



STUDY ON ENVIRONMENTAL IMPACT ASSESSMENT

July, 2013

**PROJECT:
CONSTRUCTION OF
EXPRESS WAY A1,
FROM THE BRIDGE
OF RIVER RAEC,
INTERCHANGE
“DRENOVO” TO
GRADSKO
(JUNCTION WITH
HIGHWAY A1)**

LASOY DOO

LASOY

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Appendix I (list of types of flora and fauna)

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Appendix III (overview map of the route of the expressway)

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INTRODUCTION

The public enterprise for state roads (PE for state roads) intensively invests in construction of project documentation in order to enable investment in construction of new roads to encircle the road net in Republic of Macedonia. Furthermore, reconstruction of the existing roads is continuously done and everywhere where possible, is performed expanding to improve traffic.

Besides the two Pan-European corridors which connect the country with wider encirclement in direction north-south (Corridor 10) and east-west (Corridor 8), projects for strengthening the secondary developmental axis are initiated in accordance with the national planning documents. Firstly, there are thoughts of building roads which will enable appropriate linking of the cities Kumanovo – Stip, i.e. Veles (Gradsko) – Prilep.

The route is part of the secondary west axis for development of the Republic, starting from the intersection near the region Gradsko (junction with highway A1 or Corridor 10 (E75) all the way to the bridge of the river Raec, until the interchange “Drenovo”. There are three variants made for the route. According to the technical, financial and ecological criteria it is chosen one alternative for which is making Conceptual and Main project. With this Study the variants are analyzed, i.e. it is done an assessment of impacts and it is determined the appropriate measures for protection of the environment for the chosen variant of the route.

According to the Environmental Law (“Official Journal of RM” no. 53/05; 81/05, 24/07, 159/08, 83/09, 47/10, 124/10, 51/11 and 123/12) and according to the Decision from MoEPP no. 11-2612/2 from 20.05.2013 for construction of Expressway A1 from the region Gradsko (junction with highway A1) to the bridge of the river Raec, interchange “Drenovo”, it is necessary to conduct a procedure for Assessment of the impact of the project on the environment and to develop a proper study for it. The preparation for this Study is entrusted to “LASOY” DOO Skopje. The responsible expert for the Assessment of the impact of the project on the environment is Ana Petrovska, BA, Eng, architect, which is also the team leader for the preparation of this Study.

The Study is prepared in accordance with the Regulation for the content of the requirement which the Study for assessment of the impact of the project on environment should be fulfilled (“Official Journal of RM” no.33/2006).

NONTECHNICAL RESUME

Description of the location of the route

The considered section of the Expressway A1, from the bridge of the river Raec, interchange “Drenovo” to Gradsko (junction with highway A1), starting right after the leg in main road Prilep – Gradsko which separates from the left side towards Kavadarci (opposite to the gas station of Makpetrol).

The initial part of the route is moving through hilly region within the gorge Friska; then leading parallelly with the existing road from Gradsko to Prilep, going through village Debriste, passing through the temporary flow of river Porojnica and rising towards the village Kamen Dol. At this location the route through the bridge encircles the village and is moving toward the village Sirkovo. The field between these two villages is hilly, which requires the route to pass through more notches and culverts.

Then the route passes through mostly flat terrain near the village Sirkovo; in the further course the route is rising, and then gradually descending toward the temporary water flow of the river Krusevica. Then the route is moving to a distance of around 700m from the entrance of the village Krusevica, from where gradually is rising passing through mainly flat terrain until the locality called Gologlavica (before the village Dolno Cicevo). Then, through the regions Sokolovec and Celavica, the route passes the channel in Porojnica moving through the hills Golema Glava and through the local asphalt road Gradsko – D. Cicevo ending in the foot of the Vardar Hill.

Elevation height in the beginning of the route is estimated around 203 altitude, with what the vertical alignment of the road gradually rises to the spot height of around 298 ASL (chainage of km 20...+860), which also represents a fold. From here, all the way to the end of the route the vertical alignment is descending to the spot height 180 altitude which is the lowest spot height of the investigated section. The total length of the route is 25,700 km.

Characteristics of the project

Construction of the Expressway will include the following processes:

- Staking out the corridor of the route.
- Clearing the field for construction of access roads and forming the vertical alignment. That will include removal of vegetation (including cutting trees), as well as careful removal of the surface layer of humus material.
- Compaction of the field to the needed density. Stabilization of the base means every treatment (including compaction too) of the field to strengthen its durability and to increase its waterproof.

The expressway will have the following technical characteristics:

- For $V_r=100$ km/h (80km/h)
- lanes 2×3.50 M = 7.00 M
- side lane between the driving lane and the lane for stopping the vehicle if necessary
- 2×0.20 M = 0.40 M
- Stopping lane 2×2.50 M = 5.00 M
- Lane profile 12.40 M
- shoulders 2×1.00 M
- gutter + berm $2 \times (0.75 + 1.00)$ M
- PLANUM 14.40 M (15.90 M)
- Side lanes 2×0.30 M
- Cross slope 7%

Technology for construction of the Expressway

Because of the economy during the construction of the route it will be used local materials as far as possible. For this purpose it is conducted a geological and geomechanical analyze of the surrounding terrain, identifying the attributes of the soils and the aggregate which are very important for the stability and the resistance of the base. Materials which will be used are bitumen and tar, soil and rock materials, aggregates of gravel and sand. If it proves as possible and profitable, during the construction it will be used “waste” material also instead of conventional aggregates.

The trunk road will be formed through implementation of the following layers:

- Underground

After the removal of the humus layer with 0.20 – 0.50m cca thick, the underground will mechanically compact, and the control of the density will be done by the method of examination of the dry volume weight.

- Underground - subbase layer

This position appears in cuts, where the material discovered in the dimension of the underground – subbase according to the values of the carrying characteristics, satisfy the conditions for subbase material (CBR \geq 8%).

- Embankments

The embankments will be done in horizontal layers with approximately same thickness (30cm cca), and each layer will be built in with appropriate compaction tool, during permanent control of the density.

- Subbase layer

The base layer as final layer of the lower line will be performed from incoherent material with good quality with CBR \geq 8%.

- Tampon layer

This layer which is derived from crushed rock material with appropriate quality specified in accordance with the design and tender documentation.

The technology of the construction of the Expressway will be also based on the appropriate application of constructional machinery; beside the constructional materials and machinery, for the needs of the construction of the Expressway will be used fuel (mostly diesel), electric power (for the needs of the work of the compressors and other tools), as well as water.

For the needs of the construction of the Expressway will be used material of the existing quarries located along its planned route. It is suggested several new loans too for which it will be necessary obtaining a concession according to the Law on Mineral Resources.

For removal of the spare raw material from the excavation there will be performed disposals located in a way to be properly integrated into the existing region, to be out of the catchment areas of the streamflows and out of the sensitive ecosystems.

The removal of the construction waste will be done in locations identified by the local authorities (municipalities Rosoman and Gradsko).

Condition of the environment in the area of the location

Relief and morphology

The route of the expressway belongs to the wider region of the Povardarie. It is low relief area along the river Crna and within the Tikves valley (through which passes the bigger part from the route).

The section of the route from Gradsko to the entrance in the gorge Raec it can be distinguished two significant morphological wholes:

- Lake plateau with wavy hill forms, and
- Island, isolated rocky masses with longitudinal spatial position, built and modeled in Paleozoic and Mesozoic creations along the west coast of the Tikves valley.

The lake plateau as a morphological whole is represented as morphology of a regional level into all Pliocene basins in the Povardarie and Southeast Macedonia. This geomorphologic and relief creation doesn't have any particular stamp or value which should be preserved.

The isolated rock masses appear within the Paleozoic and Mesozoic formation of the Vardar zone from Kumanovo to Demir Kapija so it can be evaluated that neither morphologic form possess uniqueness that should be protected.

Geology and hydrology of the project area

Geology

The geological development of the wider area had impact on the geological characteristics of the field along the route of the road and they are shown in continuance with their most important aspects. We put an emphasis on the following most important facts:

- The route is located within the Vardar zone which represents one of the geotectonic units from first-order;
- With the complex tectonic processes which contribute to the development of this zone for the considered section from the route, significant are the phases of the old Paleozoic and Alpine structural floor;
- With the contemporary geological processes in Quarter and Holocene, through the erosion processes and the activity of the river streamflows, it is formed the general geomorphologic condition of the field, which is characterized with forming alluvial and proluvial sediments, and on the slopes diluvial deposits.

Geomorphologic characteristics of the field

The field where the route passes almost along all its length is hilly lowland with natural inclination of the slopes. It is also cut with more gullies and ravines with significant dimensions, due to the geological construction of the field.

As a conclusion, it can be stated that the morphology of this region shows complex condition, which is caused by the presence of various lithological types of rocks, their age and the complex mutual impact on the tectonic, neotectonic and contemporary processes of decay (denudation).

Geological characteristics of the field along the route

Along the route of the road we can notice more lithogenetic units, which not only do they have different geological age, but also different properties and meaning for the performance of the construction. Along the route the following lithological units are presented:

- Alluvial sediments (al)
- Diluvial sediments (d)
- Proluvial sediments (pr)
- Conglomerates and breccias (KG, BR)
- Pliocene sediments (PI)
- Geological characteristics of the field along the route
- Serpentinities (Se)
- Quartz-sericite slates and quartzite (Sse)
- Marble (M)
- Amphibolites and amphibolite slates (A)

Hydrogeology

Having into consideration the geological characteristics of the investigated field, the represented rocky masses can be classified in the following way from aspect of their hydrogeologic function:

- Hydrogeologic collectors with intergranular porosity where are classified the fine-grained sandy-gravel layers of the Pliocene complex, which occupy very small part of the route of the road, as the alluvial sediments and proluvial creations;
- Relative hydrogeologic isolators with intergranular porosity where are classified the diluvial creations;
- Relative hydrogeologic isolators with fissural porosity where are classified conglomerates and breccias, the serpentines and the metamorphic rocks.

Hydrology

Surface waters

The route of the Expressway as a whole belongs to the catchment area of Crna River, which belongs to the Vardar basin. The basin of river Crna occupies an area of 5 890 km² and it is the right tributary of river Vardar. In its flow, the river Crna has 20 tributaries longer than 10 km with total length of 471 km.

On the analyze territory, the more important streamflows – tributaries of river Crna to which the route approaches or cuts them, are:

- Porojnica;
- Orese;
- River Krusevicka;
- River Sirkovksa
- River Raec.

In the narrower area of the route the only permanent streamflow is the river Raec. The Expressway cuts the previously mentioned river on several places and it mostly goes parallelly with it.

The river Raec is the left tributary of river Crna. It springs from the northeast slopes of the mountain Dren on altitude of 1.550m. The same comes from two rivers: Svinjarnica and river Ceresevik. Until the gorge Fariska flows in northeast direction, and then turns towards southeast and near village Sivec it flows in river Crna on a level of 154 m. It drains relatively large catchment area of 304 km² and has relative drop of 42.3%.

Undergroundwater

The abundance, like the water-resource balance component depends from the oscillations form the level of the groundwater and the possibility of their renewal. Because of that, it is also used the term groundwater dynamic reserves.

As a result of the isolative rocky masses and the absence of the significant water reservoirs, the abundance of the four springs (aquifers) represented in the region which characterize with abundance bigger than 100 l/s, (spring of river Crna - 1.0 m³/s) in the lower basin of the eponymous river through which variants of the route pass, the abundance of the springs is significantly decreased.

Water quality

The water quality, as well as the auto-purification capacity and the degree of the naturalness of the streamflow, has an impact on the creation of the habitat of the plants and the animal species. The retention capacity of the rivers is determined by the morphological condition of the streamflows as well as the actual purpose and usage of the land in the fluvial plain.

In the Study, the physical-chemical characteristics of the river Crna of the profiles Skocivir and Palikura are tabularly shown, which stretch along and which cuts the route of the road.

From the abovementioned profiles, the striking is the high concentration of BOD₅, which for the years of 2001-2004 bring the water quality of the given profiles to class IV.

There are also shown diagrams with global indicators of concentrations of nutrients and oxygen indicators in river Crna, with what it can be concluded that generally speaking, the water quality corresponds to class V.

Climate and meteorology

The region Tikves and Povardarie are under the impact of the Mediterranean climate which penetrates from south through gorge Demir Kapija and of the continental climate which penetrates from north through the Veles valley. The crush of two different climate impacts creates modified Mediterranean climate.

Waste Management

In this part of the Study, it is presented the problem of the waste management on a republic level, it is defined the hard communal waste and tabularly is presented the number and the area of the active landfills in 2010 around the regions in R. Macedonia. No data is available for the municipal and messy dumps along the route of the road. For the treatment with the waste which will generate during the performance of the Expressway, it will be established a system for its segregation: the construction waste will be separated with an inert character and the same will be removed to locations determined by the municipalities Grasko and Rosoman, which are responsible for handling this kind of waste. In cases when it is created constructional waste with dangerous character, the same will be given to the company which is licensed for treatment of this kind of waste.

Ambient air quality

Because of the lack of information, i.e. data which can be directly used for assessment of the quality of the ambient air in this rural area, informatively, it is presented data form the station of the automatic national monitoring network for air quality in the nearest places where it exists, i.e. in Kavadarci. Along the section of the Expressway A1, from the bridge of the river Raec, interchange “Drenovo” to Grasko (junction with highway A1), there isn’t any other measuring stations. Taking into consideration that close to the route of the Expressway there aren’t any industrial pollutions, it is estimated that the concentration of the waste materials is within the limits.

Noise

In lack of developed state monitoring network, for the wider area of the considered location there isn’t any data from measuring the level of noise in the environment. Consequently, there isn’t any planning documents for managing noise, i.e. strategic card and action plan of the field of the route.

Biological diversity

The Study on environmental impact assessment from the construction of the Expressway A1, to the bridge of the river Raec interchange Drenovo”, to Grasko (junction with highway A1) corresponds to a corridor with width of 40 m (200 m of each side of the route). The determined width is enough to include all the impacts during the construction and the usage of the road.

During the evaluation of the biological diversity of the existing ecosystems, the different habitats along the planned route, as well as identification of the significant areas in relation to the biological diversity, we can identify two main categories of habitats:

- Natural (oak communities, riparian habitats (with willows and reeds), open areas (hilly pastures), rocky areas (calcareous rocky slopes with chasmophytic vegetation), wetlands (rivers, streams and intermittent streams) and caves;
- Anthropogenic habitats (gardens, orchards, settlements etc.).

The division of these categories is made based on several criteria like: presence of different plant communities, distribution, level of degradation and geomorphologic characteristics. As main criterion is used classification of habitats by EUNIS¹. Dominant habitat is the oak-hornbeam forest.

The wetlands are presented with the tributaries of river Vardar and Crna, from which the biggest is river Raec, as well as streams and intermittent streams which run dry during the summer.

From the anthropogenic habitats, the represented are:

- Orchards (Represented along the entire route of the road corridor (see map of habitats). A larger area where they are represented is in the surroundings of the village Rosoman.);
- Vineyards (Common and typical for most road corridor. Regarding biodiversity, the vineyards are more important than fields; Fields and farmlands (plantations with monocultures have less importance for biodiversity than individual fields. Besides different varieties of corn, also present are tobacco, watermelon, lucerne, peppers, cabbage, etc.) and
- Inhabited and urban areas - Rural inhabited areas (villages) and facilities (quarry, limekilns, institutional and commercial facilities) (Urban areas have little importance for biodiversity. Species that inhabit urban habitats are generally cosmopolitan.)

Area

In the wider area of the road corridor the oak-hornbeam forests and the agricultural land are dominating, which extend over the hilly-forest region type with ravine part.

Besides the inhabited areas, there are also other people's constructions (quarries, limekilns, other commercial facilities, gas stations, etc).

Demographic data

Rosoman is one of the smaller rural municipalities and it is situated in the middle part of Republic of Macedonia and it occupies area of 132,9 km². The total number of inhabitants in the municipality is 4.141, with average population density of 31 inhab./km².

Gradsko is situated in the central lowland part of Republic of Macedonia. The total number of inhabitants in municipality Gradsko is estimated 3.760 with average population density of 15,91 inhab./km².

Cultural heritage

¹ <http://eunis.eea.europa.eu/habitats.jsp>

Along the determined variant solution for construction of Expressway by the Expert Elaboration, the following immovable cultural properties are registered:

- Church Sveta Bogorodica, Drenovo, XIV century;
- Bakerova Cesma, necropolis from Late Antiquity period, situated in the locality Vrano Brdo 800 m from the village Drenovo
- Gramage, settlement from Roman period 1 km south from the village Kamen Dol
- Tumbite, settlement from Neolith period, in the Cadastral Municipality Raec
- Other localities in the wider surroundings in the route.

The route of the Expressway doesn't put in danger neither of the mentioned cultural-historic properties. However, the route of the expressway approaches the monument from World War I near the loop Drenovo. It is considered that this monument is not endangered because of the distance of the expressway of the registered monument.

Considered alternatives

Zero alternatives

As a result of not building the provided expressway, the below described consequences are foreseen:

- Unchanged condition of the infrastructure in the region;
- There won't be any easy transport of people, goods and services along the designed corridor;
- The construction sector won't be activated during the construction of the road, for period of 2 years as the project runs.

On the other hand, in case this project doesn't realize, the biological variety will remain unchanged, it won't be done conversion of the quality agricultural land, and it won't exist necessity to redirect Raec in order to perform the facilities within the expressway as the bridges and the viaducts.

Alternative routes

For the needs of the design of the expressway, it is done computer simulation of the two routes (so-called "west" and "east" variant), considering the factors as a topography of the field, the profitability of the construction vis a vis number of the bridges, notches and embankments necessary for the performance of the route etc. The total length of the east variant of the route is 13+000 km and of the west is 15+600 km to the point from which both the variants are led together until to end of the route 25+700 km.

Based on the several ecological criteria, as the number of crossing over the streamflows, the length of the route with which the same will move through the agricultural land, the approximating to the settlements, the west variant is the adopted one.

Assessment of the impact on the environment of the Project

The analysis on the possible impacts on the construction of the Expressway is done during the phase of construction and the phase of its work, i.e. operational phase on the media and the regions of the environment.

Impact on the topography and the geology

During the construction it is expected small negative impact on the performance of the preparation works on the location, while during the excavation, it is expected bigger negative impact on the geology of the field.

During the performance of the excavation, there is danger of appearance of sheds and landslips in every place where the geological characteristics contribute to happening of these kinds of appearances. The potential of appearance or deepening the erosion processes as a result of the construction and exploitation of the expressway can be seen from the analysis of the geomechanical characteristics.

The designer has done an elaboration on geomechanics in which thoroughly analyzes the geological environments through which the route passes, it interprets the contemporary geological processes which can reflect on the stability of the construction, and also determines the slopes of the embankment and the notches of all the chainage, i.e. the different heights of the embankments and notches.

In the operational there aren't any significant impacts on topography and geology of the field expected.

Impact on surface water and groundwater

During the preparation of the field for new access roads and establishment of constructional zones around the route of the expressway, there can be pollution of the surface waters and groundwater of temporary character in shape of erosion and disposal of sediments and surrounding streamflows. The erosion appears mostly because of the removal of the soil cover. The pollution of the streamflows can occur as a result of leakage of the fuel and oil from the equipment and the vehicles, as well as different waste which is created during these activities.

Besides the abovementioned impacts, the access roads can also cause change in the way and mode of drainage of the atmospheric waters because of the change of the permeability of the surface because of the removal of vegetation.

In the operational phase the Expressway will have an impact on the quality of the surface waters and groundwater in raining conditions where the washing out waters from the road surfaces will be drained in the surrounding field.

Typical impacts on the quality of the waters as a consequence of the road drainage are the changed levels of heavy metals, salinity, blurring of the waters and dissolved oxygen. On the other hand, these changes in the water quality, even in regions with high humidity, are often temporary and localized as a consequence of the variations of the water quantity.

Impact on the air

The emissions in the air during the construction will appear as a result of the exhaust gases from the constructional mechanization. Within these emissions will appear pollutants as SO_x, NO_x, CO, VOC etc. Generally, it is expected low concentrations of these pollutants, for which it is expected fast dispersion of the open regions in which the project is performed, and it is also potentially expected jeopardizing small number of people, because of the small number of settlements to which the route is approaching.

Dust will appear as a result of the soil works and the activity of the preparation of the field and clearance, excavation, mining in rock etc.

It is expected that the effects from these impacts to be of local and short-term importance.

In the operational phase, emissions will appear from vehicles which will run along the expressway, i.e. from:

- System of exhale gases;
- The casings of the monitors through the exhaust pipe
- Carburetor, reservoir

On this level of planning it can be assumed that the frequency of the traffic along the expressway will be with limited volume (around 3.000 average annual day traffic). In case of increased frequencies of traffic, (increasing which can mostly by with seasonal character), it is possible to appear necessity of application of appropriate biological measures for protection of air pollution. In the same time, it is possible the measures to be combined with the administrative prohibitions, due to the establishment of the controlled mode of traffic.

Impact on habitats and ecosystems

As more sensitive habitats are considered the fragments for oak-hornbeam forests, rocky parts with chasmophytic vegetation, riparian zones with poplars and willows, aquatic habitats (streams and intermittent streams), while the rest of the habitats as the degraded oak-hornbeam forests and the deserted farmlands with ruderal vegetation are assessed as low sensitive.

The impacts on the habitats during the construction of the road will be mainly manifested through their destruction and fragmentation. The remains from the former natural habitats whose areas are greatly lowered are not enough to maintain solid populations of many species.

In the phase of usage of the road, the most serious problem is the soil, water and air pollution. However, the impacts in this phase are greatly smaller in comparison with the same in the construction phase, but are manifested in longer time period.

Impact on protected areas

The road corridor (more precisely the movement of the route between the chainage 4+000 and 7+000) passes through the gorge Drenovska which is protected area in the category Monument of the nature and has a scientific-research and botanical meaning. The gorge Drenovska is protected according to the Law on Natural Rarities in 1991.

Small part of the route penetrates in Emerald Raec area. For these reasons, the valley of the river Raec, and especially the gorge Drenovska represents a significant area and it can be expected evident negative impact during the penetrating the road and using of the access roads in relation to the fragmenting of the habitats and destroying of the populations of some plant species.

Because of that, it is necessary to undertake certain measures in this part of the route with a goal to minimize the negative impact to habitats and species.

In the operational phase, significant impacts on the protected areas are not expected.

Impact on the soil

The activities of construction and setting on the expressway directly will damage the soil quality and it will reflect on the change of the specific geological characteristics. The soil works, that will potentially have an impact on the soil characteristics and, accordingly, to the soil quality, are:

- Removal of the surface layer of the soil (humus)
- Smoothing of the surface
- Compaction to the necessary density
- Performance of quarries and dumps for removal of the remained excavated soil material

The impact in the construction phase on the soil pollution is assessed as negative with insignificant size and of temporary character.

For the operational phase characteristic are impacts connected with the soil quality damage as a result of the emissions of the pollutant from the traffic.

Along the route of the expressway there is an agricultural land. Certain zone beside the route of the expressway will be endangered due to the pollution which will occur because of the traffic.

Impacts caused by waste management

The primary forms of hard waste which will be generated during construction phase will be:

- Excess excavated soil and sand
- Packing waste
- Debris and construction waste
- Waste tires (of constructional mechanisation)
- Waste oils and greases (from construction mechanisation)
- Communal waste of working site camps (construction sites).

For managing excess excavated material, it will be made appropriate disposal sites. Their location is chosen according to the geo-mechanical elaboration and confirmed with this Study, considering that the criteria like avoiding catchment areas of rivers, avoiding areas with sensitive habitats, i.e. valuable areas, are respected. For managing construction waste, it will be done segregation of the inert material and the same will be removed on location determined by the local authorities. In case of creating waste with dangerous character, the same will be given to the licensed company.

It is not expected creating waste during the exploitation due to the fact that resting site or any other construction in the area of the road is not planned.

Impacts caused by increased noise and vibration

The construction of the expressway is connected with a series of activities which cause vibration, like using construction mechanisation and eventual rock mining during performing of the vertical alignment for the parts of the route which lead to excavation. The impacts from the vibration are expected to be insignificant, and to have an impact mainly on a local level.

Along the expressway it is not expected excessive noise because of the relatively low frequencies of traffic. However, the expressway is approaching the settlement Kamen Dol. This location is potentially endangered due to harmful noise.

Impact on the area and visual effects

The area, in the range of the construction zones, established along the expressway will be clearly changed during the construction. The number of construction zones, their size and locations of the same will be determined in the technical documentation for construction.

Generally, because of its nature, the construction of the expressway is positioned in the exposed location, which in construction phase is visually noticeable to maximum 5 km distance, main receptors of the new look of the area in phase of setting the construction will be the local population and the passengers which pass through the local roads.

In phase of usage, it is expected the visual effect of the expressway to be insignificant.

Impact on archaeological and cultural-historic heritage

Other than the planned route in the range of the location which is chosen for construction of the expressway, precisely on the locations where it will be set the expressway, there are no archaeological areas and localities with cultural heritage which would be a limiting factor in the process of planning and designing the expressway.

During the operational phase it is not expected impacts on cultural-historic natural heritage.

Impact on social elements of environment

The following positing effects on the population are expected in this project:

- Possibility for employing qualified and unqualified workers
- Purchase (expropriation) of the land in a private ownership

Taking into consideration in most, the route of the expressway passes outside a settlement, the construction activities of the same locations of the construction won't have direct impacts on the human health.

The construction phase will require temporal or permanent expropriation of the farmland and the urbanizing land in private property (residential areas in the suburb of the settlements, weekend houses etc.).

The expressway can seem a significant barrier for the local settlement due to the fact that it cuts the existing local roads which potentially have value from aspect of traditional communication and/or access to the agricultural farmland.

Measures to reduce the negative impact on the environment

Measures to reduce the impact on topography and geology

The following measures will be applied to prevent erosion of big volume during remediation of the landfills:

- Careful planning of the construction works with a goal to decrease the negative effects and to provide preventing erosion.
- Decreasing the size of the location, because of the minimizing the land which is under a negative influence, and stopping the erosion and polluting the soil
- Restriction of the movement of the vehicles and usage of mechanisation which put a smaller pressure of the area

- Precise performance of the construction works, avoiding leakage of vehicles. The vehicles should be constantly maintained to prevent leakage.
- Appropriate clearance of the material which is spilled on the spot.
- Minimizing the loss of vegetation along the construction site
- Construction works cannot run in heavy rains,
- Decreasing of the speed and volume of the polluted area drain.
- Implementing preventing measures for landslides, stabilizing the incline if necessary

Measures to reduce the impact on surface water and groundwater

The measures for protection of the surface waters and groundwater are reduced to consistent application of good construction practice during the construction works connected with the expressway, i.e. preventing erosion, managing sediments, maintaining construction mechanization out of the areas sensitive on releasing the waste waters etc.

Protection on surface and ground waters quality, in operational phase will be reached with application of appropriate system of drainage of the washing out waters from the pavement area.

Measures to reduce the impact on air

For mitigation the impacts on environment in the construction phase, it is suggested performing a strict control on the constructional methods and the used mechanization and other equipment.

As an eventual measure during the operational phase it is suggested planting a green belt in the sideways of the road which will prevent wider dispersion on air pollution caused by the traffic along the route of the road.

Measures to reduce the impact on flora and fauna

In construction phase, it will be accessed very carefully to the planning of the construction works mode in order to keep to a minimum the impact on habitats, flora and fauna. It is suggested performance on passages for wildlife, revegetation on sensitive areas and avoiding areas inhabited with sensitive flora and fauna.

The necessity for further measures during the operational phase should be determined with implementing the monitoring plan.

Measures to reduce the impact on the soil

For reducing the impacts on the soil, there will be taking measures for preventing leakage of polluting materials and oils from constructional mechanization in the surrounding soil, the eroded areas will be rehabilitated and safely stored and the construction materials and construction waste will be removed.

In operational phase, the measures to reduce the impacts are identical with the measures for mitigation of erosion.

Measures to reduce the impact caused by waste management

Because of protection of the environment (soil, waters and region), it is predicted application of statutory regulation orders relating to the waste management. Additionally, it is suggested preparation of plans for waste management of the construction locations in order to enable recycling of recyclable materials, and also to separate the dangerous fractions for the purpose

of their appropriate collecting, storing and giving to licensed companies which deal with this kind of waste.

In order to avoid pollution of the environment with constructional waste and solid waste during the exploitation of the expressway, it will implement a ban for disposal of the same along the route in the road.

Measures to reduce the impact caused by noise and vibration

The measures for mitigation of the impacts caused by noise and vibrations in construction phase include: Careful planning on preparation works in order to decrease the noise, avoiding equipment which will emit noise more than 90 dB, control on constructional methods and usage of mechanization and regular maintenance of the equipment because of the possible decrease of the noise, careful planning on time of the works in the settlements (ex: ban on construction in certain period during the day or night, as well as seasonal bans during the mating of certain animal species and/or birds), avoiding loud sound signals in the settlements/decrease of the disturbing the peace of the citizens, limiting the speed of the constructional vehicles, especially in the towns etc.

