authorities for waters in Republic of Srpska, and further in Republic of Croatia. The same is related to the accidents that might have a negative impact on waters during the construction of highway.

In terms of transboundary impact on waters, from aspect of natural floods, it should emphasize that the planned highway is designed in the zone exposed to flood waters of rivers Bosna and Sava. However, during the design of alignment, finish grade of highway was lifted enough high from prescribed level of high tide (VV 1/100 and 1/500), and with that guarantee the security of this natural occurrence.

10. SYSTEM OF MONITORING AND SELECTION OF METHODS

This document must contain the Environmental Action Plan, whose purpose is to ensure the implementation of the proposed measures of protection. Also, EAP enables the monitoring of the efficiency of such measures, their improvement and modification.

Design

The checklist during the design stage is necessary in order to consider all relevant environmental factors and issues and prepare the necessary measures of protection. Zones requiring special protection specified in the project must be respected and special protection measures must be adopted. The same condition must be met during the construction stage and this must be emphasized in the bidding document.

Construction

In order to meet all environmental requirements, it is necessary to hire an environmental engineer (expert in ecology), who will be responsible for the monitoring of construction works by means of frequent inspection and the protection of the Investor's interests.

Also, the Contractor is obliged to appoint one or more persons to monitor the implementation of environmental requirements as specified in the bidding document. The Contractor must be notified about this condition during the negotiations and prior to the signing of the contract.

The elements monitored during construction works include the implementation of the adopted measures of protection and they will be frequently inspected by the environmental engineer and are the immediate responsibility of the Contractor.

Maintenance

The environmental engineer is responsible for the assurance of adopted procedures, the technical guidebook/manual for the regular maintenance of the drainage system, safety and light signaling systems, intervention in the event of accidents (spillage of hazardous substances) and maintenance of green spaces (these documents may also be part of the bidding document).

Table 10-01: Monitoring and control

(1) Which parameter?								
(2) Where is monitoring conducted?								
(3) How is the selected parameter monitored /monitoring equipment?								
(4) When is the monitoring conducted, continuous or occasional monitoring?								
(5) Why is this parameter monitored?								
Component		(1) Which?	(2) Where?	(3) How?	(4) When?	(5) Why?	Price	Responsibility
DESIGN	Bridge	Protection against floods and seismic activity	Design studio	Checklist	Prior to project adoption	-	Add to project cost	Project manager
	Ecological road	Protection against erosion	Design studio	Checklist	Prior to project adoption	-	Add to project cost	Project manager
	Ecological road	Protection (remedial measures) for landslides and avalanches	Design studio	Checklist	Prior to project adoption	-	Add to project cost	Project manager
		Animal paths	Design studio	Checklist	At the beginning and end of project preparation	-	Add to project cost	Project manager
		Number of trees to be felled	Design studio	Checklist	At the beginning and end of project preparation	To define the program of tree relocation/replanting	Add to project cost	Project manager
		Equipment and signaling tools	Design studio	Checklist	At the beginning and end of project preparation	To make roads safe for users, especially in urban areas	Add to project cost	Project manager
DESIGN	Ecological road	Contact with local authorities and community	Design studio	Checklist	At the beginning and end of project preparation	To prepare a justifiable, realistic and purposeful project	Add to project cost	Project manager
	Total project	Selection of sensitive green spaces and their specification in bidding propositions	Design studio	Checklist	At the beginning and end of project preparation	To specify the protected areas in the requirements for the contractor	Mapping is included in the project cost	Project manager
	Total project	Requirement to appoint a person in charge of environmental requirements in bidding propositions	Design studio	Checklist	At project completion	-	Add to project cost	Project manager
	Earthworks	Design of dumps used to dispose materials	Design studio	Checklist	At the beginning and end of project preparation	To prevent the ruining of landscape, destruction of farmland, erosion, contamination of potable water	Add to project cost	Project manager
	Drainage	Drainage system and number and location of water resources along the road	Design studio	Checklist	At the beginning and end of project preparation	To improve drainage system and water quality	Add to project cost	Project manager
	Dumps and pits	Number of existent pits and dumps	Design studio	Checklist	At the beginning and end of project preparation	To prevent unnecessary opening of new pits and dumps	Add to project cost	Project manager

Component		(1) Which?	(2) Where?	(3) How?	(4) When?	(5) Why?	Price	Responsibility
DESIGN	Asphalt bases	EMP requirements must be included in bidding propositions	Design studio	Checklist	At the beginning and end of project preparation	To prevent soil, water and air pollution, reduce noise pollution and negative impact on flora and fauna	Add to project cost	Project manager
CONSTRUCTION	Road Department resources	Environmental engineer (full-time employment)	Road Department	-	-	To meet environmental requirements of the project	-	Chief of road Department
	Special requirements for contractor	Improvement related to environmental issues	Prior to contract	Qualitative checklist prior to contract	Prior to contract with contractors	To ensure full comprehension and implementation of contract requirements related to environmental issues	Add to requirements for contractor	Chief of road Department
	Road and bridge construction. Earthworks	Implementation of measures of protection against erosion, slides and avalanches	On site	Final quality inspection	During implementation	To prevent negative impact on the road	Add to requirements for contractor	Contractor/ Environmental engineer
		Approved sites for disposal of waste and surplus material	On site	Quality control	Regularly by inspection	-	Add to requirements for contractor	Contractor/ Environmental engineer
	Bridge construction	Specification of season for bridge construction	On site	Quality control	Prior to contract with contractors	To prevent negative impact on rivers, flora and fauna	Add to requirements for contractor	Contractor/ Environmental engineer
		Fauna: construction banned during spawning time	On site	Quality control	February, March	To secure fauna habitats and biodiversity	Add to requirements for contractor	Contractor/ Environmental engineer
		Flora: minimum destruction of flora in and around the river	On site	Quality control	During implementation	To secure fauna habitats and biodiversity	Add to requirements for contractor	Contractor/ Environmental engineer
	Pits, dumps, asphalt bases	Official licenses for pits, ie sites for dumps and asphalt bases	Prior to contract	Quality inspection	Prior to contract with contractors	To ensure comprehension of environmental issues inherent to project		Contractor/ Environmental engineer
CONSTRUCTION	Road/bridge construction. Earthworks, pits, asphalt bases	Number of cut and relocated trees	On site	Quality inspection	Regularly by inspection	To limit negative impact on green spaces around the road, asphalt bases and pits	Add to requirements for contractor	Contractor/ Environmental engineer
	Construction site. Earthworks.	Protection of trees against damage	On site	Quality inspection		-	Add to requirements for contractor	Contractor/ Environmental engineer
	Road/bridge construction. Earthworks, pits, asphalt bases	Proper storage of chemicals with regards to protected zones and contingency plans	On site	Quality inspection	At commencement of operations and constantly	Safety regulations	Add to requirements for contractor	Contractor/ Environmental engineer
	Asphalt bases	Accidents and spill of hazardous chemicals	On site	Inspection	In case of accident	Safety regulations	Add to requirements for contractor	Contractor/ Environmental engineer
	Bridge construction	Noise and measures of protection	On site	Equipment for measuring noise	Inspection	To minimize impact of noise on local population	Add to requirements for contractor	Contractor/ Environmental engineer
	Road construction, construction site	Noise and measures of protection	On site	Equipment for measuring noise	Frequency in accordance with requirements of environmental institutions and inspection	To minimize impact of noise on local population	Included in contractor's contract (dumps, pits, asphalt bases)	Contractor/ Environmental engineer
	Asphalt bases, pits	Noise and measures of protection	On site	Equipment for measuring noise	Frequency in accordance with requirements of environmental institutions and inspection	To minimize impact of noise on local population	Included in contractor's contract (dumps, pits, asphalt bases)	Contractor/ Environmental engineer
CONSTRUCTION	Asphalt bases Pits Construction site	Site wetting and use of enclosed lorries for transport of materials near populated areas	On site	Quality inspection	Continuously	To prevent pollution of air with dust	Included in requirements for contractor	Contractor/ Environmental engineer
	Road construction	Installation of proper signaling equipment	On site	Quality inspection	Continuously	To prevent traffic accidents near construction site	Included in requirements for contractor	Contractor/ Environmental engineer