The route of the expressway approaches to the settlement Kamen Dol to distance around 30 m and enters in the same. On this location, it will be needed a sound-protection barrier, which will be very important to prevent propagation of the noise in the location of the road which passes near/through the above-mentioned village.

Planting vegetation which is tall and dense enough can also decrease the noise. However, to reach a reduction of around 10 dB, the width of the protection belt should be at least 60 m, which is not always possible to reach.

For choice of sound-protection barrier it is necessary to determine the height, as well as the material from which the same will be performed. Apart from the necessity to prevent propagation of the noise, it is necessary for the barrier to fit in the surrounding region. The assessment of indicators of noise cause by road traffic will be made according to Appendix 1 from the Rules for application on indicators for noise, additional indicators for noise, way of measuring the noise and methods for assessment with indicators for noise in the environment (OJ of RM no. 107/08).

Measures to reduce the social impact

Among the measures for reduction of the social impact in the construction phase are the measures for protection of the workers from workplace injuries, measures for compensation of the citizens whose property is expropriated and measures for compensation of the citizens whose property is with reduced value because of the pollution of the surrounding land.

In the working phase of the expressway, it is expected positive impacts on the population and the human health, especially regarding the improving the communication, the transport of people and goods, so due to that reason, there aren't any measures predicted in this phase.

Measures to reduce the impact on the area and visual effect

The measures for mitigation of the impact on the environment, beside the recommendations for mitigation, reducing the size of the construction site, application of good practises for designing and construction, careful maintenance and appropriate maintenance of the order

and cleanness of the construction site, also include fast disposal of the constructional waste of the approved places, filling the holes/quarries made during excavation of sand by the excavated material, repairing the footpaths and roads right after finishing the works with the performance of the expressway and revegetation of the inclines, careful closing of the construction sites/places for waste disposal/cleaning of the construction site after finishing with the construction works/revegetation of the region and completing the construction activities with removal of all obstacles.

In the phase of using the expressway, it is not expected negative impacts so measures aren't necessary.

Measures to reduce the impact on archaeological and cultural-historic heritage

Taking into consideration that the route passes near the monument from World War I, the Contractor will have to make sure that the appropriate technical-protective measures determined by the Department for the Protection of Cultural Heritage are applied entirely.

Conclusion

According to the impacts, i.e. the reasons which contribute the Project to have negative impacts on the environment, in the Study are suggested measures for their reducing and neutralizing. They will be included in the project and the tender file, with the purpose to protect, reduce and mitigate the negative impact on the environment and the health of the people. The requests for monitoring are in accordance with the legal regulation and the data from the measurement will be used for verification of the achievements in relation to the proposed measures.

Having the completed analysis and observation in mind, while using the findings from the appropriate legal regulation, as well as the scientific and technical findings for the methods for assessment of the impacts in the project on the environment, *general conclusion* is that this project will not make a significant disturbance of the environment quality, with its construction and installing the predicted equipment, as well as with the entire implementing the measures for reduction (mitigation) of the impacts on the environment.

1.0. DESCRIPTION AND CHARACTERISTICS OF THE PROJECT

1.1. Description of the location of the route

The considered section of the Expressway A1 from the bridge of the river Raec, interchange “Drenovo” to Gradsko (junction with highway A1) starts from the left side of the main road Prilep – Gradsko, right after the leg which separates towards Kavadarci opposite the gas station Makpetrol. This part of the route passes through hilly region in the range of the gorge Fariska. It continues to move near the existing road from Prilep to Gradsko, then takes direction towards the village Debriste, passes through temporary flow of the river Porojnica and then gradually rises towards the village Kamen Dol. On this location, the route rounds the village through a bridge and moves towards the village Sirkovo. The field between these two villages is hilly, requiring the route to pass through several notches and culverts. Then, the route passes through mainly flat terrain in the surroundings of the village Sirkovo; in the following course, the route rises, and then gradually descends towards the temporary streamflow of the river Krusevica. Then the route moves to a distance of around 700 m from the entrance of the village Krusevica, from where gradually rises passing through flat terrain to the settlement called Gologlavica, before the village Dolno Cicevo. Then through the settlements Sokolovec and Celavica, the route passes the canal near Porojnica moving through the hills Golema Glava and through the local asphalt road Gdrasko – D. Cicevo ends in the foot of the Vardar Hill.

The spot height of the beginning of the route is around 203 m above sea level, with the vertical alignment of the road gradually increases to spot height of around 298m asl (chainage of km 20+860), which is a saddle also. From here, to the end of the route the vertical alignment descends to level 180 m above sea level which is the lowest point of the investigated section.

In the further description the movement of the route is described in more details.

The section starts in the existing route P-106 on 3 km distance south from the village Faris, i.e. 3 km west from the village Raec. On chainage 0+500,00 the route cuts the river Raec moving through forest area. On chainage 0+510,00 to 0+540,00 the route cuts three unpaved roads. On chainage 0+720,00 the route cuts the existing asphalt road Prilep – Rosoman; on 20 km distance from the section with the existing road, the route cuts the river Raec. In the next 500 m the route moves from the left side of the existing old road lead parallelly with the river Raec. Then on chainage 1+100,00 the route bridges the existing road and the river. After the bridging, the route moves from the right side of the existing road and the river. On chainage 1+215,00 i.e. 1+230,00 the route again crosses with the existing road and the river.

In the next part of the route, it moves in the lower parts of the valley of the river Raec. On 230 km distance after the last cut with the existing road and the river, the route passes through hilly land without forest cover. On chainage 1+460,00 the expressway again cuts the river Raec and the old asphalt road and continues in notch through hilly region covered with low height forest and on chainage 2+200,00 again bridges the river Raec.

Then, the route approaches to the plot of the river Raec from the north-west side; on chainage 2+600,00 the new-designed road cuts the asphalt road Prilep – Rosoman and one unpaved road and starts to move through farmland areas through which appears small percent of fallow

land. On chainage 3+860,00 the route bridges one dry valley (a terrain through which is led as viaduct) and it continues to move across relatively flat terrain on which appear farmland areas. Here the route cuts a number of rural, unpaved roads.

On chainage 5+130,00 the road pass through terrain with built houses and other ancillary facilities on private ownership. In the further course, the route leaves behind the area with farmland and it moves between two hills, parallelly with the asphalt road Prilep – Rosoman. In this region the route passes through a lot on which there are pools for lime (5+440,00) and on chainage 5+560,00 i.e. 5+580,00 cuts unpaved road and bridges the river Raec. After the bridging of the river, the Expressway shortly moves from the right side of the river and maximally approaches to the road Prilep – Rosoman from its left side. In this part, the route approaches to three facilities on average 30 km distance; on chainage 5+920,00 the route bridges the river Raec again and one unpaved road. The route moves through hilly region without forest covers in around 300 m length and on chainage 6+200,00 bridges the river Raec and the unpaved road.

In continuance, the new-designated section moves parallelly with the existing road P-106 and the river Raec crossing through hilly region without forest cover, and on chainage 6+700,00 cuts unpaved road, and on chainage 7+000,00 i.e. 7+200,00 bridges the river Raec again. On chainage 6+760,00 the route passes through a lot on which are three facilities and a retaining wall, where enters in a farmland of around 250 m length.

After the bridging and the cut with unpaved road on chainage 7+300,00 the section moves from the left side of the existing road Prilep – Gradsko i.e. northwest from the farmland area of the village Drenovo. In this part of the field, the land is mainly uncultivated.

On chainage 7+540,00, i.e. 7+870,00 the section cuts unpaved roads, while on chainage 7+980,00 and 8+120,00 it passes through dry valleys. In this part, from chainage 8+000,00 to 8+120,00 more precisely, the road moves across cultural-historic monument “Bulgarian monument from World War I” which is a witness for an historic event when 19 soldier died.

On chainage 8+420,00 the route cuts an unpaved road and then continues through farmland areas planted with vineyards. On chainage 9+000,00 the loop “Drenovo” is designated for connecting the road for town Kavadarci. Under the part from the trunk of the loop, the road will occupy vineyards, which currently are on a wider stretch around the planned loop. Except the plantation, there are commercial facilities from both the sides of the road, as well as a gas station. From the right part of the loop, there is a monument of 83 died Bulgarian soldiers from World War I on around 150 m distance. On chainage 9+160,00 the route of the Expressway cut tamponed road which leads to an existing quarry on around 650 m distance northwest from the loop. In this part, the route also cut an irrigation canal on chainage 9+300,00.

On chainage 9+450,00 and 9+750,00 the terrain is hilly and bare. Further the route passes through farmland area, planted mainly with vineyards. On chainage 10+200,00 the route cuts an asphalt road which leads towards the village Debriste. Then the route cuts unpaved roads on chainage 10+370,00, 11+088,00 and 11+100,00. On chainage 11+120,00 the route cuts a streamflow.

To chainage 11+380,00, the route passes through farmland areas, cuts an unpaved road, and on 11+620,00 passes through a fallow land. From the cut with the unpaved road, the route

again enters in farmland areas and on chainage 12+200,00 i.e. 12+480,00 passes through dry valley.

In continuance, the route approaches to the village Kamen Dol from its south side and passing easterly from the village passes through a quarry and cuts off a few houses from the east side of the village on chainage 13+350,00. On this stretch, the route (on chainage 13+370,00) cuts the dry valley and two asphalt roads – the first connects the village Kamen Dol with Rosoman and the second passes through fallow lands and bare hilly land and it cuts with the asphalt road which leads to the village Kamen Dol on chainage 13+710,00, dry valleys on 13+770,00, 14+200,00 and 14+600,00 as well as an unpaved road on 14+570,00. In the following stretch the road also cut one more dry valley on chainage 14+670,00 and an unpaved road in point 14+700,00.

Passing through farmland areas, the section approaches to the village Sirkovo and rounds it from its west side, by that cutting several dry valleys on chainage 14+930,00, 15+360,00, 15+570,00 and 16+090,00 as well as two unpaved roads on chainage 14+910,00 and 15+940,00. The route then cuts an irrigation canal on chainage 16+070,00 and streamflow on chainage 16+090,00. The first houses from the village Sirkovo are on around 50 m distance from the section.

North from Sirkovo, the Expressway runs over a farmland, on which as well can be found some fallow lands. On chainage 16+940,00 the section cuts an unpaved road and dry valley in point 16+950,00. On chainage 17+080,00 and 17+200,00 the route passes over the same dry valley three times and continues to run over farmlands cutting one unpaved road on chainage 18+040,00, the dry valley on 18+520,00, two unpaved roads on 18+780,00 i.e. 18+860,00, a dry valley on 19+080,00 and an unpaved road on 19+250,00.

On chainage 19+100,00 on the Expressway, a loop “Rosoman” is placed which connects the Expressway with the settlement Rosoman, to which attaches the road from the village Krusevica to Rosoman on chainage 19+410,00. The route in this part passes 600 m easterly from the village Krusevica.

On chainage 20+000,00 to chainage 25+500,00 near the loop “Gradsko”, which is also the end of the new-designated Expressway A1, the same runs through bigger lots of farmland in state or private property. Along the way, the route cuts several unpaved roads on chainage: 20+350,00, 20+410,00, 20+540,00, 20+860,00, 21+550,00, 21+550,00, 22+030,00, 22+810,00, 23+470,00, 23+610,00, 23+980,00, 24+050,00 and asphalt road on chainage 24+860,00 i.e. 24+660,00. The route of the Expressway is cut and with electric transition line on chainage 23+450,00 and 23+780,00. Along the way the route passes through a pig farm on chainage 23+500,00 from the road and the same is on 750 m distance. The route also cuts an irrigating canal on chainage 23+600,00 and hydrant network on chainage 25+100,00.

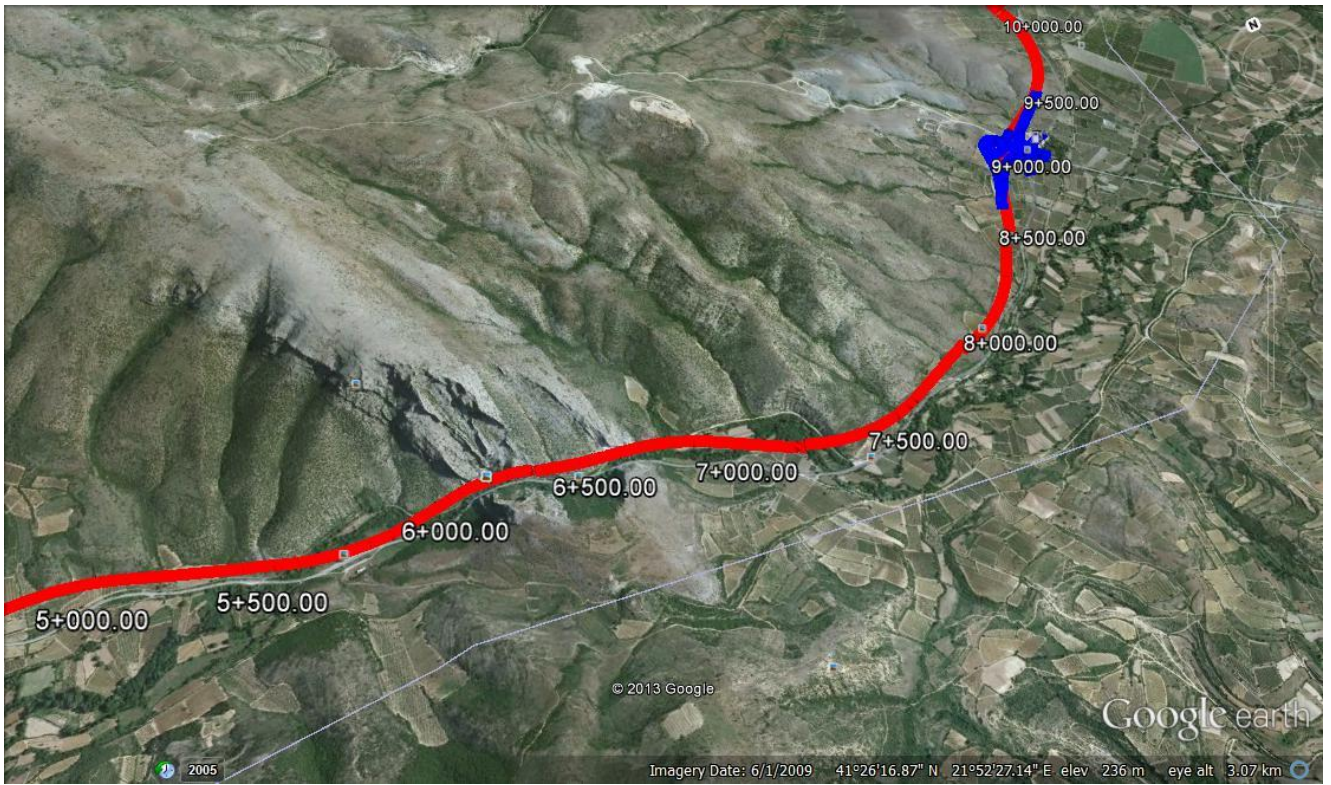
The total length of the planned expressway is 25,700 km.

The new-designated loop near Gradsko, which is set in the existing road A1, is on a farmland area and there are some commercial facilities, a gas station and housing settlement nearby.

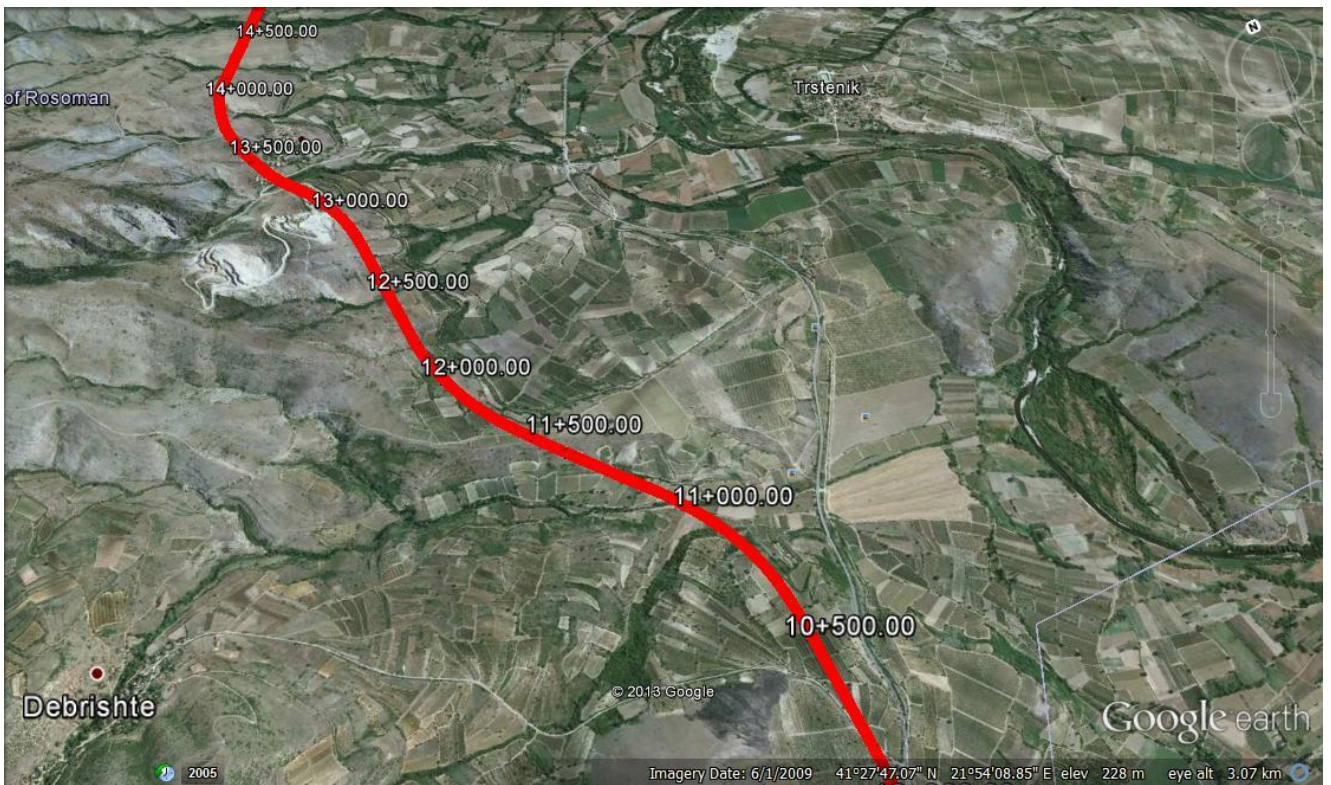
On the following maps it is presented the route of the Expressway A1 from the bridge of the river Raec, interchange “Drenovo” to Gradsko (junction with highway A1).



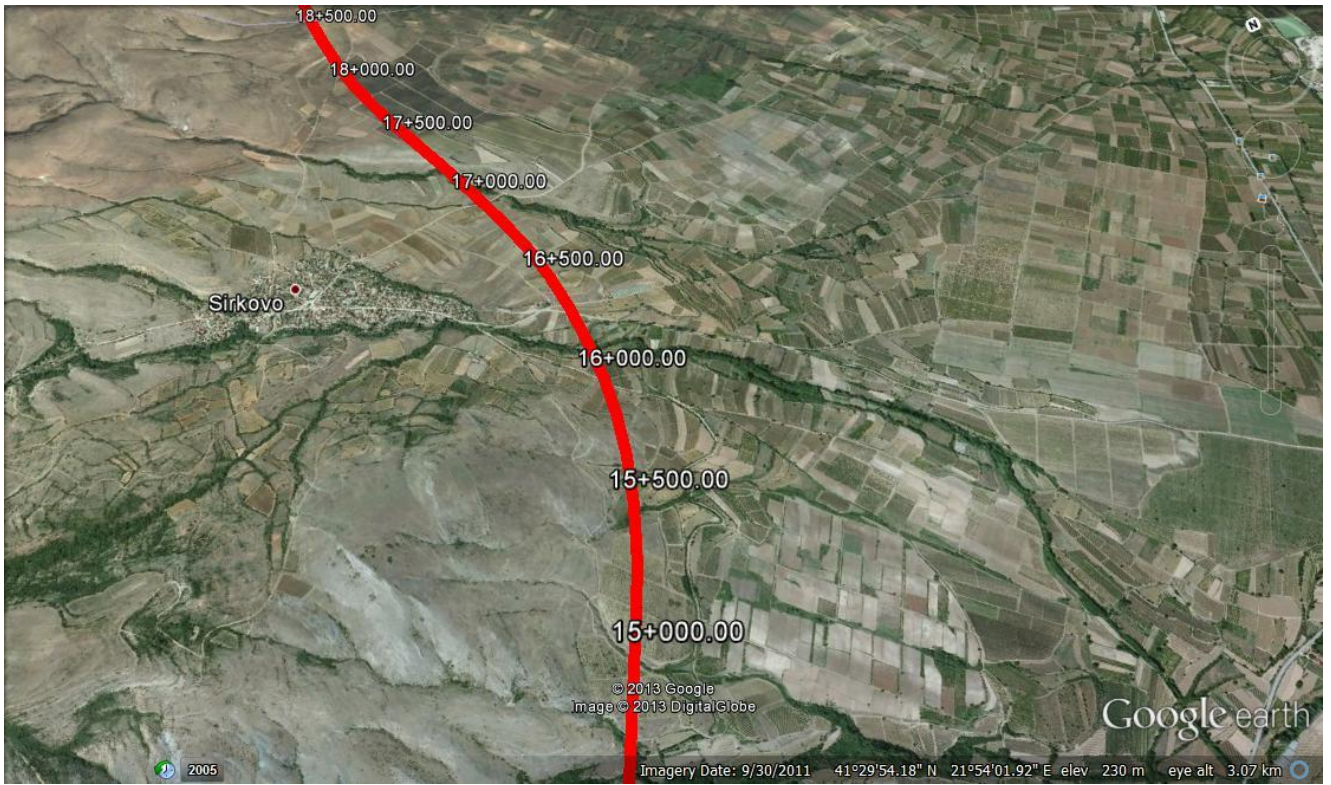
Picture 1 Section from CHAINAGE 0+000 to 5+000 km



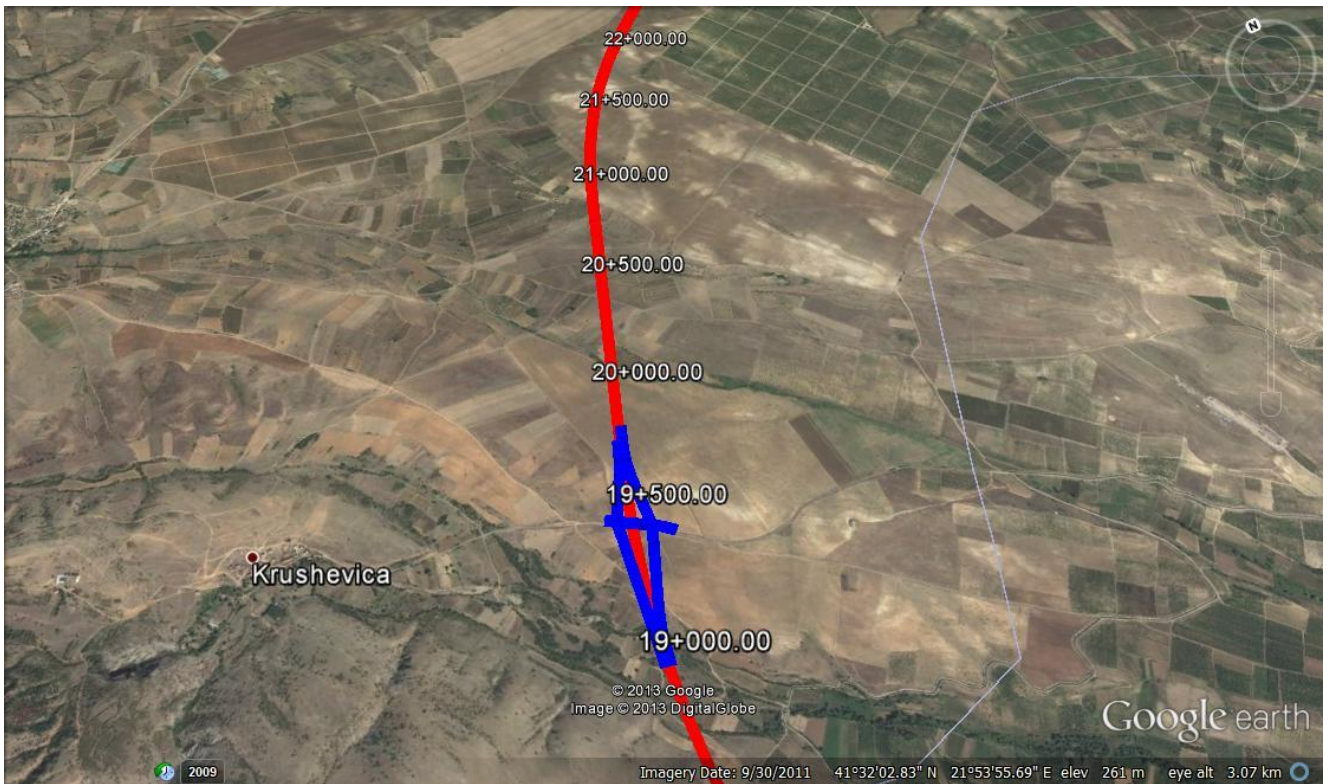
Picture 2 Section from CHAINAGE 5+000 to 10+000 km



Picture 3 Section from CHAINAGE 10+500 to 14+500 km



Picture 4 Section from CHAINAGE 15+500 to 18+500 km



Picture 5 Section from CHAINAGE 19+000 to 22+000 km



Picture 6 Section from CHAINAGE 22+500 to 25+500 km

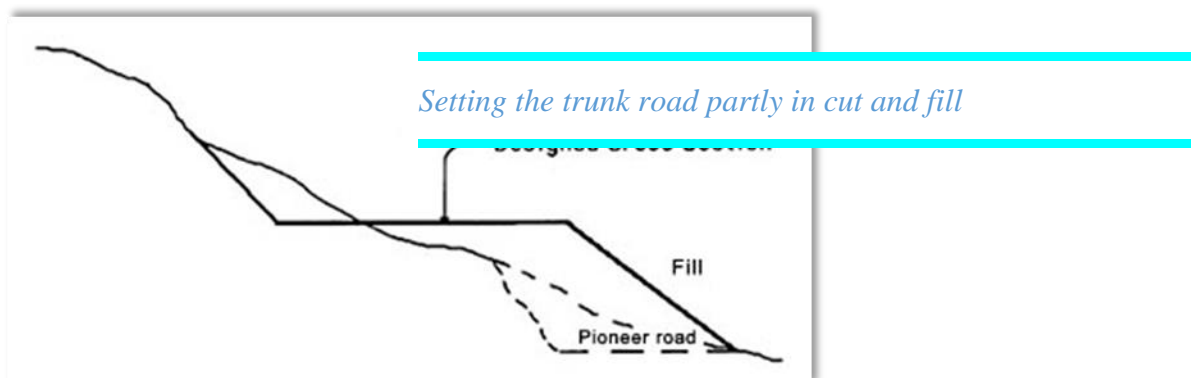
1.4. Characteristics of the project

With the performance of the Expressway it will be enabled:

- Access to locations on which construction works take place;
- Base with appropriate load capacity on which all layers from the trunk road can be performed with the necessary density;
- Final layer of asphalt which can endure the future traffic burdens;

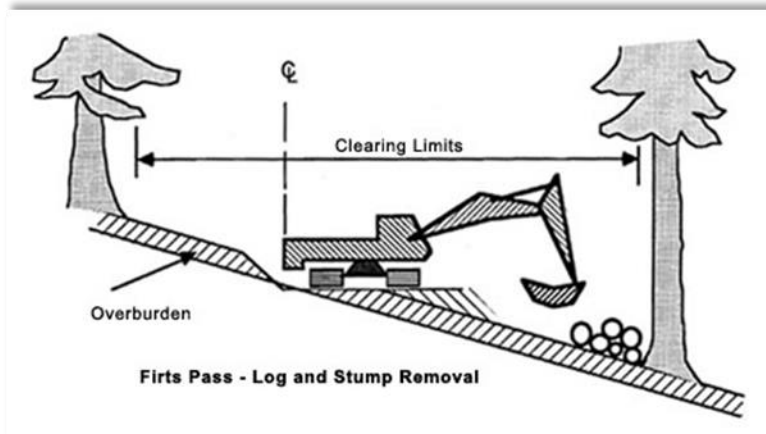
The construction of the expressway will include the next processes:

- Staking out the corridor of the route. This procedure is very important for setting the vertical alignment and avoiding additional soil works in sense of pouring soil material for stabilization of the inclines i.e. the embankments with which the trunk road is formed;



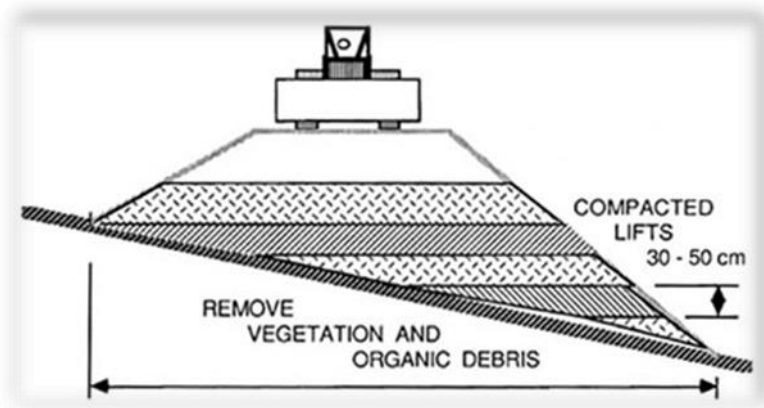
Picture 7 Cross section through the expressway

- Clearing the terrain for performance of access roads and for forming the vertical alignment. That will comprise removal of vegetation (including cutting trees), as well as careful removal of the surface layer of humus material.