Component		(1) Which?	(2) Where?	(3) How?	(4) When?	(5) Why?	Price	Responsibility
	Asphalt bases, bridge construction pits	Fauna: Prevent the destruction of bird habitats. Construction works forbidden during nesting and egg laying	On site	Quality inspection	Inspection after installing asphalt base	To ensure uninterrupted bird nestling	Included in requirements for contractor	Contractor/ Environmental engineer
	Asphalt bases Pits Construction site Disposal of surplus earth	Avoid unnecessary expropriation and use of farmland	On site	Quality inspection	Continuously	To avoid loss in crop yield	Included in requirements for contractor	Contractor/ Environmental engineer
	Asphalt bases Pits Construction site Disposal of surplus earth	Compensation for spoilt farmland or crop yield	On site		Prior to commencement of works	To avoid conflict		Road Department
	Construction camps	Adequate disposal of rubbish and sewage. Preservation of cap sheets for new use	On site	Quality inspection	Prior to acceptance of construction camp		Included in requirements for contractor	Contractor/ Environmental engineer
	Construction site, asphalt bases and pits	Remediation of construction zone	On site	Final quality inspection	Upon closing of construction site		Included in requirements for contractor	Contractor/ Environmental engineer
USE	Drainage system maintenance	Plan for regular maintenance of drainage system	Road Department				Regular maintenance	Maintenance Department
	Transport of hazardous substances	Contingency plan in case of spill of hazardous substances	Road Department					Maintenance Department
	Maintenance of safety and lighting equipment	Plan for regular maintenance of safety and lighting equipment	Road Department				Regular maintenance	Road Maintenance Department
	Maintenance of road surroundings	Plan for maintenance of green space	Road Department				Regular maintenance	Road Maintenance Department
		Removal of rubbish disposed along the road	Road Department				Regular maintenance	Community and Road Maintenance Department
		Plan for monitoring of soil quality	Road Department				Regular maintenance	Environmental institutions and Road Maintenance Department
		Plan for monitoring of water quality	Road Department				Regular maintenance	

10.1. Water quality monitoring

Monitoring is the activity whose goal is to record and measure any changes caused to the environment during the stages of construction and use. The monitoring of water quality zero measuring is the precondition for adequate analyses and measures for the two stages mentioned above. With regards to the hydro-geological, hydrographic and hydrological characteristics of the area through which the alignment will pass, the zero values of the quality of surface and ground waters in the mentioned area is presented in paragraph 4.5.4. of this study.

This study also presents the plan for the monitoring of water quality during the stages of construction and use. The most important element of the plan is the implementation of the system of monitoring of water quality in the area of the planned motorway, which means: the installation of new gauges (4) prior to the commencement of construction works (zero monitoring) and all gauges (4+5=9) for the stages of construction and use. The positions of all gauges to be used in the monitoring of surface waters are given in the Supplement 12.3.5. of this study.

10.1.1. Water quality zero monitoring

10.1.1.1. Surface water

Based on the available data, paragraph 4.5.4.1 presents the results of the zero monitoring of surface water quality for those water currents which run along the adopted alignment of motorway lot 1, or which are intersected by it. The focus is on the Bosna River and its major tributaries.

Since 2000, the quality of surface water has been monitored in 15 water currents in RS on 23 river gauges. The examination of the quality of surface water is carried out in four stages during one hydrological year (physical, chemical, microbiological and saprobiological characteristics). This study present and interprets the data for 2000–2005. These data were collected from five gauges used for sampling on the Bosna, Usora and Spreča Rivers for zero measuring and they will not be used for the same purpose on new samples.

These are the following gauges: (1) Bosna River – gauge B-12, Dobož upstream from the confluence with the Usora River; (2) Bosna River – gauge B-12', Dobož downstream from the confluence with the Spreča River; (3) Usora River – gauge Us-1 the confluence with the Bosna River; (4) Spreča River – gauge Sr-2 the confluence with the Bosna River, and (5) Bosna River – gauge B-13, downstream from town Modriča.

Also, the consultant discussed and agreed on the principles to underlie the planning of monitoring and related activities with representatives of RS Water Department – Bijeljina Office, and the Public Enterprise for Sava River Basin – Water Protection Sector – Sarajevo, based on which four (4) new gauges have been proposed to be used for the analysis of zero condition prior to the commencement of construction works. These gauges have been selected to meet the following requirements:

- To cover those sections of the motorway which intersect with surface water currents, where both intensive and extensive construction works are planned (bridges and crossings).
- To analyse the changes caused by industrial pollution and sewage and distinguish between those types of contaminating impact and that which may be caused by motorway construction works.
- To cover the relatively long sections of the motorway passing through major aquifers.

The newly proposed gauges (NG) are given in Table 10.1.1. along with the gauges (G) used by RS Water Department – Bijeljina Office for water quality inspection.