Picture 8 Clearing vegetation for construction of the road

- Compaction of the terrain to the necessary density. Under stabilization of the base it means any treatment (including compaction) of the base in order to strengthen its durability and to increase its waterproof; if the treated base can endure all pressures cause by traffic under all kinds of weather conditions, then it can be considered as stable. Methods with which can be done stabilization of the base of the expressway are: (1) mechanical and granular stabilization; (2) stabilization with cement; (3) limestone and limestone-pozzolanic stabilization; (4) bitumen stabilization. The mechanical stabilization will be done by one of the three methods for construction, using equipment for mixing on-site, mobile mixer or immobile mixer. Regardless of the method that is going to be used, the materials which will form the stabilized base will be added in appropriate proportions and will be thoroughly mixed to create homogenous material which can compact and shape by necessity. The thickness of the compact layer will mostly depend on the mixture and the equipment for compacting which the Contractor will make available on the location. For the granular mixtures to 200 mm compact thickness, it will be used vibration rollers, and for the thin layers of around 100 mm, it will be used pneumatic rollers. Without regard to the type of the equipment which will be used in the initial process of compacting, the surface of the last layer will be formed by sharp planer, and then finally it will be compacted by smooth rollers or rollers with pneumatic rubber (in order to achieve the smooth, compact and durable surface).



Picture 9 Performance of embankment in several layers brought to the required density

- Forming of the trunk road and asphaltting

The expressway will have the following technical characteristics:

- For $V_r=100$ km/h (80km/h)
- lanes 2×3.50 M = 7.00 M
- side lane between the driving lane and the lane for stopping the vehicle if necessary
- 2×0.20 M = 0.40 M
- Stopping lane 2×2.50 M = 5.00 M
- Lane profile 12.40 M
- shoulders 2×1.00 M
- gutter + berm $2 \times (0.75 + 1.00)$ M
- PLANUM 14.40 M (15.90 M)
- Side lanes 2×0.30 M
- Cross slope 7%

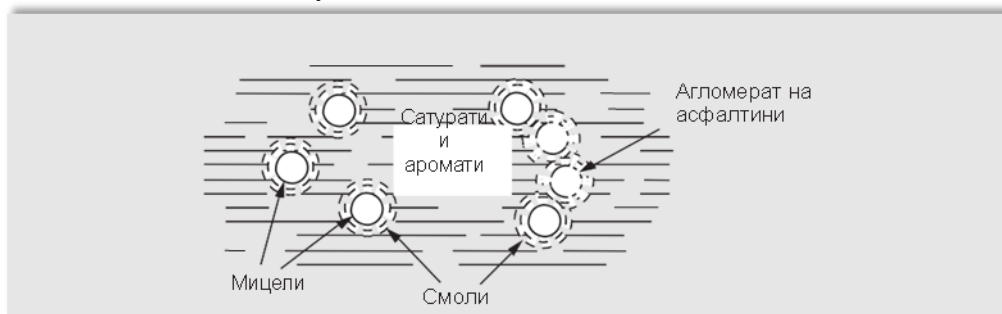
1.4.1. Technology of construction of the expressway

Due to the economy during the construction of the route of the road, it will be used local materials to a necessary degree. For this purpose, it is conducted geological and geomechanical analysis of the surrounding terrain, identifying the attributes of the soils and the aggregate which are certainly important for the stability and the resistance of the base. The used materials will be bitumen and tar, soil and rocky materials, aggregates of gravel and sand. If it proves as feasible and viable, during the construction will be used “waste” materials also instead of conventional aggregates.

The bitumen is a viscous liquid or semiliquid material, which mostly consist of hydrocarbons and their derivates, which are soluble in trichloroethylene. Even though natural bitumen exists, the variant that will be used during the construction of the expressway is by faction distillation of petroleum products.

The bitumen, which features with complex structure, is a colloidal system of asphalt micelles with high molecular weight, dispersed in a medium of malten with lower molecular weight. As it can be seen in the picture below, the micelles are asphaltenes with layer of aromatic resins with high molecular weight which act like stabilization dissolved layer. As we go further from the center of the micelles, it can be noticed gradual transition towards low aromatic resins, and they are dispersed through low aromatic oily malten medium.

The asphaltenes are brown to black, highly polarized amorphous solid materials which except carbon and hydrogen also include certain amount of nitrogen, sulfur and oxygen. The content of the asphaltenes has a big impact on the rheological characteristics of the bitumen – bigger share in asphaltenes increases the hardness of the bitumen, with higher softening point and high viscosity. The resins are dark brown semihard and hard materials. They are highly polarized, which makes them quite adhesive. The aromats are dark brown viscose liquids; they consist of 40-60% content of the bitumen. The saturates are nonpolar viscose oils with straw or white color; they consist of 5-20% of the bitumen.



For cement is considered every material which if is added in appropriate form of incoherent structure of particles, it will harden physically or chemically and it will bind the particles in coherent mass. This wide definition includes materials like bitumen, tar and limestone.

The lime is calcium oxide (CaO) and it is commonly produced by calcination (burning) of crushed limestone in vertical or rotary kilns. If the limestone is pure or almost pure calcium carbonate (CaCO₃), the production lime is called calcined or high calcined lime. When it comes to dolomite limestone with high amount of magnesium carbonate (MgCO₃), the production lime is called dolomitic or magnesium lime. The calcined and dolomitic limes are used in road bases which use burnt and slaked lime.

For the needs of the expressway, it will be combined more locally available rocky aggregates. The available rocky masses are combined in groups with mutual characteristics: aggregates of volcanic rock (ex: basalt, gabbro, granite and porphyrin rocks), and sediment rocks (ex: silicated rocks). In the following text² are given examples of location along the route where it can be used local materials for performance of the tampon layer of the expressway.

The sediment rocks are represented in the valley of the river Raec as well as in the region of the farmland area. They were formed with the products of disintegration and/or breaking apart of the older rocks which are transported by wind or water, redeposited in shape of sediment and then consolidated and cemented in a new kind of rock – ex: silicated rocks. Some rocks are formed as a product of chemical deposit of organic rest in water – ex: calcite rocks. The clay silicated rocks are formed when small particles are deposited like clay or mud and then consolidated by pressure from the top layers. These rocks are fine-grain, high-laminated and easily crushed. As a consequence, they are rarely used as aggregates for road surfaces and never as bitumen surfaces.

The sand silicated rocks are formed from litisized deposits of sand and sludge as a consequence of the pressure of the upper layers or the depositing of cement material among the grains. Some of these rocks are stiff and crumbly, and others are quite hard. The most

² More details for the usage of the locally available materials for performance of the expressway will be given in the chapter Impact on the environment, i.e. in the part regarding the landscape characteristics and the soil, focusing on the quarries and disposal sites for removal of the excess excavated material.

common mineral is quartz or Chalcedon (both SiO_2) which makes the gluing process harder between these sand aggregates and the bitumen.

The calcite rocks are result of thick deposits of rests of sea animals of the bottom of the ocean. The most common mineral is calcite (CaCO_3), which makes the rock bases. Some of the calcite rocks are too porous to be used during construction of roads, and the tests show that all crushed chalks and magnesium (dolomitic) limestones have average saturation higher than 3%, they are subjected to freezing and don't have to be used during construction of roads. Due to that reasons, it will be necessary to determine the saturation of the dolomitic limestones which will potentially be used as a material for performance of the Expressway.

From the sediment rocks, the most important aggregate groups are the gravel rocks and limestones. The useful gravel rocks are abrasive and highly resistant to wearing: tuffs, breccias, tiny, well-cemented sandstones, sludgy rocks etc. Unacceptable gravel rocks are the ones with large grains and lack of "cement". The limestone aggregate is widely used in all constructional occasions. The sands and the gravels are represented in the construction of concrete roads, because their roundness means that it is not necessary any additional processing. Some gravels need to be added some slaked lime or product against wearing, for example the ones that contain flint, if they are used in bitumen mixtures, to prevent the connective tissue to peel away from the particles. Some gravels which are used during construction of the roads should be crushed during processing in order to become more angular.

That means that on areas of the route where the same passes through a terrain of built breccias, limestones, sands and gravels, as well as other kinds of sediment rocks, the excavated material will be able to be use for performance of the trunk road.

General conditions and criteria for performance of the trunk road are the following:

- **Underground**

After the removal of the humus layer with 0.20 – 0.50m cca thick, the underground will mechanically compact, and the control of the density will be done by the method of examination of the dry volume weight;

- **Underground - subbase layer**

This position appears in notches, where the material discovered in the dimension of the underground – subbase according to the values of the carrier characteristics, satisfy the conditions for subbase material ($\text{CBR} \geq 8\%$).

- **Embankments**

The embankments will be done in horizontal layers with approximately same thickness (30cm cca), and each layer will be built in with appropriate compaction tool, during permanent control of the density. The surfaces of the pouring layers will have to be flat, with the designed diagonal and longitudinal falls from aspect of unhindered drainage and preventing moisturizing and damaging the trunk road.

- **SUBBASE**

The subbase as final layer of the lower line will be necessary to be performed from incoherent material with good quality with $\text{CBR} \geq 8\%$.

- Tampon layer

This layer which is derived from crushed rock material with appropriate quality specified in accordance with the design and tender documentation.

In order to fulfill the needs of the existing and European legislation, it will be applied compulsory constructional standards. In the next chart are presented examples of applicable standards which are used during the designing, i.e. it will be used during the performance of the expressway.

Applicable standards for performance of the expressway
МКС У.Ц4.012:1981
Designing and building roads – Dimensioning new asphalt road constructions
МКС У.Ц4.013:1991
Designing and building roads – Technical documentation. Project of performed works
МКС У.Ц4.016:1981
Designing and building roads – Climate and hydrological conditions
МКС У.Ц4.020:1982
Designing and building roads – Intensity of rainfalls
МКС У.Ц4.022:1982
Designing and building roads – Time of water flow
МКС У.Ц4.024:1982
Designing and building roads – Amount of spilled water
МКС У.Ц4.050:1990
Designing and building roads – Surface nodes. Technical conditions
МКС У.Ц4.051:1990
Designing and building roads – Surface nodes. Types of complex nodes
МКС У.Ц4.052:1990
Designing roads and city traffic - Serpentine
МКС У.Ц4.140:1990
Designing roads – Spatial leading of the route
МКС У.Ц4.198:1991
Designing and building roads – serpentine
МКС У.Ц4.200:1990
Road designing – Securing the lower layer of the roads and the total stability of the ground and the trunk of the road
МКС У.Е1.010:1981
Designing and building roads – Earth works during the construction of the roads. Technical conditions for execution
МКС У.Е1.012:1981
Designing and building roads – Sensitivity of the material-the ground under the influence of ice
МКС У.Е1.015:1981
Проектирање на патишта и градски сообраќајници-Затрупување на ровови за сместување на подземни инсталации
МКС У.Е3.020:1987
Проектирање и градење на патишта- Технички услови за изработка на цементобетонски коловоз
МКС У.Е4.014:1990
Проектирање и градење на патишта-Изработка на абечки слој од асфалт бетон по топла постапка
МКС У.Е4.016:1965

Applicable standards for performance of the expressway
Технички услови за изработка на катрански бетони МКС У.Е4.018:1965
Технички услови за изработка на асфалтни и катрански бетони по ладна постапка МКС У.Е4.019:1982
Проектирање и градење на патишта- Асфалтни мешавини со емулзијаод разреден битумен за изработка на коловозен застор по ладна постапка.Технички услови МКС У.Е4.020:1970
Технички услови за изработка на лиен асфалт МКС У.Е8.010:1981
Проектирање и градење на патишта- Носивост и рамност на ниво на постелка МКС У.Е8.016:1981
Проектирање и градење на патишта- Мерење на вредности на дефлексија на флексибилни коловози.Опрема и методи МКС У.Е8.018:1981
Проектирање и градење на патишта- Определување на меродавни вредности нза дефлексија на флексибилни коловози МКС У.Е9.020:1966
Класични и современи подлоги за на патишта- Технички услови за изработка МКС У.Е9.021:1986
Проектирање и градење на патишта- Изработка на горни носечки слоеви од битуменизиран материјал по топла постапка.Технички услови МКС У.Е9.022:1970
Носечки слоеви подлога за патишта од механички стабилизирано тло.Технички услови за изработка МКС У.Е9.024:1980
Проектирање и градење на патишта- Изработка на носечки слоеви од од коловозната конструкција од материјали стабилизирани со цемент или слични хидраулички врзива .Технички услови МКС У.Е9.026:1982
Проектирање и градење на патишта- Изработка на стабилизирани тло со вар и изработка на носечки слоевиза патишта од материјал стабилизирани со вар

The technology of the performance of the Expressway will be based on the appropriate application of constructional machines with a purpose to use optimally the appropriate procedures in the separate phases in the construction according to the local conditions. In the next chart are presented the characteristics of the construction materials and their potentially usage during the construction of the Expressway.

Chart 1 Display of construction machinery used in road construction

Вид на машина за збивање	Категорија	Број на поминувања за дебелина на збиениот слој од:		
		110 mm	150 mm	250 mm
Ваљак со мазни тркала	Маса/м-ширина (kg):			
	>2700 до 5400	16	Несоодв.	Несоодв.
Ваљак со пневматски гуми	>5400	8	16	Несоодв.
	Маса/тркало (kg):			
	>4000 up to 6000	12	Несоодв.	Несоодв.
	>6000 up to 8000	12	Несоодв.	Несоодв.
	>8000 up to 12 000	10	16	Несоодв.
Вибрирачки ваљак	>12 000	8	12	Несоодв.
	Маса/м-ширина на вибр. единица (kg):			
	>700 до 1300	16	Несоодв.	Несоодв.
	>1300 до 1800	6	16	Несоодв.
	>1800 до 2300	4	6	12
	>2300 до 2900	3	5	11
	>2900 до 3600	3	5	10
	>3600 до 4300	2	4	8
	>4300 до 5000	2	4	7
	>5000	2	3	6
Вибрир. плоча за збивање	Маса/един. плошт. на плоча (kg/m ²):			
	>1400 up to 1800	8	Несоодв.	Несоодв.
	>1800 up to 2100	5	8	Несоодв.
Вибро-тупкач	>2100	3	6	12
	Маса (kg):			
	>50 до 65	4	8	Несоодв.
	>65 до 75	3	6	12
Електричен натапкувач	>75	2	4	10
	Маса (kg):			
	100 до 500	5	8	Несоодв.
	>500	5	8	14

Besides the constructional materials and machinery, for the needs of the construction of the Expressway it will be used fuel (mostly diesel), electric power (for the needs of the compressors and other tools work), as well as water. Storing of the materials, mechanization and supporting means will be done on locations where the workshop, i.e. constructional camps will be organized. On these locations it will be mainly chosen regions which are not sensitive in relation to the pollution of water, ground waters and soil.

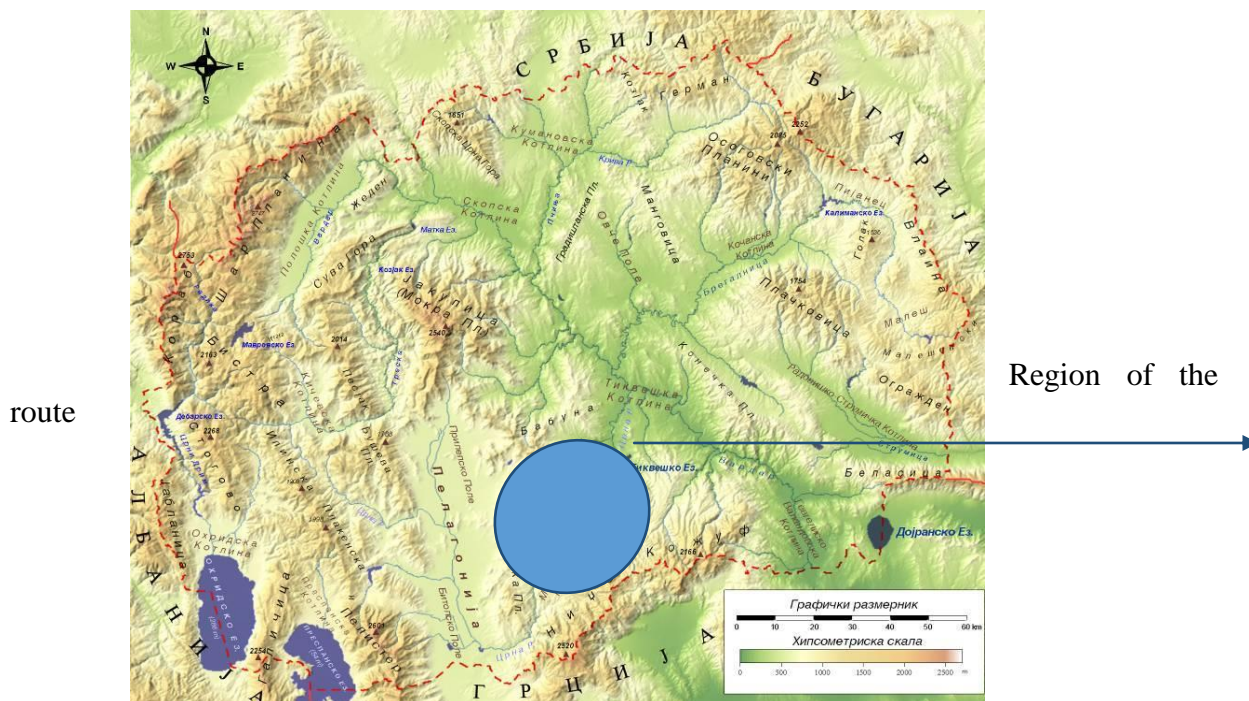
2.0. CONDITION OF THE ENVIRONMENT IN THE AREA OF THE LOCATION

2.1. Relief and morphology

The relief of Republic of Macedonia was created with mutual effect of the internal and external forces, so even since distant geological past there were turbulent movements of the magma in the Earth's core. Such movements caused cracking and faulting of the Earth's crust, with some parts descending, and because of that, the neighboring parts were rising.

From the parts that were rising, mountains were created, and from the descending, valleys were created.

Often, on places where there was strong faulting, in the past appeared volcanoes, which today aren't active. The valleys, during the humid climate were full of big lakes, which several hundreds years ago dried out or flowed. From those lakes, today, there are thick layers of fine sand and clay, on which fertile soils were formed. Because of that, the relief in our country is not monotonous, but "lively", diverse and very interesting. There is almost no region in Europe where in such a small area there are numerous valleys with low flat fields, surrounded by high mountains, which gives the relief mosaic or chess-like look.



Picture 10 Relief of Republic of Macedonia

The route of the expressway belongs to the wider region of Povardarie. That is low relief area along the valley of the river Vardar, in the central part of Republic of Macedonia.

This region was created in the past with faulting and descending the land, creating several spacious valleys. The valleys were filled with lakes for a long period, among themselves connected with flows. After their flowing into the Aegean Sea, on places of the flows and on the bottoms of the valleys, the river Vardar gradually built its composite valley. It is composite because it consists of several gorges and valley expansion which alternately are shifting.

After the short Veleska gorge, starts the Tikves valley through which passes the bigger part of the route.

On the stretch of the route from Gradsko to the entrance in the gorge Raec it can be distinguished two significant morphological wholes:

- Lake plateau with wavy hill forms, and

- Island, isolated rocky masses with longitudinal spatial position, built and modeled in Paleozoic and Mesozoic creations along the west coast of the Tikves valley.

The lake plateau as a morphological whole is represented as morphology of a regional level into all Pliocene basins in the Povardarie and Southeast Macedonia. This geomorphologic and relief creation doesn't have any particular stamp or value which should be preserved.

The isolated rock masses appear within the Paleozoic and Mesozoic formation of the Vardar zone from Kumanovo to Demir Kapija so it can be evaluated that neither morphologic form possess uniqueness that should be protected.

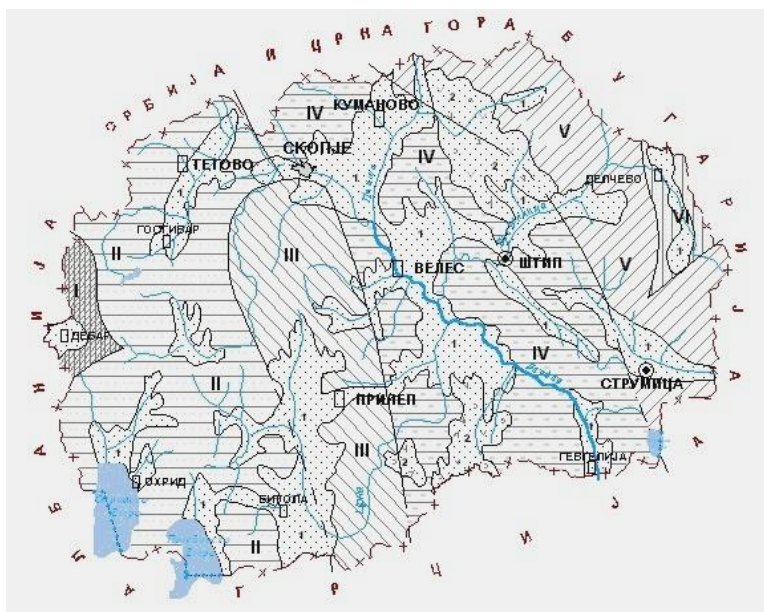
2.2. Geology and hydrology of the designed area

2.2.1. Geology

The geological development of the wider area had an impact on the geological characteristics of the area along the route and they are shown in continuance with their most significant aspects. These are the most important fact that has to be emphasized:

- The route is located within the Vardar zone which represents one of the geotectonic units from first-order;
- With the complex tectonic processes which contribute to the development of this zone for the considered section from the route, significant are the phases of the old Paleozoic and Alpine structural floor;
- With the contemporary geological processes in Quarter and Holocene, through the erosion processes and the activity of the river streamflows, it is formed the general geomorphologic condition of the field, which is characterized with forming alluvial and proluvial sediments, and on the slopes diluvial deposits.

All phases of the geological development had final impact on the forming of the today's condition of the field, which is manifested in the today's relief and conditions for designing of the road (directly or indirectly).



2.2.1.1. Geomorphologic characteristics of the terrain

The terrain where the route passes almost along all its length is hilly lowland with natural inclination of the slopes. It is also cut with more dry valleys and ravines with significant dimensions, due to the geological construction of the terrain.

Namely, the material from which this terrain is built (whether it is about Pliocene or metamorphic rocks) is a subject of intensive erosion, linear and surface. The erosion of the metamorphic rocks is conditioned mainly by the gravity and by the conditions of the terrain where these rocks appear.

The morphology of the terrain greatly preconditions the designed decisions for viaducts, bridges, notches, embankment etc.

As a conclusion, it can be stated that the morphology of this region shows complex condition, which is caused by the presence of various lithological types of rocks, their age and the complex mutual impact on the tectonic, neotectonic and contemporary processes of decay (denudation).

2.2.1.2. Geological characteristics of the terrain along the route

The spatial position of the represented lithogenetic units, i.e. their distribution horizontally, is determined through detailed engineer-geological mapping, with the method of following the geological limits and registration on all visible outgrowths, while the vertical distribution of the lithological members is determined using the investigative boreholes and wells. Thus, attention is paid on the lithological composition, the tectonic relations as well as on the presence of the contemporary geological processes.

Along the route of the road we can notice more lithogenetic units, which not only do they have different geological age, but also different properties and meaning for the performance of the construction. Based on the performed research that defines the location and the relationship between different lithological members, it can be ascertained that the following units are represented:

Alluvial sediments (al)

The alluvial sediments are presented with different granulation of gravel and sands as well as diluvial-proluvial sediments brought with the streamflows in different periods. These deposits along the road are chainage-determined only on river Krusevica on km 18+820-19+080. At this temporary streamflow, in the surface can be found large gravel grains and singles to larger raw and semi-manufactured blocks. From hydrogeologic point of view, they are collecting environment in which exist conditions for forming outgrowths zone of compact type with free level. The level of the groundwater is connected with the oscillations of the water within its river flows. It is expected that the level of the ground water of the biggest part of these sediments is depth grater than 3.0 m, except nearby the riverbeds where on some places is closer to the surface of the terrain.

Diluvial sediments (d)

These sediments are a product of the processes of surface decomposition of the basic rocky masses. The diluvial sediments are found near the metamorphic rocks which can be found along the route. Also, at the end of the first notch beside the serpentines which along the surface are dilapidated and are integral part of the thin diluvial cover. The power of these diluvial sediments along the whole route is small, mainly with centimeter dimensions where the same cover the basic rocky mass. Except the stretches on: km 12+300-12+660 where the power is greater than 4.0 m above the quartz-sericite slates, km 14+250-14+520 with power greater than 2.0 m above the conglomerates and the breccias and on km 14+740-15+560 with power greater than 3.0 m above the conglomerates and quartz-sericite slates and quartzite.

These sediments are mainly presented with dusty sands and low to middle plastic dusts, occasionally with the presence of gravel concretions, with medium stiff consistency.

Proluvial sediments (pr)

These sediments are product of the surface streamflows which transport the surface dilapidated material of hypsometric higher parts of the terrain to the lower parts on the slopes, i.e. in the foots of the valleys and the bigger ravines, where the transported material is deposited in shape of fans.

Along the route, the proluvial sediments are found in several places connected with the existing valleys and ravines. These sediments are with small thickness which usually not more than 5.0 m, and their thickness is often between 1.0 – 3.0 m. The proluvial sediments are mainly presented as sand-gravel materials with the presence of raw pieces of rocks, singles and blocks, low to medium density, dosed with certain percent of dusty fraction.

Conglomerates and breccias (KG, BR)

These Pliocene sediments can be found before the village Kamen Dol and on the stretch between this village and the village Sirkovo. Along the surface of the terrain, they consist of raw and semi-manufactured pieces of rock, loners, and rarely of larger blocks mixed with dust and sand in different ratios. Usually, the sections where they appear are unbounded and are with brown to dark brown and red color with dirt bands of bounded parties with power of around 30 cm. Before the new designed bridge in the village Kamen Dol, there is limestone breccia built of raw pieces of limestone with dimensions 10-30 cm, cemented with carbonate material and finer fraction of limestone with power 30+50 cm and with more power than 1.5 m unbounded material with identical composition.



Picture 12 Limestone breccia before the village Kamen Dol (start of new designed bridge)

On the same border with the serpentines and the limestone breccias there is also a serpentine breccia made out of finer pieces of serpentinite to 5 cm, cemented with sandy binder, and in depth are built of finer material of serpentinite. These limestone breccias are found as outgrowths after the bridge on chainage 14+250 km and before the bridge 14+550 on river Kaliska as dirt bands as well, and at the end of the bridge in shape of larger layers to BANCI. In their close surroundings, the terrain is mainly made out of dust and sand in different ratio with rare presence of raw and semi-manufactured pieces of rock and singles.

Pliocene sediments (PI)

These sediments are most common geological units along the route of the road. They are built of dusts, sands and gravels, as well as their mixtures. The materials from the Pliocene complex are usually characterized by good density.

In the Pliocene sediments, it is characteristic the frequent modification of the composition, horizontally and vertically too, i.e. there is frequent change of the dusty, sandy and gravel layers. Among the Pliocene sediments, the sand-dust formation is the most dominated, where occasionally registered content of carbonate material is. The color is different depending on the composition, often light yellow to brown and light to dark gray. Very rarely there can be found clayey series and sand gravel stretches, most often with finer gravel fraction.

Serpentines (Se)

They appear along the route on a few sections: from chainage on km 9+551-9+780 massive and cracked with several systems of tight cracks. On the surface they are modified and shattered, building the small diluvial above-layer in big percentage. On the surface of the terrain they are noticed before village Kamen Dol, where as outgrowths on the surface of the terrain represent lithological limit between limestone breccias and amphibolites. It is important to emphasize that here they are modified and slated in big part with the presence of dirt bands of quartz-sericite slate and amphibolites. On these stretches it is practically impossible their separation, because the same are changing vertically and horizontally, and partly are covered with thin diluvium. Their strength and silicate component with which they are tied on the surface is their characteristic, as well as their way of showing (shales). On the

surface of the terrain there can also appear raw pieces of limestone rocks, usually with dimensions 5-10 cm and finer pieces usually around 2 cm of serpentinites.



Picture 13 Surface-modified and silicified serpentinite (at chainage 12 +500 to 13 +090)

Quartz-sericite slates and quartzite (Sse)

They are divided into two parts of the route on section before the village Kamen Dol on chainage on km 14+260-12+480 and before the village Sirkovo. On the notch before the village Kamen Dol they appear as series together with the serpentinite where practically is impossible their separation. On other sections where they appear, they are low slated, hard enough and it is striking the presence of the quartz component, and occasionally there is appearance of quartz nests. They are light green by color and the serial mixed with serpentinite is with light brown color.

On the surface of the terrain these metamorphic rocks are subject to physical-mechanical dilapidation under the impact of the external influences (precipitation, freezing – defrosting and other factors), as a result created diluvial and proluvial creations.

Marble (M)

They are represented on the higher parts above all present lithological units, often an integral part of recent diluvial and proluvial rubble. Namely, there are pieces of marble, singles rarely and blocks in the thin diluvium in the surroundings before the quarry in Kamen Dol. They are noticed on the same route on chainage on km 13+980-14+120, where are stratified to banked, hard enough and cracked with tight cracks. They are gray-white to white by color, as the route progresses from the north-east side they are covered with thin diluvial cover.

Amphibolites and amphibolitic slates (A)

These metamorphic rocks with characteristic green color along the route are represented on chainage from km 13+300-13+980. At the beginning, they can be found on the bridge in the village Kamen Dol where they are laminar to layered, hard enough and cracked with tight

cracks. They are compact enough and are quite rare the pieces of rocks in the thin diluvium in their near surrounding. The notch above the village itself is built from these metamorphic rocks through which occasionally there are quartz nests, from the northeast side rarely on the surface there can be found outgrowth. At the end of the notch before the asphalt road, they are again alternately shifting serpentinites, amphibolites and amphibolite slates. Further on, after the progression of the route, there are amphibolites and amphibolite slates which are quite applied and serpentinitized. These rocky masses are partly slated with direction NE-SW, which indicates disadvantage during construction of the future notches from the right side of the road, and on the other hand, the advantage is from that side the amount of excavation is smaller.

2.2.1.3. Tectonic structure

Regarding the tectonic structure of the terrain, it should be emphasize that the tectonics of the Vardar zone is with greater lability. Part of the fissure structures which are shown on the map are taken by the JRC of the list Prilep 1:100 000 as well as based on the changes of the elements of fall, but because of the coverage of the field, the exact locations of the fissure structures are not confirmed.

At the beginning of the route the serpentinites appear as massive and cracked with several systems on the tight cracks in several directions, characteristic for these rocky masses. These rocky masses brake through the Old Paleozoic rocks and with them they connect the main dispokating ruptures, where the tectonics has big impact.

From the aspect of orientation, (the stretch of the quartz-sericite slate, the serpentinites and the amphiboles) most often cuts the stretch of the route of the road at an angle. The crack of the rocky masses is poorly marked; with what on some characteristic outgrowths it is done measurement on the represented crack systems which usually are tight and with metric length.

2.2.1.4. Basic seismotectonic characteristics of the designed area

In correlation with the geological development of the field and the geological processes are the seismotectonic characteristics of the area too. Globally, the route of the designed expressway is in zone with detected magnitudes of the occasional earthquakes to M 4.0 – 5.0. According to J. Jancevski (1987), these zones are connected with regional dislocations which are potentially seismoactive.

Based on the existing seismological map of R. Macedonia, for a return period of 500 years (which is recommended for application according to Eurocode 8 for seismic analysis until the bringing of the national document), it can be concluded that the route of the subject section in most part is located in areas with intensity VII^o, and only at the end with intensity VIII^o MCS (scale by Mercalli, Cancani and Sieberg). For this kind of expected earthquake intensity, with performed dynamic analysis it is adopted coefficient of seismology K_X 0.2.

porosity. This kind of classification shows that with these kinds of rock masses, it generally cannot be expected existence of typical outgrowth zones, while eventual appearances of moisturizing can be expected along the fault structures which go deeper and communicate with the surface, the individual open fissures and locally.

If we consider the location of the isolator layers within the field, it can be stated that the infiltration of the precipitation in the underground is quite difficult. On the other hand, the geological preconditions for forming outgrowth zone are mainly connected with the parts made of proluvium and Pliocene sediments. In these sediments, it can be expected forming an underground outgrowth only in the deeper zones, because until the deep to which are performed the investigated cracks there is no stated level and appearance of underground water.

2.3. Hydrology

2.3.1. Surface waters

The route of the Express way entirely belongs to the catchment area of Crna Reka, which belongs to the Vardar basin. The basin of Crna Reka occupies area of 5 890 km² and it is the right tributary of Vardar. In its flow, Crna Reka has 20 tributaries longer than 10 km with total length of 471 km.

From the right side, there are 14 tributaries with total length of 325 km and catchment area of 2.538 km², while from the left side there are only 6 rivers flowing with total length of 136 km and catchment area of 1.547 km². The rest of the total catchment area of Crna Reka is from the tributaries smaller than 10 km. In their developmental process, they were first tributaries of separate lake basins – lakes of Pelagonisko, Mariovski and Tikvesko, and after leakage of these lakes, they continue their river beds and become tributaries of Crna.

Right tributaries of Crna Reka are: Boiska, Stara, Semnica, Dragor, Kraeska, Vir, Lazecka, Jelaska, Konjarska, Trnovcica, Gradeska, Buturica, Blasica, Kamenica.

Left tributaries of Crna Reka are: Zaba, Zuresnica, Blato, Kruseicka, Dunjska and Raec.

On the analyzed territory, more significant water flows – tributaries of Crna, which approach or cut the route, are:

- Porojnica;
- Orese;
- Krusevicka River
- Sirkovska River
- River Raec

In the catchment area of Crna Reka also belong the reservoirs of lakes of Tikvesko, Strezevo, Prilepsko and Krusevsko as well as the glacial lakes Small and Big (Malo Ezero and Golemo Ezero).

The hydrological data for the analyzed area are obtained as a result of the following of the streams and water levels of the rivers of the existing hydrologic stations. Lately, because of the financing limitations, these data are not high quality.

On the next chart are shown the basic information for the catchment area through which the route passes.

Chart 2 Significant average leakages of significant water meter profiles

River	Water Profile	Catchment area km ²	Flow Q _{SR} (m ³ /s)	Special flow q l/s km ²
Crna Reka	Skocivir	397,5	21,61	5,4
	Rasimbeg. bridge	4.526	23,44	5,2
	Vozarci* ¹³	5.890	29,03	4,9
	Smiljanci	81,0	0,74	9,1

Source: Strategy for water supply and wastewaters, JICA, (2000)

Flowing waters reach very low value in dry periods, even large number small water flows dry out. The small waters shown here represent absolutely the minimal leakages with one-day duration - Q_{\min} is small flow four times exceeded in the studied period i.e. - $Q_{\min 90}$. The small waters serve to define the biological minimum, which with the usage of the waters, should remain in the riverbed and provide water for the ecosystems and to increase the water quality. The values for the biological minimum should be considered as orientational. They should be defined for the individual profiles and with detailed hydrological analysis, followed by analysis of the water pollution during flows. The biological minimum can be defined:

$$Q_b = k_1 Q_{\min} \text{ i } Q'_b = k_2 Q_{\min 90}$$

The coefficients k_1 , k_2 will be adopted regarding the condition with the load of the flowing waters with polluting materials; $k_1 = 1,6$ and $k_2 = 1,2$ are used in cases of bigger pollution of the water flow. Based on the chart information for flows and regarding the raise of the basin along the river network, in the chart below are shown the balance parameters of the available rivers (surface – middle-aged and waters in vegetation period) for Crna Reka.

Chart 3 Overview of characteristic available waters of the water management area Crna Reka

Слив	Сред. Год.		Сезонско		98% суш. Год.		* Биол. Мин.		Крит. Сезон.	
	m ³ /s	W 10 ⁶ m ³	m ³ /s	W 10 ⁶ m ³	m ³ /s	W 10 ⁶ m ³	m ³ /s	W 10 ⁶ m ³	Q _{sez}	W 10 ⁶ m ³
Црна Река - Пелагонија	21,61	682	16,11	254	5,13	162	0,75	24	4,42	47
Среден и долен тек на Црна Река.	29,3	924	22,0	347	7,75	244	0,92	29	6,64	70

Source: PROSTOREN PLAN of Republic of Macedonia (2004)

The hydrological data for the analysed field along the route of the Express way from the bridge of the river Raec to the intersection near Gradsko, are from the existing hydrological stations.

In the immediate field of the route, the only water flow is the river Raec. The express way on several places cuts the mentioned river and in big part goes parallelly with it. The river Raec is the left tributary of Crna Reka. It springs up from the north-east slopes of the mountain

³ PROTEKUVANJATA are evaluated based on the specific leakage for the MEGJUSLIV of Crna Reka in the amount of 4,1 l/s km².

Dren on altitude of 1.550 m. The same is created from two rivers: Svinjarica and river Cereševik. Until the gorge Fariska, it flows in direction north-east, and then turns to south-east and near the village Sivec, it flows into Crna Reka on POINT of 154 m. It is 33 km long. It drains relatively large catchment area of 304 km² and it has relative fall of 42,3‰.

On the next chart there are represented the basic information for the basin through with the route passes.

Chart 4 Catchment areas of Crna Reka and River Raec

Река	Вод. Профил	Слив – км ²	Проток Qsr (m ³ /s)
Црна Река	Скочивир	5890	29,3
Река Раец	Скочивир	304	/

Source: future design Gradsko – bridge of the river Raec

2.3.2. Ground waters

The waters that come from the surface (spring), are seen as spring or thermal waters. The ground waters – aquifers, are formed in the main valleys in the republic. Their quantity depends on many factors as: climatological, morphological and hydrogeological. The generosity, like water-resource balance component depends on the oscillations of the level of the ground waters and the possibility for their renewal. That is why it is used the term dynamic reserves of the ground waters.

According to the evaluation from the spatial planning of Republic of Macedonia (2004), the total flow of the springs in the area of the republic is 31.41 m³/s. That water quantity, regarding the number and the capacity of the springs, is distributed in individual water management areas. Because of the insufficient density of the piezometers and the special uncertainty of the individual aquifers in the republic, there are needed additional researches in order to define this component of the ground water potential.

The emptying of the aquifers is done through the springs. With the Cadaster of the springs in Macedonia, there are total 4.414 springs registered, with total 58 registered with generosity over 100 l/s.

In the catchment area of Crna Reka, there are 4 springs of that kind from which the Izvor (Crna) is with generosity over 1.0 m³/s. On the line of the variants of the route there aren't any noticed springs with larger generosity.

On the following chart it is presented the assumed number of springs for the water management area of Crna Reka and their generosity; the assumptions are based on previous researches by Geohydro project from Skopje, which are undertaken during the design of the Hydrological study within the spatial planning of RM.

Chart 5 Location of the springs for water management areas Pelagonija and Crna

Водостопанско подрачје	Број на извори	Штедрост	
		m ³ /s	10 ⁶ m ³ /год
Пелагонија	660	2,25	70,9
Средна и долна Црна Река	230	0,31	9,8

Source: Spatial planning of Republic of Macedonia, 2004

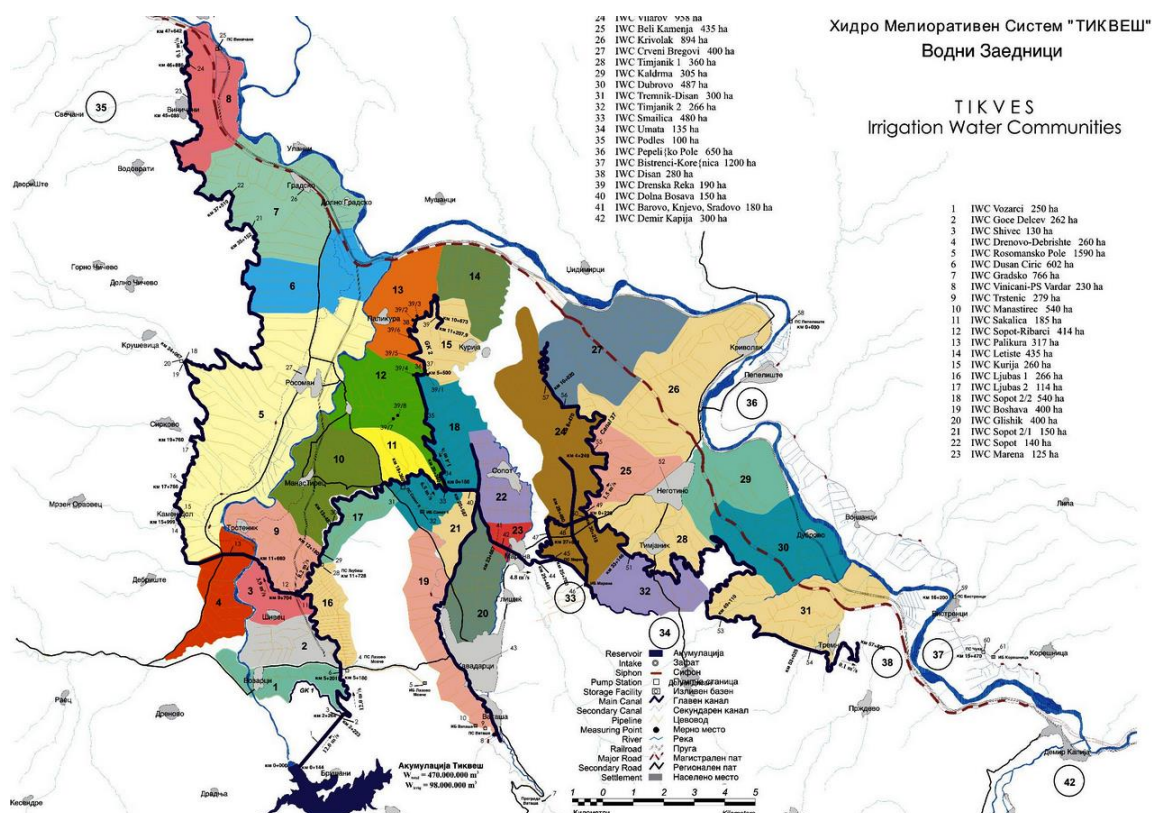
As it can be seen from the previous chart, in the lower basin of Crna Reka, through which pass the variants of the route, the generosity of the spring is significantly decreased, as a result of the isolator rocky masses and the absence of significant outgrowths.

2.3.3. Irrigation

The area of activity of “Water Management Tikves” is geographic area which covers areas and users from the municipalities: Kavadarci, Negotino, Rosoman, Gradsko and Demir Kapija. They are supplied with water from HMS Tikves with subsystems: Vozarci, Sopot 1, Makarija, Sopot 2, Trstenik-Gradsko, Ljubas, Marena, Negotino 1, Negotino 2, HS Bosava, HS Pepeliste, HS Demir Kapija, PS and small system Vinicani and Dam Podlec with main supply.

The artificial accumulation Tikves irrigates total 18.300 ha of agricultural land. The soil and climate characteristics of this field, as well as the sufficient water supply, require production of profitable agricultural crops, especially plantation viticulture and other industrial crops.

The Water Management Tikves, which in this region manages with the system for distribution of water, includes the main and the secondary canal system with the points for water supply and the control points for section pipelines and pumping stations.



Picture/map 15 Map of hydro-meliorative system Tikves

2.3.4. Water quality

The water quality, as well as the autopurification capacity and the degree of the naturalness of the water flow, also has an impact on the creation of habitats for the plant and animal species. The RETENCIONEN capacity of the rivers is determined with the morphological condition of the water flows as well as with the actual purpose and the usage of the land in fluvial plain.

The rivers which naturally meander have rich coastal vegetation, which decreases the risk of floods. On the other hand, the rivers which are regulated or the rivers which have agricultural lands spreading near their riverbeds show increased risk of floods. The rivers to which the route of the express way approaches or which cuts them are not regulated, while the coastal vegetation is normally developed. The existence of the coastal vegetation will provide the impacts on the surface waters not to be in bigger extent.

The next charts show the basic physical – chemical characteristics of Crna Reka of the profiles Skocivir and Palikura.

Chart 6 Basic physical-chemical characteristics of Crna Reka on Skocivir profile

Параметар	IV	V	VI	VII	IX	X	XI	XII	I	II	III
Вистинска боја	5	7,5	7,5	5	2,5	5	/	5	7,5	2,5	5
Месечна температура	11,2	14,6	16,5	19,8	17,4	11,8	8,7	5,4	7,1	8,6	9,1
pH	7,25	7,21	7,27	7,01	/	6,78	7,02	6,64	7,23	7,4	7,02
Алкалитет (mEq/L)	1,6	0	0	0	0	0	0	0	0	0	0
Вкупна вредност (dH)	4,99	5,49	7,54	9,1	10,67	9,79	7,96	9,98	10,71	9,1	6,9
Карбонатна тврдост (dH)	0,3	1,51	4,6	5,3	5,46	3,53	3,08	2,27	2,21	1,1	1,5
Некарбонатна тврдост (dH)	4,7	4	2,96	3,8	5,2	6,3	4,9	7,71	8,5	8	5,4
Расторен кислород O ₂ (mg/L)	8,26	5,79	4,63	2,73	2,5	1,14	3,25	4,16	2,41	2,08	3,7
ВРК5 (mg/L O ₂)	7,15	9,2	9,7	10,8	6,6	27	14,2	9,98	20,7	11,6	9,54
Амониум (mg/L)	0,26	0,233	0,663	0,977	3,031	2,403	1,907	1,938	0,406	1,38	1,289
Нитрити (mg/L)	0,023	0,042	0,097	0,094	0,034	0,085	0,072	0,064	0,095	0,067	0,043
Нитрати (mg/L)	1,197	1,275	1,479	1,946	0,915	1,338	2,434	2,414	1,793	1,634	1,121
Бикарбонати (mg/L)	97,6	-363	0,0	-366	-488	-185	-359	-317	-427	-280	-366
Фосфати (mg/L)	0,212	0,164	0,356	0,598	0,611	0,24	0,397	0,677	0,895	0,567	0,541
Сулфати (mg/L)	16,75	17,33	27,7	52,88	46,84	48,38	35,23	42,92	47,66	65,86	39,76
Карбонати (mg/L)	0	178,8	/	180	240	177	174	156	210	138	180
Хлориди (mg/L)	12,7	10,8	14,3	21,7	22,5	23,6	20,8	22	27,54	20,24	16,32
Na Cations (mg/L)	12,06	15,15	20,95	30,2	41,15	26	22,58	19,73	29,61	22,93	25,7
K Cations (mg/L)	2,32	5	5,24	6,06	7,31	9,15	5,94	5,61	9,216	4,6	5,3
Ca Cations (mg/L)	23,57	30,44	35,65	46,08	49,6	46,7	35,85	39,68	53,05	45,2	41,9
Mg Cations (mg/L)	7,15	5,36	11,11	11,65	16,25	12,99	12,83	19,26	14,31	11	11,8
Fe (ng/L)	95	/	105	25	74	13,5	54	209	114	60	169
Mn (ng/L)	36	50	86	30	108	43	105	10	121	109	93
Pb (ng/L)	/	/	/	/	0,62	/	7,57	0,89	0,53	0,96	0,88
Zn (ng/L)	16,1	25,7	47,5	4,8	2,4	0,7	/	/	0	0	/
Cd (ng/L)	0,011	0,14	0,017	0,02	/	0,406	0,034	0,158	0	0,088	0,064
Cr (ng/L)	0,12	0,09	0,62	/	/	0,2	0,65	0,2	0,08	2,51	0,3

The data is from the official page of HMS for the period 04.2006 – 03.2007

Chart 7 Physical-chemical characteristics of Crna Reka on Palikura profile

Параметар	IV	V	VI	VII	IX	X	XI	XII	I	II	III
Вистинска боја	10	5	2,5	7,5	2,5	2,5	/	2,5	3	1	2,5
Месечна температура	9,6	14,5	14,8	14,7	16,8	12,8	8	7,6	8,5	10,1	11,2
pH	7,74	8,22	8,76	7,78	/	7,86	7,86	8,83	7,97	8,6	8,27
Алкалитет (mEq/L)	1,72	0,2	0,35	0,1	0,1	0	0	0,1	0	0,15	0,12
Вкупна вредност (dH)	8,23	8,23	8,35	6,6	8,59	6,66	9,25	12,89	9,88	11,5	11,7
Карбонатна тврдост (dH)	3,8	4,53	4,5	3,9	3,38	8,43	5,4	5,54	4,38	5,5	7,1
Некарбонатна тврдост (dH)	4,4	3,7	3,9	2,7	5,2	-1,8	3,9	7,35	5,5	6	4,6
Расторен кислород O ₂ (mg/L)	10,24	11,24	13,11	9,06	9,9	9,66	9,97	10,42	11,28	7,73	13,35

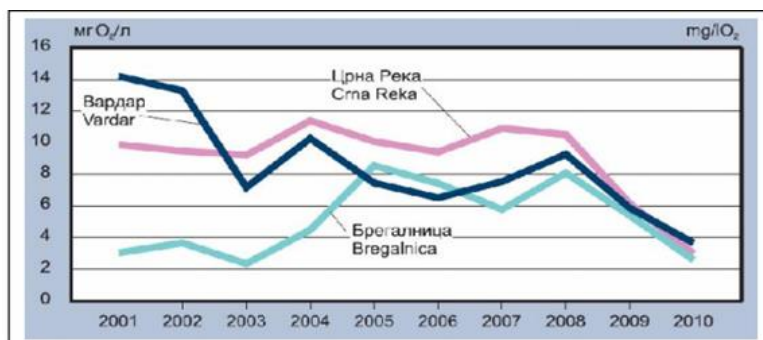
Параметар	IV	V	VI	VII	IX	X	XI	XII	I	II	III
ВРК5 (mg/L O ₂)	8,69	7,6	6,6	8,5	8,3	6,7	6,14	1,76	2,11	5,3	2
Амониум (mg/L)	0,174	0,097	0,027	0,77	0,101	0,042	0,074	0,138	0,039	0,06	0,14
Нитрити (mg/L)	0,013	0,008	0,015	0,015	0,01	0,007	0,012	0,028	0,008	0,017	0,011
Нитрати (mg/L)	1,056	1,639	1,05	1,086	1,087	1,295	1,674	2,41	1,462	1,48	1,521
Бикарбонати (mg/L)	159,9	-372	1026	-274	-329	-323	-384	-482	-414	-399	-474
Фосфати (mg/L)	0,24	0,195	0,153	0,564	0,212	0,347	0,253	0,175	0,173	0,106	0,158
Сулфати (mg/L)	29,16	19,1	32,34	23,53	37,57	42,73	25,12	47,72	24,64	34,17	34,21
Карбонати (mg/L)	3	189	/	138	165	102	189	240	204	201	237
Хлориди (mg/L)	15,7	12	12,6	9,3	11,4	8,3	13,4	17,3	14,95	18,42	16,23
Na Cations (mg/L)	17,76	19,7	19,87	16,2	18,07	11,71	17,37	21,93	17,52	22,32	25,04
K Cations (mg/L)	3,2	4	3,1	2,94	3,63	3,3	3,35	4,033	6,282	3,17	5,28
Ca Cations (mg/L)	43,21	43,21	38,54	32,63	40,68	36,97	41,37	61,5	29,47	16,7	26,6
Mg Cations (mg/L)	9,53	9,53	12,68	8,74	12,64	6,49	15,06	18,66	25,04	37	34,7
Fe (ng/L)	282	87	86	11	27	13,5	/	25	114	52	20
Mn (ng/L)	17	22	13	/	3	17	57	54	121	0	0
Pb (ng/L)	0,8	/	/	/	0,83	/	/	1,84	0,53	1,24	1,2
Zn (ng/L)	29,1	8,6	3,6	5,3	2,2	/	/	/	0	0	/
Cd (ng/L)	0,012	/	0,014	0,034	/	0,406	0,406	0,192	0	0	0,1
Cr (ng/L)	0,35	0,65	1,79	/	/	0,97	/	2,3	0,08	1,21	0,79

The data is form the official web page of HMS for the period 04.2006 – 03.2007

On the chart on picture 52, it can be noticed high concentration of BOD₅ on certain measurement points on Crna Reka, which for the period 2001 – 2004 correspond to a water quality of IV class. The biggest measured concentrates of BOD₅ on Crna Reka are estimated in 2004.

Water quality in relation with oxygen indicators

On the lower chart can be noticed high concentration of BOD₅ on certain measurement points on Crna Reka, which for the period 2001 – 2004 correspond to a water quality of IV class. The biggest measured concentrates of BOD₅ on Crna Reka are estimated in 2004.



Picture / map 10 Diagram of concentrations of BOD₅

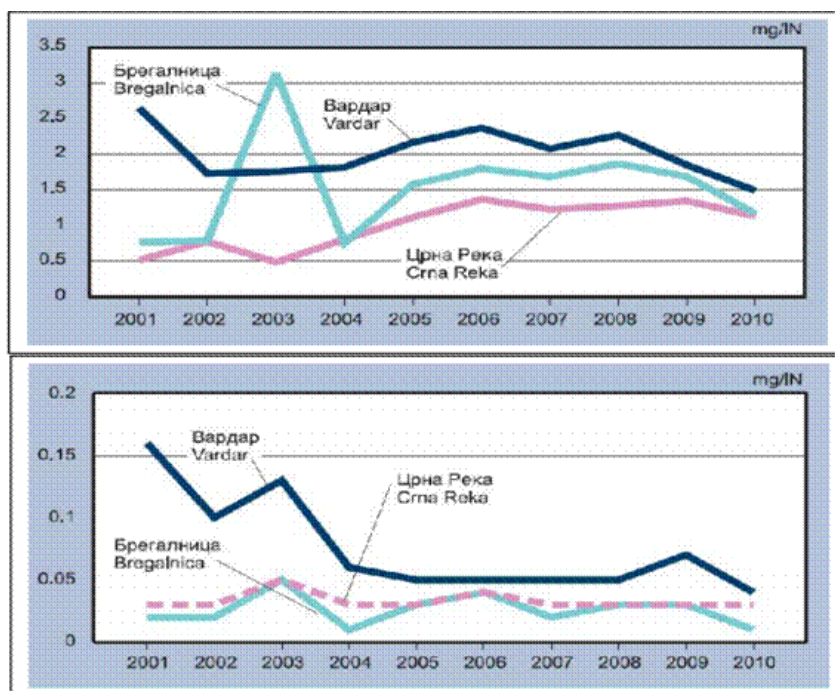
Water quality in relation with nutrients

On the chart can be noticed high concentration of N/I on certain measurement points on Crna Reka, which for the period 2001 – 2004 correspond to a water quality of II-V class. In 2001 in Crna Reka is noticed higher concentration of N/I, which corresponds to a water quality of V class.



Picture /map 11 Diagram for concentration of N/I

On the charts can be noticed concentrations of nitrates and nitrites of the measurement points of Crna Reka, according to the Regulation on classification of the waters in Republic of Macedonia.



Picture / map 16 Diagram for concentration of nitrates and nitrites

On the chart are given the concentrations of orthophosphates in Crna Reka in the period 2001 – 2004, which note minimal trend of increase, while in 2008 – 2010 is noticed minimal trend of decrease.



Picture 17 Diagram for concentration of orthophosphates

The saprobiological analyses show that Crna Reka has a water quality of IV class. According to total physical – chemical and saprobiological parameters, we can conclude that the water quality of Crna Reka corresponds to V class.

2.4. Climate and meteorology

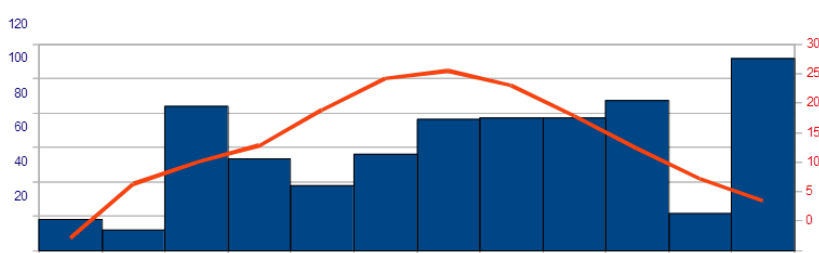
The area Tikves and Povardarie are under the influence of Mediterranean climate which penetrates from south through Demir Kapija's gorge and of Continental climate which penetrates from north through Veles's valley. The collision of two different climate influences creates modified Mediterranean climate with the next characteristics:

- Average air temperature 13,5°C
- Highest average monthly temperature in the months of July and August;
14,8°C
- Lowest average monthly temperature in January 1,4°C
- Yearly middle average temperature above 0°C
- Number of frosty days (below 0°C) around 58 days
- Middle duration of frosty period – 112 days
- Temperature amplitude – 58,6°C; absolute maximal temperature
14,8°C
- Absolute minimal temperature -17,8°C

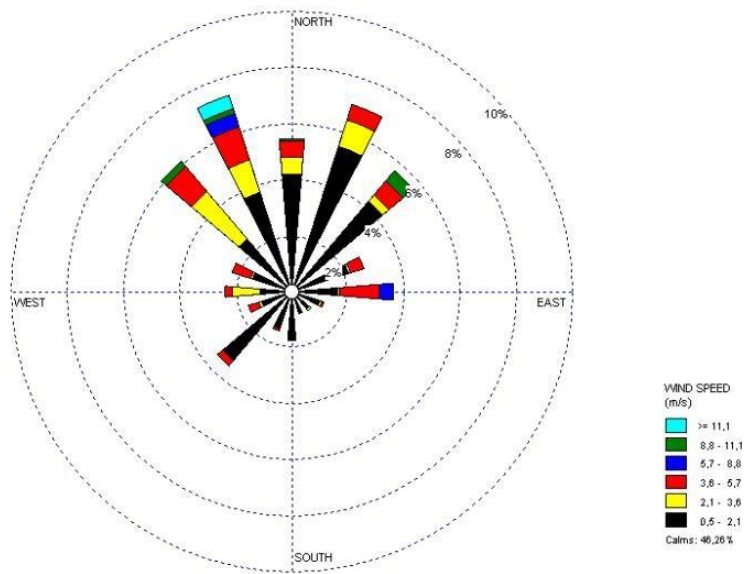
The length of duration of the sunlit, yearly for the Middle Povardarie is estimated 2230 hours with a maximum in the months of July and August.