Table 10.1-01: Overview of surface water currents and gauges used in monitoring along lot 1 Svilaj – Doboj South (Karuše)

Gauge	Water current	Nearest place name
NG 1	Sava River (1,5 km before confluence with Bosna River)	Prud
NG 2	Bosna River	Prudovi – downstream from the new bridge under construction
G 3 (Bosna gauge B-13)	Bosna River	Dobori – downstream from Modriča
NG 4	Bosna River	Majevac – Majevačko polje
NG 5	Bosna River	Crossing Rudanka – Krajčani
G 6 (Usora gauge Us-1)	Confluence of Usora and Bosna Rivers	Doboj
G 7 (Bosna gauge B-12)	Bosna River, upstream from confluence with Usora River	Doboj
G 8 (Spreča gauge Sp-2)	Confluence of Spreča and Bosna Rivers	Doboj
G 9 (Bosna gauge B-12')	Bosna River, downstream from confluence with Spreča River	Doboj

As there is no data for the zero condition on the new gauges, the minimum measuring to be conducted should be four series (two hydrological minimums and maximums), which should also be completed prior to the commencement of construction works.

After sampling, the following indicators must be checked on each of the gauges. These indicators are relevant for the examination of the impact of the motorway on the quality of surface water:

1. Temperature
2. Electrical conductivity
3. pH value
4. HPK
5. BPK₅
6. Water turbidity
7. Total suspended solids
8. Chlorides
9. Sulfates
10. Heavy metals (cadmium, copper, chromium, zinc, nickel, lead, iron, manganese, mercury)
11. Ammonia, nitrites, nitrates
12. Total fats
13. Mineral oils
14. Total phenols
15. Total organic carbon (TOC)
16. PAH – total

The quality of surface water of the main basin current and its tributaries, which is the Sava River, ie the Bosna River, will continue to be monitored in the future on the gauges selected by RS Water Department – Bijeljina. Therefore, when zero measuring is conducted on the four new gauges, this study proposes the gathering of the existing data from the five gauges, whose zero data are presented here. Since the exact time of the commencement of construction works for lot 1 of the motorway is still unknown and there is no evidence that all subsections will be constructed simultaneously, we believe the data collected by the gauges for the year 2005 (available at the time of the preparation of this study) should be updated.

10.1.1.2. Ground water

There are several ground water sources in the research area along lot 1 and they are either parts of waterworks or local water supply systems (water supply systems in villages and small settlements are not incorporated into public water supply systems and are used by a larger number of households). Based on the available data gathered during the preparation of this study, paragraph 4.5 gives an evaluation of the zero measuring of ground water quality. Those are:

- Odzak water source
- Osjecani water source
- Rudanka water source
- Krasevo water source

The following water sources in Usora Municipality need zero measuring on the spot and prior to construction works: Makljenovac, Ularice and Alibegovci.

After the initial sampling of water from these water sources in two cycles (one hydrological minimum and maximum), it is necessary to analyse the following typical indicators of impact caused by the motorway on groundwater:

1. Smell
2. Colour
3. Taste
4. Clarity of water
5. Temperature
6. Electrical conductivity
7. PH value
8. KMnO₄ consumption
9. Residual chlorine
10. Fluorides
11. Chlorides
12. Sulfates
13. Heavy metals (cadmium, lead, iron, manganese)
14. Ammonia, nitrites, nitrates
15. Total fats
16. Mineral oils
17. Total phenols
18. PAH-total

The investor, ie building constructor, has to deliver the report on conducted zero measuring of ground and surface water quality to the relevant bodies and institutions in the water and environment sector in RS and the Federation of BH.

10.1.2. Monitoring in construction stage

10.1.2.1. Surface water

Surface water quality monitoring is necessary due to the fact that the construction works on LOT1 motorway may have an impact of machines used and human factor involved. Selection of gauges on which to conduct monitoring also depends on whether all sub-sections are going to be built at the same time or just some of them. These sites are established depending on the project of construction site organisation and rhythm of work. These data ought to be specified in the Main project, i.e. it is necessary to select measuring gauges for monitoring during construction stage, depending on the section where the construction site will be active. This kind of approach is justified in order to ensure that the future investors/building constructors do not oblige themselves at this moment to monitor quality in all 9 gauges proposed for the entire section of LOT 1 if that is not necessary.

It will be necessary to conduct a detailed analysis of 16 typical indexes (paragraph 10.1.1.1) once a month during construction in order to examine the impact of the motorway construction on the quality of surface water.