The analyses of rain gauge show that the route is located on quite dry area in R. Macedonia, with low percentage of rain a year.

The air currents have biggest frequency from north and north-west.



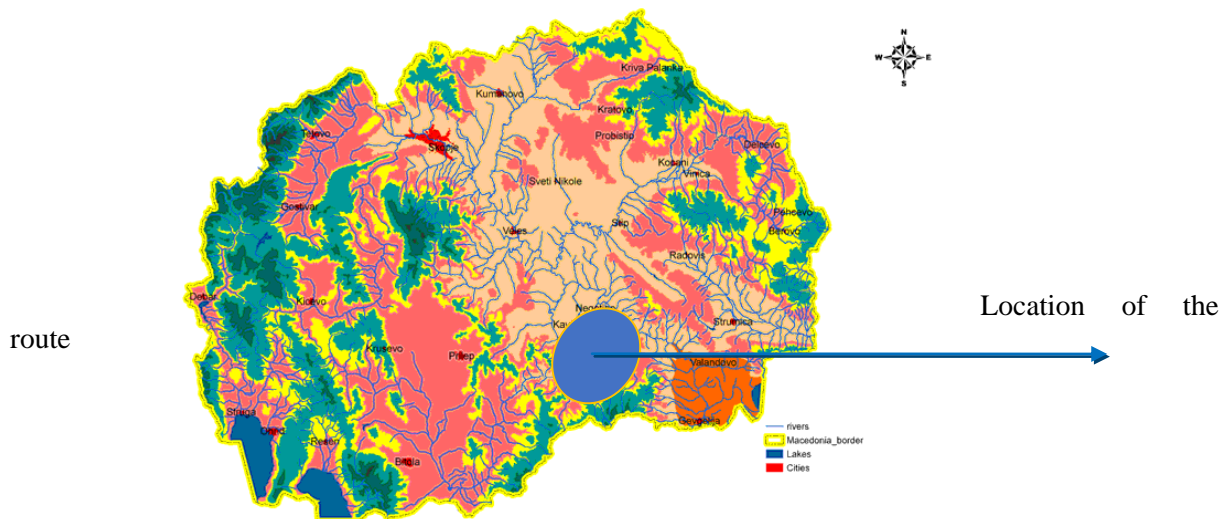
Picture 18 Annual amounts of rain and temperature in Tikves gorge



Picture 19 Wind roses in the Tikves gorge

As it can be seen from the wind roses for the Tikves gorge, most common winds are from the north-west and north-east side. Most often the winds blow with speed 0,5 – 2,1 m/s, but occasionally there can be winds with speed over 10 m/s.

On the next map there is a preview of the climate types in Republic of Macedonia.



Picture 20 Map of the climate types in Republic of Macedonia

2.6. Waste management

The waste management generates important problems in the environment in Republic of Macedonia. Most of the waste is deposited in the legal and illegal – so called dumps. The recycle of the waste in the state is not so frequent. The impact of the dumps on the environment, and on the health of the people is big, because there are emitting greenhouse gases (methane), organic micropollutants (dioxins and furans), volatile heavy metals into the

air and leachate from landfills which is emitted into the soil and the groundwater, which may contain toxic substances.

The municipal solid waste includes the waste collected from households, along with the waste from the streets and parks, waste from commercial-institutional sector and waste from the industry which is characterized as the household waste. Very few of the household waste falls into the category of hazardous waste, such as: batteries containing heavy metals and acids, stale drugs, scrap packaging of cleaning materials, pesticides and so on.

The municipal waste in the municipalities of the country is collected by the public and private utilities.

The following chart presents the number and area of active landfills by region for 2010.

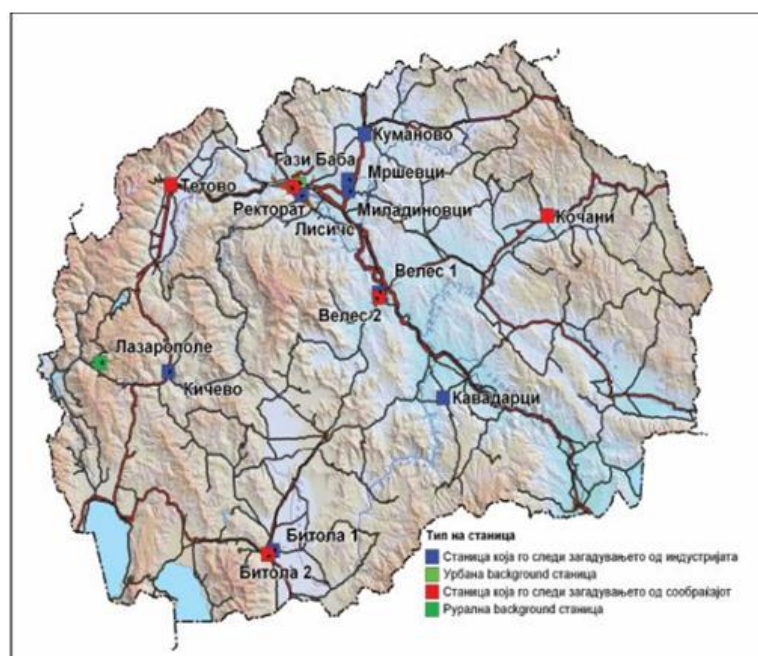
Chart 8 Number and area of active landfills in regions in Republic of Macedonia

	Де		
	Број	Вкупна површина (m ²)	Активна површина (m ²)
Р.Македонија - вкупно	47	2.592.482	1.571.070
Вардарски	7	600.753	172.000
Источен	11	340.242	213.190
Југозападен	6	162.000	67.000
Југоисточен	7	330.100	273.100
Пелагониски	7	111.660	78.630
Полошки	2	76.500	68.500
Североисточен	5	251.227	138.650
Скопски	2	720.000	560.000

There are no details available in regards to waste management in the territory of the municipalities Gradsko and Rosoman (neither one of these municipalities have a designed plan and program for waste management).

2.7. Ambient air quality

In order to determine the pollution of the air in the area of Express way A1, from the bridge of the river Raec, interchange “Drenovo” to Gradsko (junction with highway A1), there are



data used from the cadaster of polluters and a map of pollution of the air in Republic of Macedonia and from the report for the quality of the environment.

Picture 21 National automatic system for monitoring of the ambient air quality in RM

Because of the lack of information, i.e. data which can be directly used for assessment of the ambient air quality of this rural area, informatively, there are data presented from the station of the automatic national monitoring network for air quality in the closest places where it exists, i.e. in Kavadarci. Along the section Gradsko – bridge of river Raec, it doesn't exist any other measurement station.

The values which are shown in the cadaster and in the used reports, contain values of pollution materials annually of entities, domestic fireplaces, from traffic and other sources which have direct influence on the air quality. The ecological and meteorological parameters which are followed with the monitoring stations are: carbon monoxide CO (mg/m³), sulfur dioxide SO₂ (g/m³), ozone O₃ (mg/m³), suspended particles, value of PM 10 particles of 10 microns (mg/m³), nitrogen oxides NO₂ (mg/m³), non-methane volatile organic compounds NMVOC, speed and wind direction, temperature, pressure, air humidity, global radiation and other parameters.

In the next chart are shown the amount of the emissions of the pollution substances in the Vardar region in 2005.

Chart 9 Annual emissions of pollutants into the Vardar region (year 2005)

В а р д а р с к и р е г и о н	Извор на емисии	Загадувачки материи за животната средина (t/god)			
		SO ₂	CO	NO _x	TSP
	Загадување индустриски субјекти	74.047	987	12.333	404
	Домашни ложишта	3.844	12.344	126	357
	Бензински станици	NMVOC (t/god)			
		Бензин	Дизел	Екстра лесно масло	
		46	45	23	

Source: Cadaster of pollutants in the air, 2005

In the following charts are shown the most important parameters, which have influence on the area of the planned Express way, and which come from the Regulation for limiting values for levels and types of polluting substances in the ambient air and alert thresholds, deadlines for

reaching the limiting values, margins of tolerance for limiting value, goal values and long-term goals.

Chart 10 Limiting values for protection of the people of sulfur dioxide

Загадувачка супстанција	Просечен период	Гранична вредност која треба да се достигне во 2012	Дозволен број на надминувања во текот на годината	Маргина на толеранција за 2010 год.	Гранична вредност за 2010год.	Праг на алармирање
SO ₂	1 час	350 $\mu\text{g}/\text{m}^3$	24	60 $\mu\text{g}/\text{m}^3$	410 $\mu\text{g}/\text{m}^3$	
	24 часа	125 $\mu\text{g}/\text{m}^3$	3	-	125 $\mu\text{g}/\text{m}^3$	
	3 последователни часа					500 $\mu\text{g}/\text{m}^3$

The limiting value for protection of the ecosystems from pollution with sulfur dioxide is estimated 20 $\mu\text{g}/\text{m}^3$ for 2010 and 2012. The average examined period is one year and the winter period.

Chart 11 Limiting values for protection of ecosystems of sulphur dioxide

Загадувачка супстанца	Заштита	Просечен период	Гранична вредност која треба да се достигне во 2012 год.	Маргина на толеранција за 2010	Гранична вредност за 2010 год.
SO ₂	Екосистеми	Година Зимски период	20 $\mu\text{g}/\text{m}^3$	-	20 $\mu\text{g}/\text{m}^3$

In 2010, the limiting value for protection of the people from nitrogen was 240 $\mu\text{g}/\text{m}^3$. From then, the limiting value is decreased for 40 $\mu\text{g}/\text{m}^3$ to 200 $\mu\text{g}/\text{m}^3$. This limiting value is related to the average concentration during one hour. There are 18 overdrafts permitted of this value during one year.

The limiting value for average daily concentration of nitrogen dioxide in the air is 40 $\mu\text{g}/\text{m}^3$, value which in 2010 was 48 $\mu\text{g}/\text{m}^3$. There aren't any overdrafts permitted of this value annually.

Chart 12 Limiting values for protection of the health of the people of nitrogen dioxide

Загадувачка супстанца	Просечен период	Гранична вредност која треба да се достигне до 2012год.	Дозволен број на надминувања во текот на една година	Маргина на толеранција за 2010год.	Гранична вредност за 2010год.	Праг на алармирање
NO _x	1 час	200 $\mu\text{g}/\text{m}^3$	18	40 $\mu\text{g}/\text{m}^3$	240 $\mu\text{g}/\text{m}^3$	
	1 година	40 $\mu\text{g}/\text{m}^3$	0	8 $\mu\text{g}/\text{m}^3$	48 $\mu\text{g}/\text{m}^3$	
	3 последователни часа					400 $\mu\text{g}/\text{m}^3$

The limiting value for protection of the vegetation of pollution with nitrogen oxides is 30 $\mu\text{g}/\text{m}^3$ for 2010 and 2012. The average examined period in one year.

Chart 13 Limiting values for protection of the vegetation of the nitrogen oxides

Загадувачка супстанца	Заштита	Просечен период	Гранична вредност која треба да се достигне до 2012год	Маргина на толеранција за 2010год.	Гранична вредност за 2010 год
NO _x	Вегетација	Година	30 $\mu\text{g}/\text{m}^3$	-	30 $\mu\text{g}/\text{m}^3$

(NO+NO ₂)					
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In 2010, the limiting value for protection of the people from RM10 was estimated 50 $\eta\text{g}/\text{m}^3$. From then, the limiting value has not changed. This limiting value is regarding to the average concentration during one hour. There are permitted 35 overdrafts of this value during one year.

The limiting value of the average daily concentration of RM₁₀ in the air is estimated 40 $\eta\text{g}/\text{m}^3$, value which has not changed since 2010. There are no overdrafts permitted of this value annually.

Chart 14 Limiting values for protection of the health of the people in RM₁₀

Загадувачка супстанца	Просечен период	Гранична вредност која треба да се достигне до 2012год	Дозволен број на надминувања во текот на една година	Маргина на толеранција за 2010год.	Гранична вредност за 2010год	Праг на алармирање
PM10	24 часа	50 $\mu\text{g}/\text{m}^3$	35	0 $\mu\text{g}/\text{m}^3$	50 $\mu\text{g}/\text{m}^3$	
	1 година	40 $\mu\text{g}/\text{m}^3$	0	0 $\mu\text{g}/\text{m}^3$	40 $\mu\text{g}/\text{m}^3$	

In 2010, the limiting value for protection of the people from carbon monoxide was 12 $\eta\text{g}/\text{m}^3$. From then, the limiting value is decreased for 2 $\eta\text{g}/\text{m}^3$ of 10 $\eta\text{g}/\text{m}^3$. This limiting value is regarding to the average concentration during 8 hours. There are no overdrafts allowed of this value annually.

Chart 15 Limiting values for protection of the health of the people of carbon dioxide

Загадувачка супстанца	Просечен период	Гранична вредност која треба да се достигне до 2012 год.	број на надминувања во текот на една година	Маргина на толеранција за 2010год	Гранична вредност за 2010год	Праг на алармирање
CO	Максимална дневна часовна средна вредност ⁸	10 $\eta\text{g}/\text{m}^3$	0 $\mu\text{g}/\text{m}^3$	2 $\mu\text{g}/\text{m}^3$	12 $\mu\text{g}/\text{m}^3$	

When it comes to human health protection from ozone pollution, its maximal daily 8 hours average value in the air cannot reach over 120 $\eta\text{g}/\text{m}^3$ more than 25 days in the calendar year, with average value measured in a period of 3 years.

AOT40, assessed from one-hour value from May until July, for the needs of the vegetation protection cannot pass the value above 18 000 $\eta\text{g}/\text{m}^3 \cdot \text{h}$ assessed average value for a period of 5 years.

Long-termly speaking, for vegetation protection from ozone pollution, the one-hour concentrations from May until July should be moved in the range of 6000 $\eta\text{g}/\text{m}^3$.

If the ozone concentration in the air during the 3 consecutive hours is more than 180 $\eta\text{g}/\text{m}^3$, then it passes the warning threshold. The alarm threshold is passed when the concentration is over 240 $\eta\text{g}/\text{m}^3$.

Chart 16 Target values of ozone

Загадувачка	Просечен период	Целна вредност за 2010
-------------	-----------------	------------------------

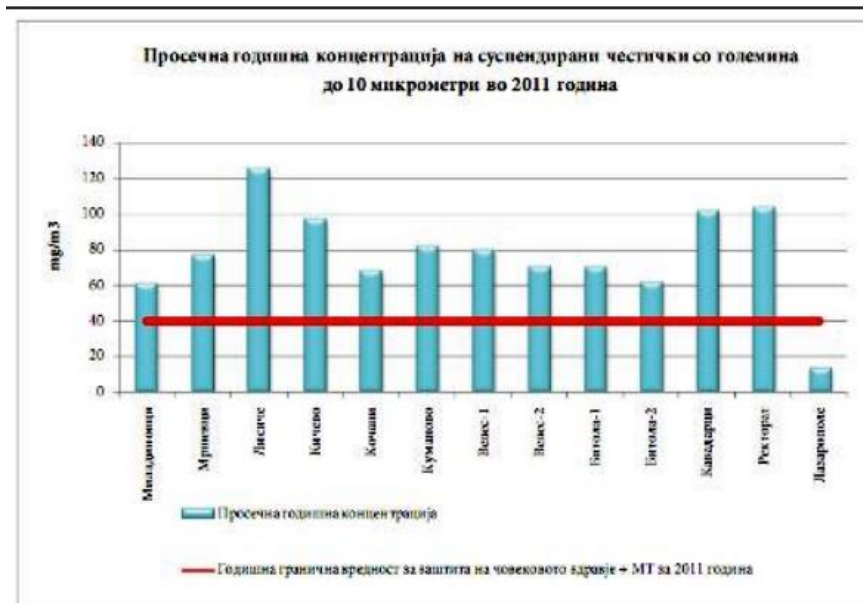
супстанца			
Озон	Максимална дневна 8 часовна средна вредност	Целна вредност за заштита на човековото здравје	120 $\mu\text{g}/\text{m}^3$, не смее да биде надмината во повеќе од 25 денови во календарска година со средна вредност измерена за период од три години
	АОТ40, Пресметана од едночасовните вредности од мај до јули	Целна вредност за заштита на вегетацијата	18000 $\mu\text{g}/\text{m}^3\cdot\text{h}$, пресметана средна вредност за период од 5 години
	Просечен период	Долгорочна цел	
	Максимална дневна 8 часовна средна вредност за концентрација во текот на една календарска година	Долгорочна цел за заштита на човековото здравје	120 $\mu\text{g}/\text{m}^3$
	АОТ40, пресметана од едночасовните вредности од мај до јули	Долгорочна цел за заштита на вегетацијата	6000 $\mu\text{g}/\text{m}^3\cdot\text{h}$
	Просечен период	Прагови	
	3 Последователни часа	Праг на предупредување	180 $\mu\text{g}/\text{m}^3$
	3 последователни часа	Праг на алармирање	240 $\mu\text{g}/\text{m}^3$

In the next chart are presented the results from the measurements done in the station located in Kavadarci. From the chart it can be noticed that in Kavadarci during 2010, the limits of one-hour values are exceeded 90 times for PM₁₀.

Chart 17 Air quality of measuring station Kavadarci for 2010

Гранична вредност	SO ₂ $\mu\text{g}/\text{m}^3$	NO ₂ $\mu\text{g}/\text{m}^3$	PM ₁₀ $\mu\text{g}/\text{m}^3$	CO $\mu\text{g}/\text{m}^3$	O ₃ $\mu\text{g}/\text{m}^3\cdot\text{h}$
Кавадарци					
Просечна годишна вредност	3,3	5,1	100	6*	100 (мај-јули)
АОТ40, ($\mu\text{g}/\text{m}^3$) Пресметана од часовните вредности од мај до јули					
Колку пати е надмината границата на 1 часовните вредности во текот на 2010 година			90		

Like in the region of Kavadarci, so as in the whole territory of Republic of Macedonia, (except in the Lazaropole region) the suspended particles are the most problematic air pollutant and their values in the reports exceed the allowed number of exceedance of the goal values for the human health protection.



Picture 22 Diagram for annual concentrations in relation to the limit values for the health people's health for 2011

2.8. Noise

The noise emission in the environment is firstly identified with the technology, industry and transport development. According to the Law for protection of noise in the environment (Official Journal of RM no. 79/07), the noise in the environment is a noise caused by unwanted or harmful external sound, made from the human activities, which is imposed by the surroundings and it causes discomfort and disturbance, including the noise emitted from vehicles, road, rail and air transport and from the industrial activity.

The discomfort of the noise means disturbance caused by the sound emission which is common and/or long lasting, made in certain time and place, and which hampers or affects the normal activity and work, concentration, rest and sleep of the people. The noise disturbance is defined through the degree of disturbance of the people from noise determined by field measurements or insights.

The intensity of the noise and the period of exposure of workplace, together with the limiting values of ambient noise for different species of urban and rural surroundings are regulated with the Law for noise and the appropriate bylaws.

The limiting values for the basic noise indicators in the environment are determined in the Regulations for limiting values for the level of noise (Official Journal of RM no. 147/08). According to the degree of protection from noise, the limiting values for the basic indicators for noise in the environment caused by different sources shouldn't be higher than:

Chart 18 Level of noise for different degrees of protection

Подрачје диференцирано според	Level of noise in dB		
	L _д ⁴	L _в ⁵	L _н ⁶
Region of I degree	50	50	40
Region of II degree	55	55	45
Region of III degree	60	60	55
Region of IV degree	70	70	60

The regions, according to the degree of noise protection, are determined in the Regulation for the locations of the measurement stations and the measurement spots (Off. Journal of RM, no. 120/08) in the next way:

- Region with I degree of noise protection is a region intended for tourism and recreation, region close to health institutions for hospital treatment and region of national parks and nature reserves.
- Region with II degree of noise protection is a region which is primarily intended for residency, i.e. residential area, region surrounding facilities intended for educational activity, facilities for social protection intended for accommodation children and elders and facilities for primary health care, region of playgrounds and public parks, greenery and recreational area and regions of local parks.
- Region with III degree of noise protection is a region where it is allowed intakes in the surroundings, in which it will be less counted on causing noise, i.e. commercial – business – residential region, which is simultaneously intended for residency, that is in which there are facilities with protected rooms, handcraft and similar activities for manufacturing (mixed region), region intended for agricultural activity and public centres, where it will be performed administrative, commercial and catering activities.
- Region with IV degree for noise protection is a region where are allowed intakes in the surroundings, which can cause disturbance with noise, regions without apartments, intended for industrial and handcraft or other similar manufacturing activities, transport activities, activities for storage and service activities and utilities which make bigger noise.

With the Decision for determining in which cases and under which conditions the peace of the citizens from harmful noise is considered disturbed (Off. Journal of RM, no. 01/09), there are actions identified which, in cases of causing noise which exceeds the limiting values of the noise level, are considerate disturbing for the peace of the citizens.

In the absence of developed state network for monitoring, for the wider region of the subject location, there are no data from measuring noise levels in the environment. Consequentially, there are no planning documents for noise managing, i.e. strategic map and action plan.

2.9. Biological diversity

⁴ L_д – day (period from 07,00 to 19,00 h)

⁵ L_в – evening (period from 19,00 to 23,00 h)

⁶ L_н – night (period from 23,00 to 07,00 h)

In the Study on environmental impact assessment from the construction of the Express way from Gradsko to the river Raec, the results from mapping the habitats, the field observations, the literary data for the composition of flora and fauna in the designated corridor, are summarized. **The study refers to a corridor 400 m wide (200 m on each side of the route).** The specified width is enough to cover all the impacts during the construction and the usage of the road.

The made research was helpful during the assessment of the biological diversity of the existing ecosystems, different areas and habitats along the planned route, as well as identification of the significant regions in relation to the biological diversity.

The habitats in the region of the research field, according to origin, belong to two main categories, natural and anthropogenic habitats. From the natural habitats, there are forest, grass, rocky and water habitats. The division of these categories is made based on several criteria like: presence of different plant communities, distribution, level of degradation and geomorphological characteristics. The classification of habitats by EUNIS⁷ is used as main criterion.

The complete lists of the species (flora and fauna) in the range of the research field are listed in **Appendix I**, while the habitat maps are submitted in **Appendix II**.

In the region of the designated road corridor are presented the next habitat types:

Table 10 Types of habitats along the research route

Natural habitats	Anthropogenic habitats
Oak forest belts: – Forests of pubescent oak and oriental hornbeam (Quercus-Carpinetum orientalis) – Degraded forests of pubescent oak and oriental hornbeam (Quercus-Carpinetum orientalis)	Agricultural land
Riparian habitats – Riparian belts with willows and poplars	Orchards
Open regions – hill pastures	Vineyards
Rocky regions - calcareous rocky slopes with chasmophytic vegetation	Fields and farmlands
Water habitats/rivers and streams	Settlements and urban regions – Rural settlements (villages) and facilities (quarry, kilns, catering and commercial facilities)
Rivers and streams (~ narrower than 5 m), HIPORITRAL	
Temporary water flows	

2.9.1. Natural habitats

The natural habitats consist of oak communities, riparian habitats (with willows and reed), open regions (hill pastures), rocky regions (calcareous rocky slopes with chasmophytic vegetation), water habitats (rivers, streams and temporary water flows) and caves.

Almost all the research field is in typical belt of forests of pubescent oak and oriental hornbeam. It is a dominant type of vegetation which determines the characteristics of the hilly regions and it represents the vegetation belt in the research field.

⁷ <http://eunis.eea.europa.eu/habitats.jsp>

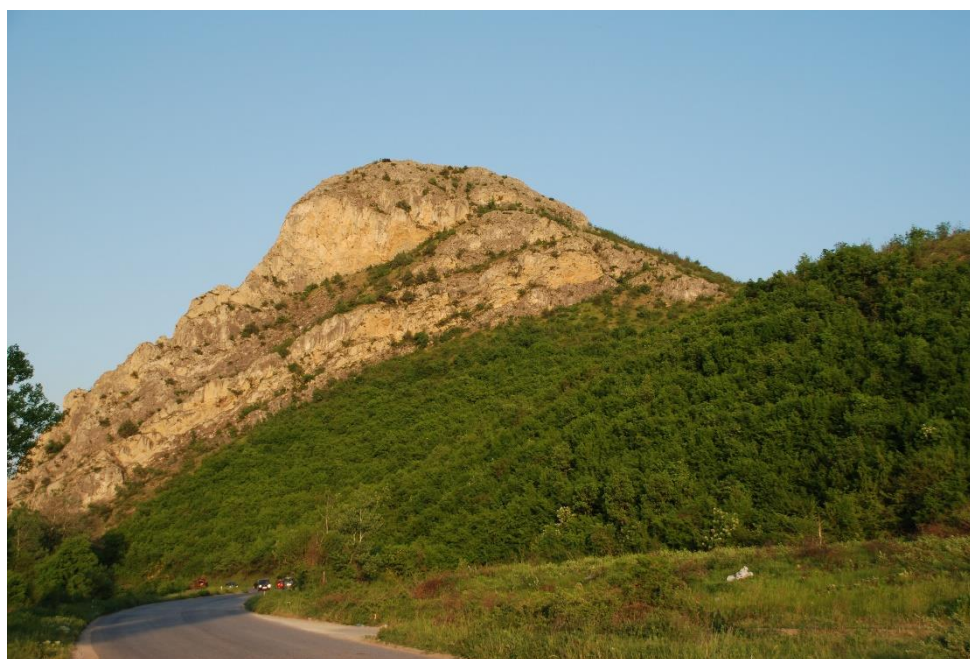
The whole area through the centuries was exposed to strong anthropogenic influence, because of which can be found habitats with different level of degradation. The water habitats are represented with the tributaries of Vardar and river Crna, from which the biggest is the river Raeka, as well as the streams and temporary water flows which during the summer dry out.

2.9.1.1. Oak forest belt

Forests of pubescent oak and oriental hornbeam (*Querco-Carpinetum orientalis*)⁸

The forests of pubescent oak and oriental hornbeam belong to the oak forest community *Querco-Carpinetum orientalis macedonicum* Rud. 39 apud Ht. 1946 (picture 26). This thermophile and xerophile community develops under the regional climate influence of the soil. Main edificators in these forests are the Pubescent Oak (*Quercus pubescens*) and the east (white) hornbeam (*Carpinus orientalis*). Besides them, in this community can be found others wood types like: *Fraxinus ornus*, *Acer monspessulanum*, *Colutea arborescens*, *Coronilla emeroides*, *Rhamnus rhodopaea*, *Ligustrum vulgare*, *Jasminum fruticans*, *Lonicera etrusca* and others. In the grassland floor, there can be seen *Cyclamen neapolitanum*, *Carex* spp. etc. This community develops to 600 m altitude to almost all expositions (east, south-east, south, south-west and west). In Macedonia, it is mainly spread in the central and east parts.

The forests of pubescent oak and oriental hornbeam are present fragmented on small areas in the initial part of the route (between chainage KM 0+000 and 0+500, 0+800 and 1+400, 5+000 and 6+000), see **map of habitats listed in Appendix II**.



Picture 23 Saved fragments from oak-hornbeam forest near the gorge Drenovska

More important representatives of the flora in the region of the route are the wood species: *Juniperus oxycedrus*, *Phillyrea media*, *Pistacia terebinthus*, *Colutea arborescens*, *Rubus*

⁸ Reference to EUNIS Habitats: G1.737 Eastern sub-Mediterranean white oak - G1.7372 Moesian white oak woods; Reference to EU HD Annex I: Eastern white oak woods 91AA; Reference to CoE BC Res. No. 4 1996: 41.7 Thermophilous and supra-Mediterranean oak woods

sanguineus, *Pyrus amygdaliformis*, *Cornus mas*, *Prunus spinosa*, *Crataegus monogyna*, *Ulmus campestris*, *Asparagus acutifolius*, *Ruscus aculeatus*, *Hedera helix*. In the floor of the grassland, there can develop: *Lathyrus* sp., *Anemone apenina*, *Lamium purpureum*, *Cardamine graeca*, *Salvia horminum*, *Lunaria* sp., *Coronilla emerus*, *Campanula glomerata*, *Dictamnus albus*, *Ophrys* sp., *Convolvulus holosericeus*, *Centaurea* sp., *Anacamptis pyramidalis* and other species.