With the aim of analysing direct impact on the surface water quality made by erected active construction sites and bases of mechanisation used in construction work, it is necessary to conduct short - weekly analyses of the water quality, which include analysis of the following indexes:

1. Total suspended solids
2. Oils and fat
3. Organic matter
4. Heavy metals (lead, iron, manganese, nickel, zinc, chromium, copper)
5. Volatile matter
6. pH value
7. Conductivity

Proposed shortened analyses of surface water quality are necessary only for the gauges next to the construction sites (where construction mechanisation will be located, personnel, etc.). Those sites are defined depending on construction site organisation project and rhythm of work. These data ought to be specified in the Main project, i.e. it is necessary to select measuring gauges for shortened analyses. Investor/building constructor will have to hire an environment expert during this stage, who ought to monitor succession of construction in sections on a daily basis, from the aspect of possible impact on the surface water quality on locations closest to construction site.

10.1.2.2. Groundwater

Groundwater quality monitoring is necessary during construction, due to the fact that the construction works on LOT1 motorway may have an impact on it made by machines used and human factor involved.

Same as for surface water, selection of water sources in which to conduct monitoring also depends on whether all sub/sections are to be built at the same time or just some of them, i.e. those sources closest to the active construction site locations ought to be monitored. As already mentioned for surface water, these data ought to be specified in the Main project, i.e. it is

necessary to select measuring gauges for monitoring during construction stage, depending on the section where the construction site will be active. This kind of approach is justified in order to ensure that the future investors/building constructors do not oblige themselves at this moment to monitor quality in all 5 sources proposed for the entire section of LOT 1 if that is not necessary.

This quality control includes sanitary control of drinking water in accordance with the relevant rulebook on a weekly basis, and detailed analyses of 18 typical indexes (paragraph 10.1.1.2.) ought to be realised at least once a month.

10.1.3. Monitoring during operations stage

10.1.3.1. Surface water

When it comes to impact of waste water coming from the road surfaces on the quality of surface water, which is possibly its future recipient, important fact is that project engineer planned a controlled enclosed system of drainage in the Draft solution, which will probably be elaborated as part of the Draft project.

Result of motorway use is wastewater coming from the roads. Wastewater is being accumulated and refined in a controlled system of internal drainage including accessory facilities. Maximum of emissions in wastewater should be harmless for the environment and satisfy the relevant requirements. In terms of maximum values definition, it should comply with the values defined in the "Rulebook on conditions of discharge of wastewater into surface water", Official Gazette of RS, No 44/01, or in the "Rulebook on conditions of discharge of wastewater into public sewerage systems", Official Gazette of RS, No 44/01. This is also recommended for the route sections passing through the territory of BiH Federation, concerning the fact that there are no relevant legal acts that regulate this matter in BiH Federation as well.

In case of wastewater discharge into surface watercourses, it should be refined and of a same quality as its water-recipient, i.e. it has to correspond to its future water/recipient on all levels and parameters.

Measuring gauges for monitoring in the motorway exploitation stage ought to be specified in the Main project, having conducted hydro-geologic research and, after that, precisely established positions of oil and fat separators and facilities for supplemental refining of wastewater, as well as finding solutions for wastewater discharge from them.

Measuring needs to be conducted every three months for at least five calendar years. If during that period results show that there is no impact of the motorway on the surface water quality, then number and frequency of those analyses can be reduced and brought into accordance with the requirements set by the Act on water of RS, that is FBiH.

10.1.3.2. Groundwater

After the motorway is opened for public, it is necessary to conduct a sanitary control of drinking water in sources (five established) of public and local water supply systems close to the motorway, on a monthly basis, for at least five calendar years. Apart from that, at least four times a year, during two hydrological minimums and maximums, an analysis of the 18 typical parameters (paragraph 10.1.1.2.) should be conducted too.

If during that period results show that there are no impacts of the motorway on these sources while being used, then number and frequency of these analyses can be reduced and brought in

accordance with the requirements by the Act on water of RS, i.e. FBiH, which dictates the minimum number of stipulated examinations.

10.1.3.3. Wastewater from oil and fat separators and refining facilities

Quality of wastewater coming from the roads needs to be controlled in places of its discharge from oil and fat separators and supplemental refining facilities.

This control needs to be realised four times a year. A must is to do it once during heavy precipitation and once during the summer upon the first rain and after a long drought period and the most intensive use of the motorway.

Monitoring should be conducted on at least two separators' locations, on locations of discharge from the separators and before the entrance into a filter field and after the filter field prior to discharge of wastewater into a recipient or soil. During those analyses, it is necessary to conduct analyses of 16 indexes mentioned in paragraph 10.1.1.1.

Monitoring locations should be specified in the Main project, upon hydro-geological research, and precisely determined positions of separators and facilities for additional refining of wastewater. It must be noted that these monitoring activities will include separators placed on locations that will be evaluated as zones and places of the highest risk of groundwater pollution after a detailed hydro-geologic research. What is proposed at the same time is a research of the filter field sediment capacity at least twice a year for certain indexes.

Limits of wastewater discharge are to be defined in accordance with the type of the recipient of wastewater from the roads (sewerage system, ground, surface water). In order to determine the limits (maximum values), values defined in the following rulebooks should be used: "Rulebook on conditions of discharge of wastewater into surface water", Official Gazette of RS, No 44/01, or in the "Rulebook on conditions of discharge of wastewater into public sewerage systems", Official Gazette of RS, No 44/01, or in the "Rulebook on treatment and drainage of wastewater for inhabited areas with no sewerage systems", Official Gazette of RS, No 68/01.

10.2. Soil monitoring

10.2.1. Zero status in soil monitoring (prior to the commencement of construction activities)

Determination of the zero level and monitoring of the soils on the section of the corridor Vc, LOT 1 Svilaj – Karuše, are the major preconditions in designing measures of special precaution and protection of soils on the jeopardized section 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, and who would develop the study on the current status and monitoring program, that would include:

a) Field research

1. Reconnaissance and probation of the terrain located within a 500 m strip on each side of the route, aimed at identification of the pedo-systemic affiliation of the soils and mapping units.

2. Conduct soil sampling, one average sample from the surface layer of the intact – natural soil every 2 km of the route, which makes a total of 31 samples, trying for the samples to “cover” all types of soil use. For each major soil type (approximately 24 pedo-systemic units) one average soil sample should be taken on a location precisely determined by GPS, which would be used for a continuous monitoring of the soil status. For the complete analysis, a total of 56 samples would be taken.
3. Make an assessment and detailed observation of the status of the crops and natural – forest vegetation along the route. A method of comparative phenological observations will be used for this purpose.

b) Laboratory analysis

For the purpose of identifying the soils, standard chemical analysis would be run on all samples in the laboratory. This analysis would include pH, humus, hydrolytic acidity, analysis of adsorptive complex, content of NPK nutrient. In addition, all the samples would be subject to the analysis on heavy metals and PAH - polycyclic aromatic hydrocarbons, in accordance with the provisions of the Instructions on determining the allowed quantities of harmful and hazardous matters in soil and methods for their testing, FBiH Official Gazette No. 11/99 and RS Official Gazette No.23 of 18.03.1994.

c) Processing of results

Processing of the results of the field observations and laboratory analysis would be presented in digital form as well as on a pedology map in GIS technology which would be used in future continuous monitoring of the soil following the completion of the highway, in the scale 1: 25 000 for the entire route, and in scale 1: 5 000 for each location of future monitoring.

10.2.2. Monitoring during the construction phase

Good and quality organization of the construction site is an important precondition for the phase of construction; it has to honor previously determined status and recommendations, all in accordance with the rules of good practice in this area of expertise. Control over the execution of work should be carried out by an adequate inspection team that would include experts in ecology and land protection. The project should define precise boundaries of the area within which the contractor's machinery would be allowed to move; this would help to avoid the misunderstandings in the field, with the local population, as well as damaging that goes beyond the absolutely necessary level.

“Excessive” cutting of the wood and removal of the vegetation cover outside the areas determined by the project are very common. This has negative impact on environment.

Erosion of small particles caused by trench digging, which brings them into the watercourses and onto the land surface, should be reduced to the least possible level, as it disturbs both land and water biodiversity, and helps the transportation of heavy metals such of lead and cadmium.

During the construction, all materials used should be subject to control; they should be checked on radionuclide contamination, which is likely to happen given the uncontrolled influx of a number of materials in the market, while also some natural materials could be contaminated. In case that the soil somehow gets contaminated (petroleum, oil or some other organic or inorganic polluter) during the construction, it is necessary to remove the soil from the subject area and have it stored in accordance with the regulations on decontamination, far away from the watercourses, potential impact on the contamination of underground waters and karstic areas.