From mammals, it can also be found the mole (*Talpa europea*), the hedgehog (*Erinaceus concolor*), the fox (*Vulpes vulpes*), the hare (*Lepus europeus*), some rodents (*Mus macedonicus*, *Apodemus sylvaticus*) and other species.

Common inhabitants of the oak forests are the birds: blackbird (*Turdus merula*), jay (*Garrulus glandarius*), chaffinch (*Fringilla coelebs*), great tit (*Parus major*), the red robin (*Erithacus rubecula*). It can also be found: *Parus lugubris*, *Streptopelia decaocto*, *S. turtur*, *Otus scops*, *Oriolus oriolus*, *Buteo buteo*, *Picus viridis*, *Troglodytes troglodytes*, *Turdus viscivorus*, *Aegithalos caudatus*, *Carduelis carduelis*, *C. chloris*.

Characteristic kinds of lizards are the green one (*Lacerta viridis*) and the Balkan green lizard (*Lacerta trilineata*), and from the snakes it can be found *Zamenis longissimus* and *Platyceps najadum*.

Most characteristic types of amphibians are: the common toad (*Bufo bufo*), the green toad (*Pseudepidalea viridis*), the European tree frog (*Hyla arborea*) etc.

From the insects, most characteristic kinds are: *Cerambyx cerdo* and *Morimus funereus*, and it can also be found some representatives from *Carabus* spp. The forests are not typical habitats for butterflies, but sporadically, it can be found *Colias crocea*, *Vanessa atalanta* and others.

[Degraded forests of pubescent oak and oriental hornbeam⁹](#)

The degraded forests of pubescent oak and oriental hornbeam feature with presence of the same plants as in the previous habitat. As a result of overexploitation in the past, today also some of the wood species like *Carpinus orientalis*, *Quercus pubescens*, *Fraxinus ornus* and others are less present. This habitat is very similar to the previous, and due to that, both have almost identical distribution.

In the research area, they are present as small fragments between chainage 0+000 and 2+200 and on places between chainage 3+000 and 8+000 and 11+500 and 13+500.

These degraded habitats are characterized with the presence of *Juniperus oxycedrus*, *Paliurus spina-christi*, *Ligustrum vulgare*, *Jasminum nudiflorum*, *Prunus spinosa*, *Pyrus amygdaliformis*, *Coronilla emeroides* etc. Representative from the grass plants are: *Ajuga laxmanii*, *Minuartia glomerata*, *Euphorbia myrsinites*, *Knautia orientalis*, *Althea* sp., *Ornithogalum umbellatum*, *Lathyrus roseus* and others.

[2.9.1.2. Fauna in pubescent oak and oriental hornbeam forests](#)

⁹ Reference to EUNIS habitats: G1.7C2 [*Carpinus orientalis*] woods - G1.7C22 Helleno-Balkan oriental hornbeam woods; F5.16 Deciduous [*Quercus*] matorral; F6.66 Balkan peninsula supra-Mediterranean garrigues -

Common types of mammals are the following: the hedgehog (*Erinaceus concolor*), the marble polecat (*Vormela peregusna*), Günther's vole (*Microtus guentheri*) and it can also appear: *Apodemus flavicolis*, *A. agrarius*, *Rattus rattus*, *Mus macedonicus*, *Lepus europeus*, *Vulpes vulpes*, *Mustela nivalis*, *Meles meles*.

The birds are presented with *Passer hispaniolensis*, *Sylvia* spp., *Lanius collurio*, *L. senator*, as some types of the genus *Emberiza*, characteristic for the hilly pastures.

The fauna of reptiles and amphibians is identical in the pubescent oak and oriental forest.

From the invertebrates, it can be found almost the same representative from the pubescent oak and oriental forests and the hilly pastures.



Picture 24 Degraded oak-hornbeam forest near the village Kamen Dol

2.9.1.3. Riparian habitats – Riparian belts with willows and poplars¹⁰

These forest and bush communities are developed along the river shores and canals in the whole research area. Well-kept forests of this kind are very rare. The people clean these habitats out in order to get fertile alluvial soil for agriculture. These forest communities belong to the alliance *Salicion albae* Soó (30) 1940.

The belts with willows and poplars usually appear beside almost all water flows. They represent the rest of the typical forests with willows and poplars. These kinds of forest belong to the community *Salicetum albae-fragilis* Issler 1926. Most typical kinds of trees are *Salix alba* и *Salix fragilis*, додека *Populus nigra*, *Alnus glutinosa*, *Sambucus nigra*, *Viburnum opulus*, *Cornus sanguinea*, *Rhamnus frangula*, *Amorpha fruticosa* etc. and they appear in smaller groups or individually (Pic. 25). In the grassland floor, most common species are: *Poa*

¹⁰ Reference to EUNIS Habitats: G1.11 Riverine [*Salix*] woodland - G1.112 Mediterranean tall [*Salix*] galleries (G1.1121 Mediterranean white willow galleries); Reference to EU HD Annex I: 92A0 *Salix alba* and *Populus alba* galleries; Reference to CoE BC Res. No. 4 1996: 44.1 Riparian willow formations

trivialis, *Poa palustris*, *Carex vulpina*, *Polygonum lapatifolium*, *P. hidropiper*, *Rumex sanguineum*, *Veronica anagalis-aquatica*, *Scirpus lacustris* and others. The belts with willows and poplars are characterized with poorer flora composition, and often miss some of the characteristic materials.

From the birds, characteristic for this habitat are: warbler (*Cettia cetti*) and the tit (*Remiz pendulinus*). A lot of other species use the willows and the poplars as places for nesting and protection, usually the nightingale (*Luscinia megarhynchos*), the robin (*Erithacus rubecula*), the blackcap (*Sylvia atricapilla*) and others. A lot of migrating species, especially the herons (Ardeidae), use the willows as a place for nesting.

The well-developed riparian belts with willows and poplars are present mainly beside the Raeca river, as well beside the streams near the village Kamen Dol (see map of habitats).



Picture 25 Riparian belt of willows and poplars along the river Raeca

2.9.1.4. Open areas – Hilly pastures¹¹

This habitat features with grass vegetation in whose surroundings has oak forest with different degree of degradation (Pic. 24). They represent secondary vegetation formation which occur with gradual and long-term degradation of the forests which in this area in the past stretch on big areas. The vegetation in this habitat is a result of the specific climate, geological, geomorphological, pedological and other features, including the anthropogenic influence.

¹¹ Reference to EUNIS Habitats: E1.33 East Mediterranean xeric grassland (E1.332 Heleno-Balkan shrot grass and therophyte communities); Reference to EU HD Annex I: 6220 Pseudo-steppe with grasses and annuals of the Thero-Brachypodieta; Reference to CoE BC Res. No. 4 1996: 34.5 Mediterranean xeric grasslands

There are represented trees characteristic for strong degraded forests (*Quercus pubescens*, *Fraxinus ornus*, *Carpinus orientalis*, *Cornus mas*, *Crataegus monogyna*, *Pyrus amygdaliformis*, *Ulmus* sp.) or bushes (*Prunus spinosa*, *Paliurus spina christi*, *Rosa* spp., *Colutea arborescens*, *Coronilla emeroides*, *Evonymus europaeus*) and others.

The hilly pastures appear in the second half of the road corridor, between the chainage KM 13+500 and KM 16+500, as well as the small area between the chainage KM 9+500 and KM 9+800 and around KM 19 (see map of habitats).



Picture 26 Hill pastures

2.9.1.5. Fauna in open hilly pastures

From the mammals common are: *Mus macedonicus* (Macedonian mouse) is characteristic for habitats with rare bushes, and beside it, *Vormela peregusna* (marbled polecat) also appears, as well as species which come from the neighboring habitats searching for food: the fox (*Vulpes vulpes*), the marten (*Martes* sp.) and the badger (*Meles meles*).

From birds, more important are: *Galerida cristata*, *Lanius collurio*, *L. senator*, *Buteo buteo*, *Merops apiaster*, *Columba livia*, *Oenanthe oenanthe*, *Passer domesticus*, *Corvus cornix*, *Pica pica*, *Sylvia communis*, *Turdus viscivorus*, *Upupa epops* and others.

From reptiles and amphibians, characteristics species for this habitat are: *Testudo graeca* (Mediterranean tortoise), *Elaphe quatorlineata* (four-lined snake) and *Vipera ammodytes* (viper). Besides the characteristic species, here can also be found *Dolichophis caspius* and *Platycephalus najadum* too.

As representatives for invertebrates of butterflies, appear: *Iphiclides podalirius*, *Euchloe ausonia*, *Maniola jurtina*, *Colias alfacariensis*, from the beetles *Acinopus picipes* и *Dixus obscurus*, and from locusts *Acrida meridionalis*.

2.9.1.6. Rocky regions - calcareous rocky slopes with chasmophytic vegetation¹²

In the investigated corridor, there are small areas with calcareous cliffs and rocks which form special habitat type. The rocky habitats are characterized with very low biological production and extreme climate and soil conditions. The temperature variation during the day and the year are big. These habitats feature with low humidity because of the weak water-retaining of the parent substrate and poorly developed soils. These ecological conditions are reason for the appearance of specialized types of plants (chasmophyte) and animals. The vegetation shroud is poorly developed, and because of that, the physiognomy of the habitat is determined by the composition and the structure of the rocks. Nevertheless, an important characteristic of these habitats is the presence of rare kinds of plants.

On the calcareous rocks and cliffs develops specific flora and vegetation. In the literature there is some data for the composition of the flora and the plant communities which develop in the investigated corridor. In the cracks of the rocks develop the chasmophytes. During the field investigation, there were noticed the next plant species: *Stachis iva*, *Campanula formaneckiana*, *Sedum acre*, *S. album*, *Centaurea* spp., *Ceterach officinarum*, *Asplenium trichomanes* and others. From the animal life of the rocks in the gorge, present is the endemic snail (*Carinigera drenovoensis*), while from the birds, it can be found: *Bubo bubo*, *Aquila chrysaetos*, *Buteo rufinus*, *Neophron percnopterus* and others.

In the Drenovska gorge it can be found some smaller caves that develop specific animal life (arthropods and bats). Some of the caves are inhabited with Blasius's Horseshoe Bat (*Rhinolophus blasii*).

This habitat is present on a small area in the initial part of the road corridor near Drenovska gorge (chainage KM 5+500).



Picture 26 Drnovska gorge



Picture 27 Caves in the gorge Drenovska

2.9.1.7. Water habitats

In the investigated region, there are three types of water habitats: water habitats with constant water flow (streams and rivers nearly narrower than 5 m), hiporitral rivers), temporary water flows (which dry out during the summer period) and canals for irrigation.

¹²

Directive of EU 92/43/EEC (Annex I): 8210 Calcareous rocky slopes with chasmophytic vegetation

Rivers/streams (~narrower than 5 m) hiporithral¹³

Main characteristics: In the region of the road corridor, the only bigger water flow is the river Raecka (Pic. 29). The river is under the influence of eutrophication from the agriculture, which enables development of macrophytes. The macrophytes are present during the whole year. Most dominant kind during the summer period is *Potamogeton fluitans*, while in the slower water flows *Lemna minor* which covers the water area.

From the birds, it can be found the dipper (*Cinclus cinclus*) and several semiaquatic species amphibians and reptiles. From the frogs, characteristic are two kinds: Greek toad (*Rana graeca*) and marsh frog (*Pelophylax ridibundus*), and from the reptiles the grass snake (*Natrix natrix*).



Picture 29 River Raecka

Streams and temporary water flows¹⁴

The streams and the temporary water flows are part of the catchment area of the rivers Vardar and Crna, and have water only during the humid period of the year (Pic. 30). In early spring with the melting of the snow and/or the spring rains, the level of the water rises, and the rest of the period of the year, the riverbeds are dry. Because of that, these water flows do not have any importance as the water ecosystems. From the animal life, it can be found amphibians (common toad – *Bufo bufo*, the green toad - *Pseudepidalea viridis* and the yellow bellied toad - *Bombina variegata*). From invertebrates common are the butterflies (*Parnassius*

¹³ Reference to EUNIS Habitats: C2.22 Hiporithral streams; Reference to EU HD Annex I: HD Annex I: 3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitriche-Batrachion vegetation; Reference to CoE BC Res. No. 4 1996: none

¹⁴ Reference to EUNIS Habitats: C2.5 Temporary running waters; Reference to EU HD Annex I: HD Annex I: 3290 Intermittently flowing Mediterranean rivers of the Paspalo-Agrostidion; Reference to CoE BC Res. No. 4 1996: none

mnemosyne, *Zerynthia cerisy*, *Vanessa atalanta*), as well as some representatives of dragonfly (*Cordulegaster heros*).

These habitats appear in separate places along the whole corridor.



Picture 30 Stream near the village Kamen Dol

2.9.2. Anthropogenic habitats

2.9.2.1. Agricultural land

*Orchards*¹⁵

Fruit growing in the region of the road corridor is one of the characteristic agricultural activities, and the biggest part of the orchards are represented by peaches, which are planted adjacent the villages. The orchards are present on big areas.

¹⁵ Reference to EUNIS Habitats: G1.D4 Fruit orchards and FB.31 Shrub and low-stem tree orchards; Reference to EU HD Annex I: none; Reference to CoE BC Res. No. 4 1996: none

The orchards (Pic. 31) are present along the whole route of the road corridor, mixed with vineyards and farmlands (see map of habitats). They are spread on a bigger surface near the village Rosoman.



Picture 31 Peach orchards near the village Rosoman

From the aspect of biological diversity, most important are the animal species. The mammals which can be found in the orchards can be also found in the other agricultural habitats. Most common are: the hedgehog (*Erinaceus concolor*), the lesser shrew (*Crocidura suaveolens*), the lesser mole rat (*Nannospalax leucodon*), the edible dormouse (*Glis glis*), the Macedonian mouse (*Mus macedonicus*), the hare (*Lepus europeus*), the fox (*Vulpes vulpes*) and others. In the orchard, there are very few kinds of birds. Here, there are nests by *Merops apiaster*, *Upupa epops*, *Galerida cristata* и *Oenanthe oenanthe*, and other species come searching for food. The fauna of amphibians and reptiles is the same as in the neighboring habitats. In the orchards, it can be found several kinds of butterflies and racers.

Vineyards¹⁶

The vineyards (Pic. 32) are common and typical for the bigger part of the road corridor. In regards to the biodiversity, the vineyards have bigger importance from the fields.

This habitat is rich with birds because it enables good conditions for nourishment. Most common kind is the common starling (*Sturnus vulgaris*). Here there are a lot of birds breeding, like for example: the blackbird (*Turdus merula*) and the house sparrow (*Passer domesticus*). In this habitat can be found several species of butterflies, from which most common are: *Artogeia napi*, *A. rapae*, *Celastrina argiolus*, *Colias alfacariensis*, *Leptotes pirithous*, *Polyommatus icarus*, *Pieris brassicae*, *Polyommatus icarus*, etc.



Picture 32 Vineyards near the gorge Drenovska

The vineyards are widely spread. As for the previous habitat there appear along the whole route of the road corridor, mixed with farmlands and orchards (see map of habitats).

Fields and farmlands¹⁷

¹⁶ Reference to EUNIS Habitats: FB.41 Traditional vineyards; Reference to EU HD Annex I: none; Reference to CoE BC Res. No. 4 1996: none

¹⁷ Reference to EUNIS Habitats: I1.3 Arable land with unmixed crops grown by low-intensity agricultural methods; Reference to EU HD Annex I: none; Reference to CoE BC Res. No. 4 1996: none

The plantations with monocultures have less importance for the biological diversity than the individual fields. The fields and the farmlands in the region of the road corridor are with different cultures. Besides the different sorts of corn, there are also other cultures: tobacco, watermelon, lucerne, pepper, cabbage etc. The monotype cultures of the community, the ecological conditions controlled by the human and the usage of the significant amounts of pesticides and fertilizers determine the development of the biocenosis with small diversity. Because of the wealth of food, the fields and farmlands are favorable habitat for many species of mammals and birds, while not so favorable for butterflies.

The fields and farmlands occupy small areas and are spread among the orchards and the vineyards.

*Settlements and urban regions – Rural settlements (villages) and facilities (quarry, kilns, catering and commercial facilities)*¹⁸

Main characteristics: The urban regions have less significance for the biological diversity. The species which inhabits the urban habitats are often cosmopolites. From plants, they are most often nitrophilous and ruderal species, with small conservational meaning because of what they are cosmopolites. The fauna of the birds in the rural regions is somewhat specific, although some of the species live in the natural habitats too: *Hirundo rustica*, *Delichon urbica*, *Passer domesticus*, *Phoenicurus ochruros*, *Pica pica*, *Corvus monedula*, *Corvus cornix*, *Passer domesticus*.

The only inhabited place near the investigated corridor is the village Kamen Dol. Other than that, in the corridor there are several more facilities (the quarry near the village Kamen Dol, part of the village Gradsko, kilns, more catering facilities, gas stations and others).



Picture 33 The village Kamen Dol

2.5. Area

The region reflects the changes that happen and/or are happening as a result of the natural forces or the human activities which occupy the cultural and natural components together. As a starting point for identification of the regions, it is taken the relief and the altitude, as well

¹⁸ Reference to EUNIS Habitats: J3.2 Active opencast mineral extraction sites, including quarries; J3.3 Recently abandoned above-ground spaces of extractive industrial sites; J1.4 Urban and suburban industrial and commercial sites still in active use; Reference to EU HD Annex I: none; Reference to CoE BC Res. No. 4 1996: none

as: the geographical region, the basic natural characteristics, the dominant effect, the visual and the esthetic aspects and the influence of the human and its activities. The access in the region, basically should enable maximal preservation of the nature in conditions of total implementation of the human intentions and projects. In the specific case, the region should sustain construction of a road with all the supporting elements and facilities with minimal consequences on the environment. With the introduction of this kind of infrastructure it will be made significant change on its natural elements. Because of that, it will be imposed the need to determine and describe the natural characteristics of the types of regions in the area of the road.

In the wider area of the road corridor, there were and there are human activities with different intensity. The presence of the dominant vegetation types (pubescent oak and oriental hornbeam, mainly degraded) also, have impact on the look of the region in the area of the road corridor. Big part of the area in the range of the investigated field is intended for agricultural activities.

Taking in consideration the previously mentioned anthropogenic, bio-geographical and physical-chemical characteristics as criteria, in the region of the road corridor it can be noticed hill-forested region type and ravine part. This region type is widely spread in the hilly part of whole Macedonia. It is characterized with hilly relief with steeper and milder slopes, cut with dry valleys through which pass temporary water flows. The region features with forest vegetation of pubescent oak and oriental hornbeam communities with different degree of degradation. Better kept forests of this community appear in fragmented on small areas in the surroundings of the Drenovska gorge and the village Kamen Dol.



Picture 34 Gorge Drenovska

In the bigger part appear the pubescent oak and oriented hornbeam forests, with hilly pasutres and agricultural areas. The degraded pubescent oak and oriented hornbeam forests with red

juniper are often with transitional stage from the progressive and from the regressive succession of the oak forest ecosystems, as for the degraded pubescent oak and oriented hornbeam forests with Christ's thorn, typical for the Balkan Peninsula. The hilly pastures appear in the second half of the road corridor (between chainage KM 13+500 and KM 16+500, as well as on small surface between chainage KM 9+500 and KM 9+800 and KM 19). Besides the inhabited places, through the region there are scattered also other human constructions (quarry, kilns, more catering facilities, gas stations and more).



Picture 35 Hilly forest area near the village Kamen Dol

The agricultural areas are mainly presented with orchards (peaches) and vineyards characteristic for this region from Macedonia and in small part of farmlands. On the following picture is shown characteristic region formed form vineyards which are common view in the Tikvesija.



2.10. Natural heritage

The natural heritage of Republic of Macedonia is regulated with the Law for protection of the nature (Off. Journal of RM, no. 67/04, 14/06, 84/07, 35/10, 47/11, 148/11, 59/12 and 13/13).

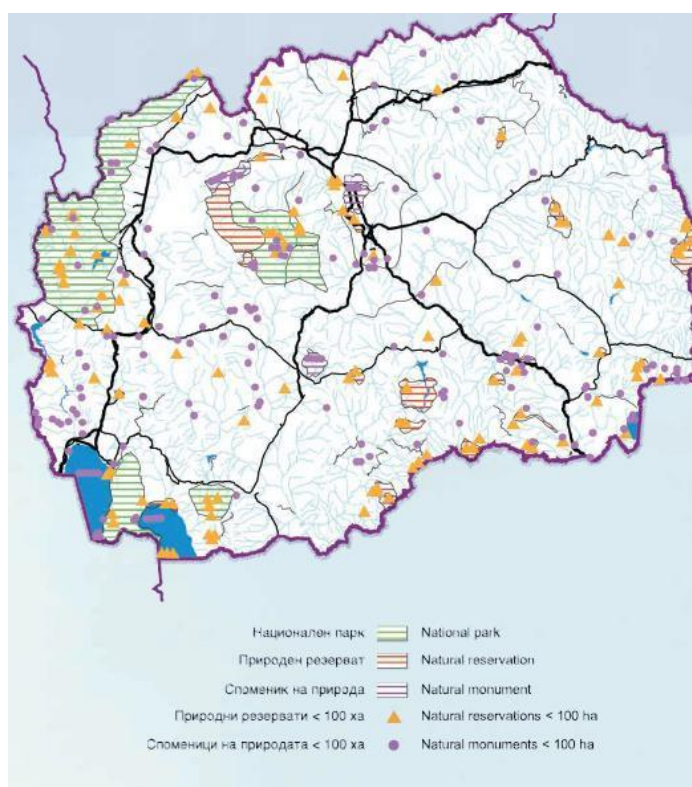
According to the legally regulated procedure for protection of localities with natural values, there are 6 categories established for protected natural heritage.

There are also formed: CORINE biotopes with 77 CORINE places and National Emerald network of Republic of Macedonia with 35 emerald regions and 11 protected regions included in the Macedonian green belt, as a part of the Balkan green belt.

The number of protected regions is with increased trend in the last decade, from 7,4% of national territory in 1991 to 8,7% in 2008. The area of protected regions is estimated 2.220.5 km².

However, there is registered degradation of natural habitats and decrease of the areas of spreading endemic, relict, rare plant species and rank growth fungi, slight decrease of the populations of several species of water migratory birds near lake, river and bog habitats, as well as decrease of the populations of 4 globally endangered predatory birds (eagles and vultures), and globally endangered mammals (bats, otter and others).

On the next map there are regions shown which have different level of protection.



Picture 37 Protected areas in Republic of Macedonia

The route of the newly planned Expressway A1 section from the inhabited place Gradsko (junction with highway A1) up to the bridge of the river Raec, the interchange “Drenovo”, **passes through a protected natural heritage, SP gorge Drenovska**. This natural monument was proclaimed as such in 1991 in accordance with the Law on Natural Rarities, and was later confirmed by the Spatial Planning of the Republic of Macedonia and in accordance with the Law on Protection of the Nature and the Environmental Law. The route of the highway passes through this natural monument with a length of 3 kilometres (from the chainage 4+000 to 7+000).

The gorge Drenovska covers an area of 0,26 ha. It is located in the gorge of the river Raec- gorge Drenovska, on the road Skopje- Prilep, whose borders are naturally determined. Here we can find the group Phragmition, represented through the following types: *Molinia coerulea* Vor, *Erianthus hostii*, *Adiantum copillus veneris*, *Pyracantha coccinea* | *Carex cuspidate*.

In order for a specific area to be protected, according to the International status IUCN III on Natural monuments, it should contain one or more specific distinctions with high national significance, which due to their uniqueness and rarity must be protected. Foremost, they must be protected against potential human influence. Their size has almost no influence, it is only their specific characteristics or the presence of representative ecosystems that has a crucial role in reaching a positive decision for attaining the status – Monument of nature.

Basic measures that can be undertaken within the protected areas are:

- Permanent preservation and protection of the natural characteristics and the specific, endangered and rare distinctions, attributes and forms;
- Requirements for conducting scientific research and educational activities related to their natural characteristics;
- Preventing activities that could have a negative impact on their natural characteristics.

According to the Law on Protection of the Nature (Official Gazette of RM, No. 67/04, 14/06, 84/07, 35/10, 47/11, 148/11, 59/12 и 13/13), there are specific limitations, prohibitions and requirements for actions within the area protected by law.

2.11. Socioeconomic characteristics of the surroundings of the express route

2.11.1 Demographic data

Municipality Rosoman

Rosoman is one of the smaller rural municipalities and it is located in the central part of the Republic of Macedonia, covering a surface area of 132,9 km². The total number of inhabitants in the municipality is 4.141, with an average population density of 31 inhab./km², which makes it one of the least densely populated municipalities within the territory of the R. Macedonia. The municipality centre is located in the Rosoman settlement, where nearly 62% of the population lives, and the rest are scattered within the remaining 9 inhabited places that are part of the municipality; and those are: Debrishte, Kamen Dol, Krushevica, Manastirec, Mrzen Oraovec, Palikura, Ribarci, Rosoman, Sirkovo and Trstenik.

Municipality Gradsko

Gradsko is located in the central lowland part of the Republic of Macedonia. The total number of inhabitants in the municipality Gradsko is 3.760, with average population density of 15,92 inhab./km². The territory of the municipality, including the village of Gradsko, has a total of 16 inhabited places; and those are: Vinichani, Vodovrati, Gorno Chichevo, Gradsko, Granchishte, Dvorishte, Dolno Chichevo, Zgropolci, Kochilari, Kuridere, Nogaevci, Podles, Svekjani, Skachinci, Ubogo and Ulanci. The territory of the municipality covers a surface area of 236,19 km².

Municipality Kavadarci

The territory of the Municipality Kavadarci spreads across the area of the middle Povardarie and it covers a part along the river Crna Reka. The total amount of population is 39 005 inhabitants and it covers a surface area of 391 km². There is a total of 40 inhabited places within the territory of the municipality Kavadarci: Begnishte, Bojanchishte, Bohula, Brushani, Bunarce, Vozarci, Galishte, Garnikovo, Gorna Boshava, Grbovec, Dabnishte, Dobrotino, Dolna Boshava, Dragozhel, Dradnja, Drenovo, Kesendre, Klinovo, Konopishte, Koshani, Krnjevo, Kumanichevo, Majden, Marena, Mrezhichko, Pravednik, R'zhanovo, Radnja, Raec, Resava, Rozhden, Sopot, Stragovo, Farish, Chemersko, Sheshkovo and Shivec.

Chart 19 General data on the municipalities through which the route passes

Municipality	Surface area km ²	Inhabitants/km ²	Inhabitants	No. of settlements
Rosoman	132,9	31,16	4,141	10
Gradsko	236,19	15,92	3,760	16
Kavadarci	391	39,04	39,005	40

Source: Census 2002

In respect of nationality, the inhabitants of all three municipalities are predominantly of Macedonian nationality, followed by Roma, Turks, Serbs, Bosniaks etc. The following chart gives the precise numbers of the ethnical structure, taken from the State Statistical Office from the Census of 2002.

Chart 20 Structure of the presence of different nationalities in the municipalities Gradsko and Rosoman

Municipalities Gradsko, Rosoman and Kavadarci								
Nationality	Macedonians	Roma	Turks	Serbs	Bosniaks	Albanians	Vlachs	Other
Total Municipality Gradsko	2 924	127	71	23	465	125	-	25
Total Municipality Rosoman	3 694	6	-	409	-	-	-	32
Total Municipality Kavadarci	37 499	679	167	218	4	2	27	145

Source: Census 2002

In respect of the age structure, specific for the municipalities through which the route passes is that the dominant population is between the age of 20 and 60, where the age subgroups are almost identically represented, which points to a high percentage of population capable of working. The young population, i.e. the population up to 20 years of age, is also a great part of the population, which is a good indicator that the economy in this part of the Republic of Macedonia is developing. By investing in the infrastructure, (including this newly planned Expressway) new conditions will be offered, so that the young population can stay in their birthplaces. On the other hand, it can be expected that there will be returning migration of the population to the rural areas and an intensive investment in the private economy, which additionally to the economical growth can influence the increased natality of population due to the improved living conditions.

The following chart shows the population numbers in respect of age, divided in age groups:

Chart 21 Age structure of the municipalities Gradsko and Rosoman

Demographic age of the population					
Municipalities	Age 0-19	Age 20-39	Age 40-59	Age 60-85+	Unknown
Rosoman	1030	1198	1098	813	2
Gradsko	1034	1122	975	629	-
Kavadarci	8333	11375	11648	7612	-

According to the data from the State Statistical Office, showed hereinafter in the chart, we can conclude that agriculture is the basic activity in the region of the municipalities Rosoman, Gradsko and Kavadarci. The total agricultural surface within the municipality Gradsko covers around 7 000 hectares, whereby over 80% are provided with irrigation network. From agriculture, the biggest income in the municipality comes from gardening, as well as vine growing. The arable land in Rosoman covers around 6.543 hectares, and only 68 hectares are forest. Agriculture is the main, i.e. the most present activity in this municipality as well (especially gardening).