During the construction it is mandatory to control the treatment of waste waters on the construction site, preventing them from entering the watercourses without being previously treated, by means of basins, ponds, fenced basins and other similar facilities for sedimentation and treatment of waste waters.

10.2.3. Monitoring during the exploitation of the facility

Surveys that are to be carried out during the development of the “Study on zero-level status”, will continue not only during the construction of the highway, but also upon its completion. The sample analysis will be conducted once a year on approximately 20-25 locations (with a 3 km interspace) along the highway route. The selection of locations, as stated before, will be based on type properties of the soil and other pedo-genetic factors deemed important for a particular micro-location.

Exact locations will be established upon the completion of each individual section, bearing in mind the fact that they have to cover the strip immediate to the highway as well as the one reasonably distant from the highway margin. Monitoring of the status changes would be done on the same locality over a long period of time, while selected indicators would generally center on chemical changes and accumulation of pollutants, with a possibility of expanding the survey depending on the changes taking place in the field. Special attention should be given to measuring the level of heavy metals such as Cd, Hg, Pb, Mo, As, Co, Ni, Cu, Cr, Zn, content of PAH (polycyclic aromatic hydrocarbons), and oils of mineral origin if necessary.

Regular monitoring of the drainage system maintenance is crucial in protection and preservation of environment, as it should provide unimpeded transportation of all run-off waters coming from the road itself and its surrounding. Control and cleansing of the waste water collection and sedimentation facilities are also extremely important as they are the principle barrier to the polluters getting into the watercourses and surrounding agricultural land.

The control of the functioning and maintenance of the equipment at the gas stations, as well as other infrastructural facilities, plays a significant role in soil and water protection and prevention of accidental occurrences. Disposal of solid and sanitation of liquid waste materials should be in compliance with the strictest criteria in the area of waste management.

The monitoring should be executed by an institution competent for this type of job, while reporting on the status of the future highway monitoring should be regularly submitted to the future road administration and relevant ministries for environment. Data must be public and accessible to all parties involved in this area.

11. MEASURES RELATED TO WORK CONDITIONS IN EXTRAORDINARY SITUATIONS

The analysis of effects on the environment should also include the effects that are the consequence of accident situations during the phase of building and the exploitation of the highway, that represent the risk in the sense of possible negative influence on the environment.

There are a number of types of risks that may occur during the building and exploitation stage of the planned highway. It is usual to analyze all accident situations as part of the four possible groups:

- The first group of possible risks is present in all situations when the planned measures of protection of the environment during exploitation prove unsuccessful.
- The second group of possible risks is related to accident situations that may occur in the stage of conducting works, as well as works on the maintenance of road in exploitation.
- The third group of possible risks is related to accident situation that is the consequence of accidents of vehicles transporting hazardous matters.
- The fourth group of possible risks occurs as a consequence of occurrence of natural disasters such as floods, fires or earthquakes.

The probability of stated risks depends on several factors, it is most frequently low, but if they occur, they may involve serious consequences. The seriousness of possible consequences is the main reason for the analysis of the risk of accidents in the process of evaluation of effects of the concerned section on the environment.

11.1 Risk of inadequate protection measures

The failure of prescribed and realized measures of protection of the environment may in certain circumstances lead to consequences similar to those analyzed within each separate influence, however, the existence of a certain risk that can lead to much more extensive consequences for the environment, is also evident.

The risk of these, and similar events, has to be analyzed and adequate measures have to be prescribed in order to prevent the problem from getting bigger, which primarily implies the efficient protection against the traffic noise and especially pollution of sources for water supply.

Given the planned measures for protection of the environment for this specific spatial unit, the risk that is connected to inadequate solutions may occur in the first place with inadequately built system for collection of atmospheric waters and protection of water sources as well as protection against noise. In order to decrease the probability of the mentioned risks, the planned systems must be done entirely in accordance with the technical documentation, and in addition to that:

- Permanently monitor the situation of the environment in the area of the planned highway (monitoring) and ensure conditions for timely undertaking of additional protection measures;
- Prescribe adequate maintenance measures directed toward the protection of the environment in the field of all possible influences;
- Plan additional protection measures in all those places in which inefficiency of already taken measures has been proved during exploitation, or where the possibility of risk due to inefficiently taken measures was proved.

11.2 Risk of accidents during building and maintenance

In the period of building and maintenance of the highway circumstances may arise that lead to undesired events or accidents, most frequently in the field of risk for health and life of the immediate participants in the work process, but also of the users of the highway.

Accidents that may happen during conducting of the works and maintenance on the road, can cause exposure to hazardous chemicals or injuries of workers.

Building of the road also implies the risks for health and the risks related to safety of conducting works for the workers operating machines, hazardous materials, sources of power or for those who are exposed to unfavorable conditions during works (exposure to dust and toxic evaporations from chemicals used during works, exposure to lead paints in maintenance of the bridge constructions, to collapsing of scaffolding etc.)

Observance of basic principles in the field of protection at work will ensure significant decrease of possible risks during conducting works. Limiting the time of exposure to dust particles, chemicals, noise and by wearing protective clothes and protective glasses for special works, may help decrease the risk of undesired consequences. The procedures on handling toxic materials, explosive and other hazardous substances have to be elaborated in detail.

Especially important part of the risk is related to conducting of works under traffic. In order to decrease these risks, a number of procedures in the domain of organization of conduct of works are necessary. In order to lessen the possible risks, it is necessary to elaborate complete plans for conducting works under traffic on existing roads in the area of planned highway.

11.3 Risk of accidents of hazardous cargoes

Given all the circumstances characterizing the exploitation of a highway, and first of all having in mind the possibility of chemical accident as a consequence of crashing of vehicles transporting such matters, it is necessary to perform an analysis of such an occurrence in order to be able to specify special procedures that would possibly relate to this subject.

The planned highway has been identified as a road on which the intensive transport of hazardous matters will be conducted, given the fact that it connects the units of area of international importance.

Hazardous matters imply all those matters that have very toxic, oxidizing, explosive, ecotoxic, flammable, self-combustible and other properties dangerous for the life of the people and the environment. Every road has a certain role in transport of hazardous materials considering its position in the network, and possible consequences are especially emphasized in biologically valuable areas and in the places of concentration of the traffic flow, which is evidently the characteristic of the planned highway. Given the characteristics of transport conducted over the planned communication, the following hazardous matters can be expected:

- Flammable liquids – petrol and diesel fuel, transported on cisterns as well as different oils (machine, engine, reduction, hydraulic, emulsion), transported in different packaging,
- Compressed gases - propane, butane, packed in special containers made of steel,
- Oxidizing matters – chlorides, peroxides, transported on cisterns,

- Rusting or corroding matters – sulfur, hydrochloride and nitrogen acid transported on cisterns or in balloons,
- Poisonous and contagious matters – pesticides, herbicides packed in sacks and small carton boxes.

Matters that do not fall in the mentioned groups and that while transported may occur as polluters in case of accidents, are the foodstuffs transported in commercial network, agricultural products, industrial final consumer 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 the main data on the traffic accidents on the concerned section are known. Based on these data it is possible to determine the probability of possible accident and take appropriate protection measures accordingly. Considering the number of accidents on the planned highway we can draw a conclusion that the probability of crashes of vehicles with hazardous matters is low but certain, due to which appropriate measures of protection of the environment must be taken.

11.4 Risk of natural disasters

Disasters may involve the road and its environment, and the road may be a key factor in planning emergency actions. Natural catastrophes can damage the road and the road can be the factor in either aggravating or ameliorating the effects of these disasters.

- The road was designed in the area that is exposed to the flood wave of the Bosna and the Sava rivers. The level relations of the planned highway guarantee safety with this natural phenomenon.
- All objects on the road as well as the body of the road are designed to ensure safety in case of occurrence of earthquake.

12. LIST OF ANNEXES

- 12.1. Decision about the preparation of EIA/Decision about preparation of SUZS
- 12.2. Reports from terrain visits (questionnaires forms, photo and video forms).

Graphical annexes prepared in S 1:25000

- 12.3.1. Situation of the highway on Corridor Vc
- 12.3.2. Geological map
- 12.3.3. Engineering-geological map
- 12.3.4. Hydrogeological map
- 12.3.5. Map of limitations related to water resources
- 12.3.6. Map of limitations related to flood zones and planned hydro power plants objekte
- 12.3.7. Map of limitations related to soil and agricultural land
- 12.3.8. Map of limitations related to flora and protected natural area
- 12.3.9. Map of limitations related to landscape
- 12.3.10. Map of cultural-historical heritage
- 12.3.11. Map of limitations from planning documentation

Other graphical annexes

- 6.3.10.1 Map of noise without noise control measures 1:25.000
- 6.3.10.2 Map of noise with noise control measures 1:25.000