Chart 22 Overview of the employed persons according to their activity in the municipalities Gradsko, Kavadarci and Rosoman

Municipality, activity	Total
Rosoman	820
Agriculture, hunting and forestry	419
Fishery	-
Mining and extraction of stone	-
Manufacturing industry	110
Providing electricity, gas and water	16
Construction	79
Wholesale and retail sale, servicing of motor vehicles, motorcycles and personal and household equipment	53
Hotels and restaurants	14
Traffic, warehousing and connections	34
Financial consulting	2
Activities related to real estate, renting and business activities	-
Public authorities and defence, compulsory social protection	45
Education	35
Health and social welfare	8
Other public utilities, cultural, general and personal service activities	3
Private households with employed persons	-
Extraterritorial organizations and bodies	-
Unclassified according to activity (unknown activity)	2

Municipality, activity	Total
Gradsko	728
Agriculture, hunting and forestry	436
Fishery	-
Mining and extraction of stone	-
Manufacturing industry	46
Providing electricity, gas and water	5
Construction	31
Wholesale and retail sale, servicing of motor vehicles, motorcycles and personal and household equipment	56
Hotels and restaurants	6
Traffic, warehousing and connections	27
Financial consulting	-
Activities related to real estate, renting and business activities	1
Public authorities and defence, compulsory social protection	58
Education	22
Health and social welfare	18
Other public utilities, cultural, general and personal service activities	22
Private households with employed persons	-
Extraterritorial organizations and bodies	-
Unclassified according to activity (unknown activity)	-
Kavadarci	
Agriculture, hunting and forestry	928
Fishery	9
Mining and extraction of stone	33
Manufacturing industry	2552
Providing electricity, gas and water	393
Construction	520
Wholesale and retail sale, servicing of motor vehicles, motorcycles and personal and household equipment	1092
Hotels and restaurants	164
Traffic, warehousing and connections	423
Financial consulting	126
Activities related to real estate, renting and business activities	139
Public authorities and defence, compulsory social protection	625
Education	640
Health and social welfare	552
Other public utilities, cultural, general and personal service activities	179
Private households with employed persons	-
Extraterritorial organizations and bodies	3
Unclassified according to activity (unknown activity)	52

Unemployment is a major problem for the municipalities Rosoman, Gradsko and Kavadarci, same as for other municipalities in the Republic of Macedonia, especially for young people who are lately attaining higher education degrees in a greater number. The inappropriate type of education in correlation to the market needs has had huge consequences for their lives. Due to the shutdown of a large number of capacities from the former state, many middle-aged people, who are capable of working, were left unemployed. Therefore, people have started to turn to the fields again; they are developing the agricultural sector, whereby timely provided help by the state and the intensive investment in infrastructural projects will be of great help for the population and a great incentive for domestic and foreign investors.

Chart 23 Total population aged between 15 and more according to activity

Municipality	Total	Economically active			Economically inactive
		total	employed	unemployed	
Rosoman	3378	1612	820	792	1766
Gradsko	3024	1418	728	690	1606
Kavadarci	31624	16710	8451	8259	14914

Almost half of the population of the municipalities Gradsko, Rosoman and Kavadarci is inactive. 50% of the active population is unemployed.

The educational structure of these municipalities is also very unfavourable. Around 1,5% of the population has finished higher education, and around 7% of the population is without any education. This educational structure does not promise economical growth in these municipalities even if the investment activities of the region were to increase.

Chart 24 Total population aged between 15 and more according to educational attainment

Municipality	Total population	Educational attainment								Still in primary education
		Without education	Incomplete primary education	Primary education	Secondary education	College	Higher education, faculty, academy	MA, MSc	PhD	
Gradsko	3034	234	738	1104	845	59	46	-	-	8
Rosoman	3380	223	835	1123	1099	71	27	-	-	2
Kavadarci	31685	847	4394	8046	15076	1277	1998	21	5	21

In respect of the structure of housing within these municipalities, according to the statistical information, we can conclude that the number of housings is bigger than the number of households. This is probably due to the fact that in rural areas, there are many housings that have been abandoned, but also due to the fact, there are weekend houses that are only used in periods of holidays and summer vacations. The data regarding the number of households and apartments are given in the following chart.

Chart 25 Total population, households and apartments in the municipalities Gradsko and Rosoman.

Municipality	Total population	Households	Apartments (all type of households)
Rosoman	4141	1284	1663
Gradsko	3760	1137	1436
Kavadarci	38741	12026	16324

2.11.2 Cultural heritage

The Republican institute for the protection of monuments of culture, for the needs of the Spatial Planning of the Republic of Macedonia, prepared an expert report on the protection of cultural heritage, which contains an inventory of the immovable cultural heritage of special significance. It contains a list of registered immovable cultural goods specified as monuments, among which: archaeological sites, churches, monasteries, mosques, baths, covered markets (bezistan), towers, clock towers, türbe, mausoleums, konak, bridges, buildings, houses, old bazaars, old city cores and other monuments with their names, locations, nearby inhabited places, period of origination and the municipalities where they are located.

According to the Law on Protection of Cultural Heritage (Official Gazette of RM No. 20/04, 115/07, 18/11, 148/11 и 23/13), types of immovable cultural heritage are: monuments, monument installations and cultural areas.

The following cultural goods have been registered along the determined solution for the construction of the Expressway according to the Expert report:

- Church Sveta Bogorodica, Drenovo, 14th century;
- Monument Mogila na Nepobedenite, Prilep, 20th century;
- Prilep Old Bazaar;
- Mosque Skrshena dzamija, Prilep, 15th century;
- Church Sveto Blagoveshtanie, Prilep, 1838;
- Mosque Charshi dzamija, Prilep, 1475.

In the Cadastral municipalities through which the newly planned route is passing and according to the Archaeological map of the Republic of Macedonia containing all prehistorical and historical layers of human existence, the following sites have been registered for the analyzed area:

CM Vodovrati

- Vidin, settlement from the bronze and early antique era, located 500 m northwest of the village;
- Vodovratski pat, necropolis from the transition of bronze into iron age, 2,5 km of the village Vodovrasti;
- Glavje, settlement from Neolithic era, 500 northeast of the village;
- Melnishta, settlement and necropolis from the late antique age, located 1,5 km southeast of the village;
- Church, medieval church and necropolis west of the village Vodovrasti;
- Crkvishte, finding from the roman period.

CM Sirkovo

- Potoche-Bavche, finding from the roman period;
- Przhelka, settlement from the roman period;
- Sirkite, settlement and necropolis from the late antique period, 2 km northeast of the village;
- Strupliva cheshma, necropolis from the helenic and roman period on the southwest end of the village;
- Tabanica, isolated finding from the roman period;
- Chernec, settlement from the roman period.

CM Kamen Dol

- Gramagje, settlement from the roman times 1km south of the village.

CM Debrishte

- Source, marble mine from the roman and late antique period, located on the west end of the village;
- Kurilovo, marble mine from the roman period, located 2km west of the village;
- Under the village, mining settlement from the roman period.

CM Drenovo

- Bekerova Cheshma, necropolis from the late antique period, located within the site Vrano Brdo, 800 m of the village;
- Valevica, sacral object and necropolis from the roman period, located 3km of the village;
- Vrano Brdo, fortified settlement- refugium from the roman period, 900 m east of the village;
- Gradishte- Devolgrad, settlement from the early antique and roman period, located 2,5 km of the village;

- Gramagje, settlement from the late antique period, located on a small surface, 2km of village;
- Gjupski Rid, settlement from the late antique period, 2km northeast of the village;
- Jachkovec, settlement and necropolis from the roman period, 2km east of the village;
- Kartzov Rid, villa rustica from the roman period, located north of the village;
- Kolibri, settlement from the late antique period, 700 m east of the village;
- Mutichanski Dol, settlement from the late antique period, 1,5km southwest of the village;
- Penur, necropolis from the late antique period, located east of the village;
- Pitranec, villa rustica from the late antique period, 2 km west of the village;
- Sveta Bogorodica, settlement from the roman period and medieval necropolis, near the church Sveta Bogorodica;
- Skala, settlement from the roman period, located 2,5 km northwest of the village, opposite the site Gradishte- Divol.

CM Raec

- Gramagje, settlement from the late antique period;
- Old graveyards, necropolis from the late antique period;
- Tumbite, settlement from the Neolithic period.

CM Farish

- Dabica, necropolis from the roman period, near the village school;
- Sveta Bogorodica, isolated finding from the roman period;
- Selishte, settlement from the late antique period, 1,5 km southeast of the village;
- Strazha, fortified settlement from the late antique period, 2 km southeast of the village.

CM Trojaci

- Vasilicki Grobishta, necropolis from the roman period, 1km northeast of the village;
- Gramagje, settlement from the roman period, 1,5 km north of the village;
- Debel Rid, isolated finding- coins from the roman period, 2km northwest of the village;
- Gjorgjevica, settlement from the roman period;
- Manastirche, settlement from the roman period, 500 m southeast of the village;
- Rakida, necropolis from the iron age, 500 m southeast of the village;
- Ridot, settlement from the Neolithic period, southeast of the village;
- Solishta, isolated finding- coins from the late antique period, 4 km northwest of the village;
- Church Sveti Gjrogjija, finding from the roman period located in the village;
- Crkvishte, finding from the roman period located in the village.

The route of the expressway comes close to the World War I monument at the loop Drenovo. It is considered that this monument is not endangered due to the distance between the expressway and the registered monument.

2.11.3 Land exploitation and ownership structure of the land

The following chart shows the structure of the land exploitation within the territory of the municipalities Gradsko, Kavadarci and Rosoman.

As it can be seen from the chart below, the municipality Kavadarci has registered 5786, Rosoman 1.444, and the municipality Gradsko 967 individual agricultural businesses. According to the statistical data, almost all of the available land is exploited, small part of the land is under lease, i.e. it is cultivated by people who do not own the cultivated land.

Chart 26 Number of agricultural businesses, exploited agricultural land and number of separate parts of exploited land

Municipality	Number of individual agricultural businesses	Total available surface area of the land (ha)	Exploited agricultural land (ha)				Number of separate parts of exploited land
			Total of exploited land	Own land	Taken for exploitation from others	Given for exploitation to others	
Gradsko	957	1682,84	1525,50	1042,30	496,15	12,95	1893
Rosoman	1444	2184,42	2068,99	1667,19	427,65	25,86	3975
Kavadarci	5796	6445.66	5455.18	4956.95	516.33	18.09	11263

Of the total available land the highest percentage is under viticulture, i.e. plough field, gardens. In Kavadarci, a large portion of the agricultural surface is vine growing, and in Rosoman, there are predominantly orchards. On the other hand, in comparison to Rosoman, Gradsko has more pastures.

Chart 27 Surface area of the exploited agricultural land according to categories

Municipality	Total	plough fields, gardens and home gardens	Meadow	Pastures	Orchards	Vineyards	seed-beds
Gradsko	1525,50	941,06	64,59	309,50	47,62	162,53	0,20
Rosoman	2068,99	351,20	13,12	30,61	635,86	1037,73	0,46
Kavadarci	5455,18	378,92	129,17	212,41	145,58	4587,94	1,16

In respect of plough fields and gardens, mostly represented are crops and vegetable and partially fodder crops.

Chart 28 Surface areas of exploited plough fields, gardens and house gardens

Municipality	Total of exploited plough fields, gardens and house gardens	Crops	Industrial crops	Fodder crops	Vegetable	Aromatic and medical plants	Flowers and decorative plants	Seeds and seed-beds	Fallow plough fields and gardens
Gradsko	941,06	620,55	6,95	59,24	162,28	1,05	1,65	0,01	89,34
Rosoman	351,20	107,92	1,65	94,98	118,18	2,00	0,80	0,10	25,57
Kavadarci	378,92	128,85	5,84	56,01	107,73	-	0,93	0,80	78,76

The chart below shows that the most dominant fruit tree in Rosoman is peach, but there are also apples, pears and prunes. In comparison to Rosoman, the surface area covered with orchards is far smaller in Gradsko and Kavadarci; however, the peach is dominant fruit tree in these municipalities as well.

Chart 29 Number of trees and surface area of apple, pear, plum and peach orchards

Municipality	Apples		Pears		Prunes		Apricots		Peaches	
	No. of trees	Surface area hectares	No. of trees	Surface area hectares	No. of trees	Surface area hectares	No. of trees	Surface area hectares	No. of trees	Surface area hectares
Gradsko	721	1,18	446	0,87	4.200	5,12	5.118	7,62	18255	26,74
Rosoman	7.080	10,15	6.842	9,20	6.498	17,38	9.237	13,46	390.598	581,77
Kavadarci	18339	24,46	4431	5,60	12507	20,54	3066	5,52	45189	72,68

The number of cherry, sour cherry, walnut and almond orchards is minimal. Details are given in the chart bellow.

Chart 30 Number of trees and surface area of cherry, sour cherry, walnuts and almond orchards

Municipality	Cherries		Sour cherries		Walnuts		Almonds	
	No. of trees	Surface area hectares	No. of trees	Surface area hectares	No. of trees	Surface area hectares	No. of trees	Surface area hectares
Gradsko	437	0,71	324	0,66	304	1,39	798	1,26
Rosoman	111	0,15	234	0,45	75	0,37	1242	2,38
Kavadarci	862	1,51	3477	3,84	627	7,15	705	1,44

The land in Kavadarci and Rosoman is also exploited for vine growing: vineyards cover 1.037,73 hectares with a total of 3.683.517 tree stumps. The vineyards in municipality Gradsko are relatively poor; bit in comparison to other cultures, their presence is nonetheless evident.

Chart 31 Vineyards

Municipality	Total of vineyards		Vineyards with vine breeds		Vineyards with table breeds	
	No. of tree stumps	Total surface area	No. of tree stumps	Total surface area	No. of tree stumps	Total surface area
Gradsko	489.505	162,53	483.615	160,49	5.890	2,04
Rosoman	3.683.517	1.037,73	3.476.596	975,07	206.921	62,66
Kavadarci	17.045.887	4587,94	15834792	4262,35	1211095	325,59

In Rosoman and Gradsko, tobacco is grown on a relatively small surface area. Sugar beet is also grown in Gradsko, However, it can be stated that the industrial crops are minimally represented in comparison to other agricultural crops.

Chart 32 Surface areas under industrial crops

Municipality	Total	Soybean	Sunflower	Oilseed rape	Tobacco	Sugar beet	Other industrial crops
Gradsko	6,95	-	-	-	5,55	0,50	0,90
Rosoman	1,65	-	-	-	1,65	-	-
Kavadarci	5,84	-	-	0,30	3,56	0,25	1,73

As the chart bellow shows, vegetables are grown on 182 hectares in Gradsko, i.e. 118 hectares in Rosoman. Predominant in Gradsko are the paprika, the potato, the watermelon and the tomato, whereas in Rosoman predominant are the paprika and the tomato.

Chart: Surface areas with vegetables, flowers and decorative plants

	VEGETABLE														Decorative plants
	Total	Tomatoes	Paprika	Cucumbers	Beans	Potatoes	Onion	Garlic	Carrot	Cabbage	Watermelon	Melon	Strawberries	Other vegetables	
Gradsko	162,28	11,46	83,98	1,74	2,88	11,35	3,37	0,58	1,98	0,45	36,29	6,03	0,10	2,08	1,65
Rosoman	118,18	11,33	83,93	4,59	0,79	2,15	1,81	0,66	0,14	4,97	3,59	1,40	0,34	2,49	0,80
Kavadarci	107,73	20,40	17,25	4,73	7,59	25,26	4,39	14,9	0,60	1,63	6,01	0,40	1,62	2,86	0,93

3.0 CONSIDERED ALTERNATIVES

3.1 Zero alternative

Looking into this alternative means not implementing the project in full, i.e. the expressway Prilep-Gradsko, and not just not implementing this section. Therefore, in such case the consequences shall be:

- Unchanged condition of the infrastructure in the region. Having in mind the fact that along this section there is no route, the potential for development of this area shall remain unexploited;
- There won't be any easy transport of people, goods and services along the designed corridor;
- The construction sector won't be activated during the construction of the road, for period of 2 years as the project runs.

On the other hand, in case this project remain unimplemented, the biological diversity shall remain unchanged, there won't be any conversion of the quality agricultural land, and there won't be any necessity to redirect Raec in order to perform the facilities within the expressway, such as the bridges and the viaducts.

3.2 Alternative routes

The chart bellow illustrates the process of choosing the location of the expressway. With location testing the basic information for the design have been provided, whereby the economic, environmental and social analyses have been taken in consideration in order for the final location of the projected road, i.e. its geometrical and structural design to cause as least as possible conflicts.

Thematic area	Characteristics	Factors
Engineering and economics	Construction costs	Topography, geology, geomorphology, materials, soils, vegetation, drainage, design criteria, safety
	Maintenance costs	Climate, traffic frequency, soils, materials, topography, drainage, geomorphology
	Costs of use	Traffic frequency, topography, time of travel, safety
	Land expropriation costs	Land price, land use, damage costs, traffic frequency, design criteria, plumbing, electricity and other installation, tax base
	Potential for development	Agriculture, forestry, excavation of minerals, trade and industry, tourism, personal mobility, political strategy
Social aspects	Characteristics of the area around the route	Population, culture, land use, land price, institutions, availability of transport, historical sites, public utilities, municipal borders, tax base, traffic frequency, employment, dynamic changes
Social/environmental	Recreation and preservation	Exploitation of land, flora, fauna, fish stock, areas with valuable sceneries, drainage, topography
Environmental	Pollution	Noise, water and air pollution, spills of polluting material, thermal and chemical waste
Aesthetics	Scenery value	Areas with valuable sceneries, road view, view toward the road, disfiguring elements, topography, vegetation, drainage

For the needs of the design of the expressway, a computer simulation of the two routes (so-called "west" and "east" variant) has been conducted, considering the factors as the topography of the field, the profitability of the construction vis a vis the

number of the bridges, notches and embankments necessary for the performance of the route etc.

The total length of the east variant of the route is 13+000 km, and of the west is 15+600 km; both variants merge together at the end point and until the end (i.e. the chainage 25+700 km) are considered as a single route, which is identical with the determined route.

The areas where the variants of the route are passing can be divided in several functional and spatially separated units. These are the following:

- Lake plateau with wavy hill shapes (area present in the greater part of the east variant of the route) and
- Island, isolated rocky masses with longitudinal spatial position, built and modelled in Palaeozoic and Mesozoic creations along the west coast of the Tikvesh valley (area present in the greater part of the west variant of the route).

The following chart illustrates the areas through which the alternative routes are passing, defined with separate chainages.

Chart 33 Areas along which the alternative routes are passing by alignment

Chainages	Exploitation of land in the route corridor
West variant	
3+000-6+800	Intensive exploitation of agricultural land- vineyards and pastures
0+900-2+300	Intensive exploitation of agricultural land- orchards and field
2+300-3+000	Pastures
0+900; 12+200	Riverbed, partially overgrown
3+300-3+600;	Settlements
0+000-5+800	Irrigation channels
13+200-15+300	Fallow
1+400-2+000	Sub-Mediterranean degraded forest
East variant	
0+000-7+500	Intensive exploitation of agricultural land- vineyards and pastures
7+500-8+500; 9+100-13+600	Intensive exploitation of agricultural land- orchards and field
0+000-8+500; 9+100-13+600	Irrigation channels
1+300; 7+100	Riverbed, partially overgrown
8+500-9+200	Settlements

The most adequate alternative of the route was chosen by taking in consideration the environmental aspects in the following manner:

- The east variant passes through a larger number of ravines/temporary water flows in comparison to the west variant; that way the influence on surface waters would be more significant for the east in comparison to the west variant;
- Most of the length of the west variant passes through a hilly terrain and through a land which mostly consists of lower cadastral classes, therefore this variant has a smaller risk of surface waters and groundwater pollution;
- The east variant will also contribute to the lost of quality agricultural land, it will potentially bring up the need to dislocate the irrigation channels within the Tikvesh system, which makes this variant to be even more unfavourable in respect of the impact it has on the environment, which is more significant for this alternative route in comparison to the west variant.

Due to the above stated criteria, but also due to the fact that a larger amount of money is necessary for the expropriation of the land necessary for the east variant, the designers opted the **west variant of the route**. During the preparation of the Main design, the route was additionally determined in detail and as such is the subject matter of the analysis within this Study on Environmental Impact Assessment.

4. ASSESSMENT OF THE IMPACT ON THE ENVIRONMENT OF THE PROJECT

In compliance with the procedure for the implementation of the EIA procedure and the Rulebook on the contents of the requirements that the Study on Environmental Impact Assessment should fulfil, during the analysis of the possible impact this Project could have on the environment, as a main guidance we took the opinion of the Ministry of Environment and Spatial Planning regarding the scope of the Study, and thus, inspected in the phase of construction and the phase of work. According to the impact, i.e. the reasons contributing to the negative environmental impact of this Project, a set of measure for the reduction of such negative impacts has been proposed.

The analysis on the possible impacts from the Expressway Project is done during the phase of construction and the phase of its work, i.e. operational phase on the media and the regions of the environment.

The following activities are planned for the construction phase:

- Preparation works for marking and clearing of the terrain of the construction site, the expressway route and the access roads;
- Construction activities related to land excavation and access roads;
- Construction of notches, embankments, placing of tampon layer and asphaltting of the road;
- Finished construction works and clearing of the construction site.

Within the operational phase, we have investigated the impact from the expressway use (exploitation).

The impacts have been assessed by using a qualitative assessment of the following parameters:

Type:	Positive (+); Negative (-)
Magnitude:	A - big, B-medium и C-small/insignificant
Degree: (on the surrounding area)	Local impact (on the place itself); Broader impact
Duration:	Gradual impact; Temporary impact;
Time adjustment:	Immediate; Postponed;
Reversibility:	Reversible;
Irreversible	

4.1. Impact on topography and geology

4.1.1 Construction phase

During the construction phase of the expressway, a degradation and erosion of the

rocky masses/sediments is expected to occur due to:

- The construction of the access roads,
- Land excavation and
- Placing of the body of the expressway

During the construction a small negative influence is expected during the preparation works on the site (cutting of trees, removal of humus and levelling the terrain), while during the excavation a greater negative impact on the terrain's geology is expected. Because of this, there is danger of appearance of sheds and landslips during the land excavation. The sheds and landslips can affect the planned activities and the safety of workers.

During the construction, i.e. the excavations there is a danger of landslips and sheds everywhere where the geological characteristics on the terrain contribute to such appearances.

Basically, the topography and the geology are mainly endangered by the work related to the excavations and the embankments for the construction of the expressway in the hill and mountain areas. During the construction, earth works have to be performed for the placing of the grading line in the necessary position in order to achieve the necessary stability. The inappropriate protection of the excavations (notches) and the embankments can cause land erosion, and in specific cases, it may affect the stability and thus create landslips of different scope and with different effects.

It is important to define 2 types of problems regarding the stability of the slopes, i.e.: deep and shallow slides/erosion. Deep disruptions of the stability of the slopes are of geomechanical nature and can be solved only through an appropriate geometry of the notches. In respect of the shallow disruptions, the problem is the difficulty to quantify the depth, i.e. the type of measure for solving the problem. They can also occur in slopes that with geomechanical analysis were deemed as stable, but because of heavier rainfalls can cause sheds.

The potential of appearance or deepening the erosion processes as a result of the construction and exploitation of the expressway can be seen from the analysis of the geomechanical characteristics.

The designer has prepared a report on geomechanics in which he thoroughly analyzes the geological environments through which the route passes, it interprets the contemporary geological processes that can reflect on the stability of the construction, and also determines the slopes of the embankment and the notches of all the chainage, i.e. the different heights of the embankments and notches.

Additionally to the analysis for identification of zones where erosion can occur, inspections and laboratory analysis have also been conducted by a team authorized for engineering-geological and geomechanical inspection in order to determine the following parameters:

- Plasticity index (PI);
- Content of humidity (%);

- Estimated optimal content of humidity (%); and
- Estimated maximal density of dry state in relation to the density of moist state (kg/m^3).

The morphology of this region shows a complex state, caused by a complex mutual influence of the tectonic, neotectonic, contemporary processes of decay, that have contributed to the creation of today's relief. The route goes through complex geological and hydro geological surroundings and therefore the proposed measures for the stabilization of slopes are different according to the changes of the specific sections.

Along the route of the road, a large number of notches are planned, whereby the height of the general slope of several notches amounts even more than 20.0 m. They will be mainly constructed in: Pliocene sediments, serpentinites and metamorphic rocks. Within the frames of each geological environment or quasi-homogenous zone, specific profiles have been chosen, for which an analysis of the slope stability has been conducted on the grounds of the proposed inclines, shown on the transversal geotechnical profiles.

Along the route of the subject matter section, several longer embankments with a height over 10.0 m are planned, as well as several smaller. The base on which the embankments are to be constructed has a very small inclination or almost horizontal and the same is built on different geological units.

Having in mind the physical – mechanical parameters of the materials present in the foundation, no greater risks are expected from the development of bigger deformations. On the other hand, for the zones where the embankments are designed on a steeper terrain, a cascading indentation of the foundation is recommended, while in cases where the embankment toe falls far from its face, shortening of the embankment with a supporting wall is recommended.

Since the stability of the embankment slopes constructed on a good foundation depends foremost from the characteristics of the materials and the manner and quality of their embedding, it is necessary to have an optimal dimensioning of the inclinations of the slopes.

The topography and geology of the terrain will be altered due to the necessary exploitation of the locally available material for the construction of the road structure. On the grounds of the engineering and geological mapping of the terrain, near the route of the planned road, possible materials for the construction of the sub base and tampon layer are the existing quarries and separations located near the route.

Loans

Possible loans are the quarries and the separation in s. Kamen Dol, the material from this loan can be used for the whole route. Having in mind that an existing quarry will be used, there will be no need to attain a right to use the material for the purposes of the construction upon attaining concession.

Indicated as a material for the structure of the embankment is the material from loan I, located around 50 m of the intersection, and near (in chainage on km 9+200) the planned route. The same is constructed from a diluvial sloping material from dusty sand and rock debris from semi-treated and treated pieces of serpentinite.

Loan II is located around 1.0 km north of s. Sirkovo, which can be reached though macadam roads, and it is closest to the left side of the route (chainage on km 17+540). The surroundings of this loan consist of proluvial material, consisting of dusty-like shingly sand.

The originating rocks are limestone conglomerates and breccias that are the basis for this slope and the surrounding higher peaks. The pieces of rock found here are mostly not treated or semi-treated with dimensions around 10 cm, rarely bit larger, and have a diverse genetic origin as a limestone, quartz, slate, serpentinite etc.

The possible loan III (located on the left side of the river Krushevichka, i.e. on the left side of the route on chaniage 19+420 km) did not get the expected results, and therefore was replaced by loan IV (located on the right side of the river in the alluvial deposit). Namely, the location of loan IV is the former riverbed of the river Krushevichka, where the gravels are with dimensions of around 10 cm, rarely in larger blocks.

In a close proximity of the route (km 21+500) the loan V is located in Pliocene sediments consisting of sandy gravel and sand dominated by a fine fraction 1-2 cm. The morphology of the terrain is suitable for the notch to be continued and used as a good material for embankment.

The loan VI spreads across the peak of Golema glava (chainage km 24+960) on a larger surface area und it is being exploited. The material is sandy gravel with bigger gravels of 5 cm and even larger. Under the outlined area, sporadically on a depth of around 1.5 m, northeast and north, possible cemented gravel grains (conglomerates) appear, which can also be used as a good material.



Picture 37 Loan VI, "Golema glava"

This loan will be re-cultivated in such a way, that it will be organized as a landfill for removal of excess earth material.

For every new loan, a procedure for attaining concession shall be conducted according to the provisions of the Law on Mineral Resources. This law also prescribes the requirement of appropriate Studies or Reports on Environment Protection, when attaining the right to conduct geological and geomechanical research, as well as for the exploitation of mineral resources.

With the erection of loans, the visual and geomorphologic characteristics of the terrain shall be altered. It is possible to reduce the impact, which is discussed in the chapter Measures for reducing the negative impact on the environment.

Landfills

The geology and topography of the terrain will be affected by the erection of the landfills for removal of the excess excavated material that cannot be used for the embankments and/or the sub base for the construction of the road structure.

As basic criteria for most efficient and economic organization of works within the construction phase, the following aspects were taken in consideration when recommending landfills locations:

- geo-ecological conditions and
- conditions of transport.

This is more evident from the following criteria:

- to enable as short as possible transport;
- the foundation should be stabile in respect of its deformable and strength characteristics, so that the disposed material does not cause additional settling of the terrain or initiate instability on the foundation, as well as on the landfill itself;
- to exclude the possibility of groundwater and surface water pollution;
- in respect of hydrological conditions, a free flow of the atmospheric water should be provided in time of intensive rainfalls;
- when selecting the proposed landfill locations, all facilities that are to be built in the future should be taken into consideration.

The proposal for landfills does not take into consideration the property legal relations, i.e. there is no information regarding the land ownership for the proposed locations.

- Landfill O1 (km 9+580)

The first landfill is located at the beginning of the route, on the left side around 100 m away. The excess material of the first notch in the serpentinite shall be deposited on the location that shall be erected in the same serpentinite surroundings. The landfill has a capacity of cca 25.000 m³.

- Landfill D2 (km 11+980)

This landfill is located on the right side of the road route in close proximity of around 20 m, where the terrain is a gentle slope with a surface are of 8.000m². The terrain is built of Pliocene sediments, consisting of a mixture of sand and dust. As a location for removal of excess material from the notches and steps, this landfill has a capacity of cca 20.000 m³.

- Landfill D3 (km 14+120)

It is located on the left side of the road route, 100 m away. The terrain of this zone is a gentle slope with surface area of around 20000m². According to the geological mapping, it was determined that the terrain consists of marble, which is covered on the surface with thin diluvium. Through a rough estimation, it can be estimated that the location has a capacity for removal of excess material of cca 40000 m³.

- Landfill D4 (km 17+300)

Located on the left side, around 100 m away from the route, on the road to the locality called Pintovec. The terrain is a gentle slope with a surface area of around 10.000m². The terrain consists of Pliocene sediments. The landfill has a capacity of 25.000 m³.

- Landfill D5 (km 25+100)

This landfill is located on the left side, 500 m away from the road route, on the northwest after the peck Golema Glava. This zone consists of Pliocene sediments. The landfill has a capacity of cca 30.000 m³.

The landfill locations for excess excavated material should be confirmed by the Ministry of Environment and Spatial Planning on the grounds of this Study.

The inadequate disposal of the construction waste on the construction site, as well as in the surroundings, may temporary disrupt the local topography and geology.

No construction waste shall be disposed on the landfill locations. The construction waste shall be disposed on locations determined by the local authorities.

Additionally to the height, i.e. the inclination of the notches and embankments, very important is the stability of the drainage. Corresponding measures should be prescribed in order to reduce this impact.

4.1.2 Operational phase

In the Operational phase of the expressway no influence on the topographic and geological structures of the locality is expected, if the contractor of the expressway obeys the legislation, the ruling regulations and the good construction practice.

4.2. Impact on surface water and groundwater

4.2.1 Construction phase

During the excavation and setting of the structure of the expressway on locations in close proximity to streamflows, it could come to short-term temporary pollution of the water with soil, solid particles that can cause blurring of the water, oil or fuel spills from vehicles and the used equipment or part of the created waste.

In addition, during the preparation of the land for new access roads, establishment of constructional zones around the route of the expressway, there can be pollution of the surface waters and groundwater of temporary character in the form of:

- Erosion of sediments due to the removal of the soil cover
- Leakage of fuel and oil from the equipment and the vehicles
- Different type of waste which is created during these activities

Establishing a linear construction belt and construction zone during the construction of the expressway and the construction of the access roads to specific parts of the route may affect the quality of surface waters in the following manner:

- Disruption and removal of the soil cover (the humus) and part of the rocky masses/sediment can cause an erosion of the sediments and potential pollution of the surrounding surface waters by increasing the level of the solid suspended particles in them
- The untimely disposal and dislocation of the excavated masses during the construction of the pipeline can result in the creation of artificial fence and accumulation of water in the down stream of the surface flows
- Spills of polluted water on the places with construction activities
- Leakage of fuel and oil from vehicle and construction mechanization
- By disposing, i.e. dumping waste in the surface waters
- Heavy metals from the vehicle emissions

The access roads can have the following impact:

- to change the way and mode of drainage of the atmospheric waters because of the alteration of the permeability of the surface due to the removal of the vegetation
- to evoke erosion and
- under the influence of rainfalls, deposit and suspended material can be transported along the natural drainage roads and finally this material can be brought to streamflows, which will then be blurred.

In the construction phase, the compacting of the underground, as well as other measures for providing stability can evoke alteration of the consistency of the ground, which directly influences the regime of surface waters and groundwater.

When the expressway is in an embankment, then it can be a serious physical obstacle for the movement of surface waters and groundwater that flow into that watershed flowing toward the recipient. It may come to an unnecessary retention on the terrain or excessive moisturising, even flooding.

When the route is in notches or steps, then the groundwater are intersected. In that case when the level of groundwater is elevated, when there is a rise of ground waters due to the disruption of the network of groundwater, the surrounding land is endangered.

The construction of the expressway will cause the destruction of the soil and the rocks to smaller fractions, which will accumulate on the slopes, i.e. near the riverbeds. During snow meltdowns and more intensive rainfalls this fractions shall be transported to the riverbeds. The rocks and the soil that have been removed or dissolved during the construction of the expressway will result in increased turbidity, i.e. increased amount of hard-suspended particles. On the other hand, this will increase the content of the heavy metals, and thus the toxic effects on the environment.

However, the biggest danger during the construction of the expressway comes from accidental leakage of fuels, oils and lubricants from the vehicles and the mechanisation used for the construction of the expressway. It is well known that the carbon hydrogen present in fuels and oils are extremely toxic to life beings.

No irreversible direct effects on the network and quality of the surface waters during the construction works are expected.

Other possible effects from the construction of the expressway come from the camps of the workers, as well the locations intended for cleaning and maintaining of the vehicles and the mechanisation.

The workers' camps can be a source of pollution with faeces (communal waste) waters, but also solid waste.

It is expected that the camps of the construction sites would generate sanitary wastewater. The inappropriate management of wastewaters from these temporary facilities may have medium negative impact (due to the duration and continuity of the influence) on groundwater, since they can cause their pollution.

Wastewaters shall appear on locations where there will be water sprinkling in order to reduce the emissions of dust during the excavations; wastewaters will be drained in zones at the crossing of the expressway through a river (bridges).

The amount of water necessary for conducting the construction works is not expected to have a significant impact on the reduction of the available waters for irrigation and other needs. The water shall be delivered to the construction site by tanks; during the testing of the expressway in respect of the quality of the construction (in order to detect potential point of leakages) a significant amount would have to be provided. Therefore, it may be necessary to install a temporary system of water supply.

If during the excavations made for the construction of the expressway any groundwater appear and a drainage has been done, then it may have effects on the hydrology of the area in case of prolonged drainage.

The inappropriate drainage or changing of the course of the waters may result in the appearance of marshland around the location of construction, which can, if it is not drained on time, create a suitable environment for the spreading of insects- vermin.

The irrigation in gleying and sandy soils with the help of surface pumps may cause the upper soil layer to wash away, which in turn can create voids and pockets in the soils around the location where the excavation is conducted and around the facilities located near the earth works.

Normally the water with changed course is relatively clean and may be drained in the sewage or it may even be drained in the surrounding stream flow. Still, some exceptions must be made when there is a change of course near a polluted ravine or near an existing source of pollution for the groundwater. This is applicable to areas where the excavations will be near existing gas station or near pig farms, where the groundwater could be polluted by carbon hydrogen or chemicals. Even though such cases are rare, if they occur it may be necessary for the contaminated water to be collected and appropriately treated.

The drainage of wastewater shall be conducted in the recipient nearest to the expressway, on the grounds of a permission issued by an authorised body.

The chart shows the main junctions with stream flows, ravines and irrigation

channels, as well as places of approaching accumulations along the analysed section.

Chart 34 Locations that potentially will be affected in respect of the quality of the surface waters

Chainage	constructive element	proximity and intersection with a streamflow
0+000.00 - 0+373.00	embankment	alignment of the route on the left side of the river Raec
0+373.00 - 0+439.00	bridge	alignment of the route on the left side of the river Raec
0+439.00 - 0+535.00	embankment	bridging of the river Raec
0+535.00 - 0+580.00	excavation	alignment of the route on the right side of the river Raec
0+580.00 - 0+685.00	tunnel	alignment of the route on the right side of the river Raec
0+685.00 - 0+707.00	excavation	alignment of the route on the right side of the river Raec
0+707.00 - 0+790.00	bridge	bridging of the river Raec and the asphalted road Prilep-Rosoman
0+790.00 - 0+930.00	half-through bridge	alignment of the route on the left side of the river Raec
0+930.00 - 1+020.00	bridge	bridging of the river Raec and the asphalted road Prilep-Rosoman
1+020.00 - 1+075.00	half-through bridge	alignment of the route on the right side of the river Raec
1+075.00 - 1+258.00	bridge	bridging of the river Raec and the asphalted road Prilep-Rosoman
1+258.00 - 1+310.00	half-through bridge	alignment of the route on the left side of the river Raec
1+310.00 - 1+390.00	gallery	alignment of the route on the right side of the river Raec
1+390.00 - 1+445.00	excavation	alignment of the route on the right side of the river Raec
1+445.00 - 1+520.00	bridge	bridging of the river Raec and the asphalted road Prilep-Rosoman
1+520.00 - 1+575.00	supp. wall	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
1+575.00 - 1+615.00	gallery	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
1+615.00 - 1+635.00	supp. wall	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
1+635.00 - 1+660.00	notch	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
1+660.00 - 1+880.00	supp. wall	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
1+880.00 - 2+030.00	notch	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman

Chainage	constructive element	proximity and intersection with a streamflow
2+030.00 - 2+107.00	embankment, wall	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
2+107.00 - 2+260.00	bridge	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
2+260.00 - 2+338.00	half-through bridge	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
2+338.00 - 2+380.00	notch	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
2+380.00 - 2+570.00	excavation	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
2+570.00 - 2+593.00	embankment	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
3+440.00 - 3+545.00	bridge	parallel alignment with the asphalted road Prilep-Rosoman on its right side
3+830.00 - 3+935.00	bridge	parallel alignment with the asphalted road Prilep-Rosoman on its right side
5+543.00 - 5+643.00	bridge	bridging of the river Raec and the road Prilep-Rosoman
5+915.00 - 5+939.00	bridge	bridging of the river Raec and the road Prilep-Rosoman
5+939.00 - 5+995.00	embankment	parallel alignment with the asphalted road Prilep-Rosoman and the river Raec
5+995.00 - 6+085.00	notch	parallel alignment with the asphalted road Prilep-Rosoman and the river Raec
6+085.00 - 6+150.00	supp. wall	parallel alignment with the asphalted road Prilep-Rosoman and the river Raec
6+150.00 - 6+271.00	bridge	bridging of the river Raec and the road Prilep-Rosoman
6+271.00 - 6+360.00	notch	parallel alignment with the asphalted road Prilep-Rosoman and the river Raec
6+360.00 - 6+559.00	excavation	parallel alignment with the asphalted road Prilep-Rosoman and the river Raec
6+559.00 - 6+629.00	supp. wall	parallel alignment with the asphalted road Prilep-Rosoman and the river Raec
6+629.00 - 7+001.00	embankment	parallel alignment with the asphalted local road and the river Raec
7+001.00 - 7+020.00	bridge	bridging of the river Raec
7+210.00 - 7+235.00	bridge	bridging of the asphalted local road and the river Raec
10+852.00 - 11+477.00	embankment	intersection with a streamflow
16+074.00 - 16+134.00	bridge, channel	coming near the village Sirkovo (100 m), intersection of a streamflow and near a siphon
17+062.00 - 17+095.00	bridge	

The previous chart shows when the route is led into a notch, and when into an embankment for the sections that potentially endanger the quality of the surface

waters. This data is important for the designing of the drainage system for the washing off waters from the road.

When designing the sections, a special attention has been given in order for them to be out of the scope of the facilities of the hydromeliorative system of „Vodostopanstvo Tikvesh”.

At the end of the route, where it approaches the highway E-75, the route goes northwest of the irrigation channel. Due to technical and terrain related conditions, on specific chainages, the route approaches and cuts part of the meliorative system, and thus: the connection of the Expressway with Highway A1 Tabanovce-Bogorodica on the chainage 24+750,00, as well as on the chainages 10+000,00 to 11+500,00 and 21+000,00 to 22+000,00, where the route cuts part of the underground pipeline network managed by v.z. Drenovo Debrishte and v.z. Podles.

The following chart shows the chainages and the land exploitation on the route sections, where there is a potential for endangering of the existing irrigation system.

Chart 35 Locations of potentially endangered irrigational channels

Chainage	Land exploitation	Potentially endangered part of the irrigation system
9+250.00-9+379.00	irrigation channel, vineyard	intersection of the irrigation channel
9+745.00 - 10+197.00	irrigated, arable land- vineyards	intersection with the underwater pipeline network km 10+000,00 to km 11+500,00
11+477.00 - 12+157.00	fallow land, arable land	intersection with the underground pipeline network km 10+000,00 to km 11+500,00
12+157.00 - 12+237.00	arable land	approaching the irrigation channel (50m)
12+237.00 - 12+597.00	fallow land, irrigated surfaces- vineyards, dry ravine	approaching the irrigation channel (50m)
12+597.00 - 12+937.00	small orchard, fallow land and quarry	approaching the irrigation channel (50m), approaching the quarry
12+937.00 - 13+037.00	intersection with an asphalt road, fallow land and agricultural auxiliary facilities	approaching the irrigation channel (50m), approaching the quarry
13+037.00 - 13+087.00	asphalt road, fallow land	approaching the irrigation channel, quarry
13+233.00 - 13+449.00	inhabited place, waterside vegetation, dry ravine	passes through the village Kamen Dol and near a siphon
14+217.00 - 14+511.00	fallow land	approaching the irrigation channel (50m)
14+548.00 - 14+691.00	fallow land	approaching a siphon (70m)
14+691.00 - 14+727.00	fallow land	approaching the irrigation channel (50m)
14+727.00 - 14+857.00	irrigated land- vineyards	approaching the irrigation channel (50m)

Chainage	Land exploitation	Potentially endangered part of the irrigation system
14+857.00 - 14+977.00	dry ravine, irrigated land- vineyards	approaching the irrigation channel (50m)
14+977.00 - 15+189.00	irrigated land- vineyards	approaching the irrigation channel (50m)
15+189.00 - 15+349.00	irrigated land- vineyards, fallow land	approaching the irrigation channel (50m)
15+349.00 - 15+463.00	dry ravine, irrigated land- vineyards	approaching the irrigation channel (50m)
15+463.00 - 16+037.00	irrigated land- vineyards, earth road	approaching the irrigation channel (70m)
16+037.00 - 16+074.00	fallow land	intersection with siphon
16+074.00 - 16+134.00	small orchard, fallow land and quarry	approaching the village Sirkovo (100 m), intersection of the streamflow and near a siphon
24+517.00 - 24+817.00	irrigated land and intersection with earth roads	intersection with the main channel for irrigation km 24+750,00

The contractor should pay a special attention to these parts of the route, so that the functioning of this system would not be endangered, and if is endangered, then the situation should be returned in its former state in order to prolong the process of free distribution of water.

3.2.2 Operational phase

In the operational phase, the expressway will have an impact on the quality of the surface waters and groundwater in raining conditions where the washing out waters from the road surfaces will be drained in the surrounding field.

Typical impacts on the quality of the waters as a consequence of the road drainage are the changed levels of heavy metals, salinity, blurring of the waters and dissolved oxygen. On the other hand, these changes in the water quality, even in regions with high humidity, are often temporary and localized as a consequence of the variations of the water quantity.

According to the conducted research in respect of the effect on groundwater from the penetration of washing out waters, it has been confirmed that small traces of substances in a concentrated form have been measured in groundwater in the first inflows of washing out waters.

The washing out waters from the road (especially the first inflows of rainfalls that contain high concentration of polluting material) traces of petrol, fuel, heavy metals that may endanger the aquatic environment and scenery. The concentration of harmful materials in the washing out waters of the roads, induced by traffic come from the combustion of motor fuel (particles and gases), abrasion i.e. wearing off of tires, from brakes and vehicle leakages (oil etc.)

One of the most dangerous impacts on the environment is the leakage of polluting material during accidents.

Additionally to the washing out waters, the use of salts and other agents for initiating melting of ice and the snow cover may also endanger groundwater. The primary agent for defrosting, NaCl, causes corrosion of vehicles and bridges, it contaminates the sources of drinking water and it is toxic for many plants, as well as fishes and other water organisms. The defrosting agents influence the mobility of the chemical elements in the soil, such as the heavy metals (with the help of NaCl) and Na, Cl, Ca and Mg (through CMA). This process facilitates the contamination of groundwater, aquifers and streams. Due to the effect of dissolving, the chemical impact of the chemical deposits from the roads has the biggest influence on small streams, especially in areas where they come close or intersect with the road. These locations are identified in chart 34.

3.3. Impact on the air

3.3.1 Construction phase

The emissions in the air during the construction will appear as a result of the exhaust gases from the constructional mechanization (rippers, bulldozer and excavator, trunks and tanks). Within these emissions pollutants such as SO_x, NO_x, CO, VOC etc will appear. Generally, a low concentrations of these pollutants is expected, but when the machines are operating, or when the motor is not functioning properly (potentially due to the poor maintenance of the construction machines), potential harmful polluting material may be released. Still a fast dispersion of these pollutants within the regions where the project is performed is expected, and it is also expected to potential jeopardize a small number of people, because of the small number of settlements near which the route is approaching.

Dust will appear as a result of the earth works and the activity of the preparation of the terrain and clearance, excavation, rock mining etc. When constructing the expressway in a rocky environment, it may be necessary to use explosives. These activities shall generate dust and solid particles.

Other major source for dust is the movement of vehicles transporting the equipment within the zones to the construction sites.

It is expected that the effects from these impacts to be of local and short-term importance. The reoccurrence and importance of generating dust will depend on the meteorological and soil conditions in time of the activities and on the location. However, under normal meteorological conditions, the effects from dust shall be limited to a few meters from the area where the project is conducted.

Generating dust may influence the ability of the surrounding vegetation to survive and maintain efficient transpiration. The occurrence of dust may also represent a potential source for health problems for the workers (disruption of breathing) in the area where the construction works are conducted. Namely, dust may represent a source for irritation and health risk for people, but in the case of uncontaminated soils, the dust raised into air is considered just an unpleasant occurrence for those exposed to it.

The proposed route for the expressway stretches in a distance from inhabited places, public surfaces (for example parks) and other public facilities and it is considered that there are no crucial sensitive receptors of air pollution (including dust), such as schools, hospitals, natural reserves, recreational areas etc.

The only location where the trace may potentially endanger sensitive locations is the settlement Kamen Dol, through which the route of the expressway passes.

As an indirect source of emissions in the air are the traffic jams that may occur during construction. The vehicle emissions in the air are usually generated during disruptions in traffic, including traffic jams.

This negative impact has been estimated as temporary with a medium size.

3.3.2 Operation phase

During the exploitation, emissions will appear from vehicles that will run along the expressway, i.e. from:

- System of exhaust gases;
- The casings of the monitors through the exhaust pipe
- Carburettor, reservoir

It is considered that the exhaust gases from vehicle have 180 organic components as harmful material, whose concentration is the highest at places with increased number of vehicles and motors working in place or stopping, when the emission of toxic matter is 2,5 times higher than when moving with a speed of 70 km/h. According to the research in this domain, it is estimated that 1000 l. of burned gas from motor vehicles, emits in the atmosphere 98 kg carbon monoxide, 6-8 kg nitrogen oxide and 4-5 kg sulphurous compounds.

The impact from toxic gases may have consequences for people who have been directly and for a long period of time exposed to them through their direct actions (inhaling), as well as indirect. The smoke, for example, mostly influences the respiratory organs, the skin etc., and the carbon oxide acts as a strong poison and antioxidant.

The nitrogen oxide causes asthma, allergies and malignant diseases on the respiration system. Some compounds from the group of polycyclic carbon hydrogen, benzopyrene, for example, which is a product from the burning of fuel (one ton fuel gives 50 mg benzopyrene) is first on the list, and it is the most spread of the cancerogenic substances, also very cancerogenic are the solid particles as a product of the burning.

The maximum allowed amount of harmful substances according to the legal provisions should be within the following values:

Chart 36 Maximum permissible values of emissions of mobile sources

Components	Emissions Amount MDK gr/h	Concentration of emissions MDK mg/m ³
Nitrogen oxide	5000.0	500.0-800.0
Carbon hydrogen		500.0
Formaldehyde	100.0	20.0
Solid particles		130.0
Carbon monoxide		650.0
Carbon dioxide (%)		2.5

Source: Meteorology office, Ministry of economics

The amount of exhaust gases during the combustion of fuel in the motors with internal combustion and the content of CO in gases depends on the vehicle type, the strength, the speed of movement, the road inclination etc.

According to the research on emission of polluting matters, the following values have been adapted:

- The mean value for the specific weight of petrol may amount 0,740 kg/l
- The mean value for the specific weight of diesel fuels may amount 0,840 kg/l

The emission factors for individual polluters may amount:

- Only 95% of the sulphurous content converts into SO₂

According to the data from the VDI 2053 standard it is evident that a motor vehicle with a petrol engine with an average strength of cca 1,500 cm³ of the propulsion aggregate during idle motion produces 5-10 Nm³/h exhaust gases, which contain approximately 10% volume parts of CO. While during driving the same vehicle with the same propulsion aggregate, 40-60 Nm³/h are emitted, with approximately 5% volume parts of CO.

In respect of vehicles with diesel aggregate, with the same performances as the previous case, the amount of CO in the exhaust gases is smaller than 0,1-0,2 %, i.e. the amount of CO in passenger vehicles for 1 hour of moving with a speed of 50 km/h amounts:

VCO= 0,025 m³/h, or 250 gr. CO.

In respect of the freight motor vehicles, while moving with a speed of 50 km/h the amount of CO per hour amounts:

VCO= 0,070 m³/h, or 700 gr. CO.

The average amount of CO upon participation of 30% of freight motor vehicles amounts:

VCO= 0,038 m³/km per motor vehicle.

The total number of registered passenger motor vehicle in the Republic of Macedonia in 2008 is 308494 vehicles. In 2008, 263.112 passenger cars were registered or 128.5 cars per 1000 inhabitants.

Out of total number of registered passenger vehicle, 225.216 are in the private sector, out of which 17.587 are passenger vehicles with first registration. In the last period, 8.626 motorcycles, 2.270 buses, 13.325 freight car, 756 tractors and work vehicles and 4.850 trailer vehicles have been registered.

Because of the changes in the regional politics, the traffic circulation within the last 15 years has been altered several times. However, the traffic density of highways remains the low.

The value of AADT (Average Annual Day Traffic) in the average annual report of 2002 amounts 3.000 to 4.000 vehicles per day. The measuring of traffic in 2006 showed a traffic density between 3.000 and 5.500 vehicles per day on the highway and 1.500 to 3.200 on regional roads. This data regarding the traffic have been collected by automatic vehicle numerators, with high level of accuracy and reliability. This shows that there is a modest rise of the traffic in urban parts, with evident increase within the capital Skopje, due to the increased number of individual vehicles.

The measurements of the traffic published in the newsletter on road traffic in 2008 showed average annual day traffic of around 5.210 vehicles on the main roads and an average annual day traffic of around 2.185 vehicles on regional roads.

The estimations regarding the emissions in the air calculated by using the above stated formulas and coefficients can only be conducted if the exact number of the Average annual day traffic (AADT) is known, i.e. when the estimations for the exploitation period of the express way become available. In addition, it is necessary to make a distinction between the petrol vehicles and diesel vehicles, regarding of which it is necessary to have the percentages of diesel versus petrol vehicles. This kind of distinction among vehicles does not exist in the available statistical information. Because of these limiting factors, it is not possible to make the appropriate estimation of the polluting material emissions from the traffic during the exploitation of the expressway.

On this level of planning, it can be assumed that the frequency of the traffic along the expressway will be with limited volume (around 3.000 average annual day traffic). In case of increased frequencies of traffic, (increasing, which can mostly by with seasonal character), it is possible that a necessity for application of appropriate biological measures for protection against air pollution appears. In the same time, it is possible for the measures to be combined with the administrative prohibitions, for the purpose of establishing of controlled traffic mode.

3.4 Impact on habitats and ecosystems

In order to estimated the possible impact during the construction and operation of the road in more detail and in order to be able to propose efficient measures for

protection and management, several specific important ecosystems and habitats were selected and their sensitivity was tested. Those are the following habitats:

- Forest habitats (oak-hornbeam forests and zones with poplars and willows)
- Hill pastures with scarce bushes
- Rocky areas
- Aquatic habitats
- Anthropogenic habitats

The sensitivity of the above mentioned habitats was estimated on the grounds of several criteria, and thus: the appearance on the List of significant habitats in Annex I from the EU Directive on habitation, rear communities in Macedonia, well preserved natural communities, representation of types from the IUCN global red list, representation of endemic and endangered species, area values, function as bio-corridor etc. According to these criteria as more sensitive habitats are considered the fragments for oak-hornbeam forests, rocky parts with chasmophytic vegetation, riparian zones with poplars and willows, aquatic habitats (streams and intermittent streams), while the rest of the habitats as the degraded oak-hornbeam forests and the deserted farmlands with ruderal vegetation are assessed as low sensitive.

3.4.1 Impact on habitats in construction phase

The impacts on the habitats during the construction of the road will be mainly manifested through their destruction and fragmentation. The remains from the former natural habitats whose areas have been greatly reduced are not enough to maintain solid populations of many species. The following text investigates the potential impact on the more significant habitats. Thereby, it points out all possible conflicts and problems that can occur during the construction of the road.

Forest habitats

In the region of the road corridor, there are small surfaces with well-developed oak-hornbeam forests. As a result of excessive exploitation in the past and today, they are in most part degraded. There are better preserved remains of these forests at the beginning of the route (chainage of km 0+000 to 1+400 and of km 5+000 to 6+000), while most part of the route is covered with degraded stadiums of shrubbery from red spruce and Christ-thorn. The negative effect that could occur in this phase shall be the temporary or permanent lose of the oak-hornbeam forests. Given the fact that most of them are degraded, no serious conflicts are expected.

The riparian zones with poplars and willows are of azonal type of vegetation connected to the flows of the rivers and streams. These communities are important because of their specific environmental functions (pollution control, protection against floods and erosions). In the area around the planned road corridor, occasional streamflows along the river Raechka can be found. No serious conflicts regarding the zones with poplars and willows are expected during the construction of the road.

Hill pastures with scarce bushes

Within the area of interest hill pastures can be found on small surfaces (km 9+500 to 9+800; km 13+500 to 16+500 and around km 19+000), they don't have a greater

significance for the biological diversity. They represent secondary vegetation formations that originated through gradual and long lasting degradation of forests, which in the past used to stretch upon larger surfaces. During the construction of the road, there will be a direct destruction of parts of the hill pastures, but this conflict does not have a high priority.

Rocky areas

These habitats are distinguished by the presence of rear communities, endemic species and area values due to which they are designated as highly sensitive. Within the frames of the road corridor the most significant **rocky area is the gorge Drenovska Klisura, which is a protected area and falls under the category Monument of culture**. It is significant due to the many vegetation species of global significance (chasmophytic vegetation), rare types of insects, endangered bird species, bats, as well as one type of snail, who is a local endemism. Even though the planned route follows the existing road, still due to the significance of this habitat it is expected that this conflict would have a high priority.

Aquatic habitats

These habitats are represented through streams, intermittent streams, dry ravines and they can be found on a very small surface area. With the exception of river Raechka, the others have water only during the rainy period, and for the remaining part of the year they are dried out. Because of that, most of them do not have a great significance as water aquatic ecosystems. During the construction of the road, there could be a possible negative effect from deposits of material from the construction sites, solid waste, wastewaters from the workers' camps etc. A great negative impact can also have the leakage of fuels, oils and lubricants, which due their high toxic levels can cause damage to the aquatic environments. The construction of bridges can cause an alteration in the course of the rivers, and the solid big materials (stones and rocks) and the smaller material (sand, soil) can result in blurring of the water and increased turbidity. The construction of the road will have different negative impacts, but most of which are revisable.

Anthropogenic habitats

These habitats (fields and farmlands, orchards, vineyards, deserted farmlands with ruderal vegetation and artificial facilities) have a small significance in respect of biological diversity. During the construction of the road, the destruction of parts of these habitats is inevitable (directly through the construction of the road and the construction of the access roads). However, these conflicts have been deemed as low, due to the lower sensitivity of the habitat.

3.4.2 . Impact on habitats in the operational phase (exploitation)

In the phase of usage of the road, the most serious problem is the soil, water and air pollution. However, the impacts in this phase are greatly smaller in comparison with the same in the construction phase, but are manifested in longer time period. In general, those impacts are:

- destruction of forests- the negative effect shall be manifested through occasional, but permanent cutting of the better preserved fragments of the developed oak-hornbeam forests, which will result in their permanent loss for a longer period of time.
- pollution of groundwater- given that the industrial inert and not dangerous waste will be stored, which mainly does not degrade, no negative impact is expected. Potential sources of pollution would be the leakage of fuel and oil, drainage etc.
- vibrations (caused by transport vehicles)
- accidental fire outbursts.

The following chart gives an overview of the location where a fragmentation of habitats as a result of the presence of the road is expected.

Chart 37 Locations where a potential fragmentation of the habitats is expected

Chainage	endangered habitat	location
0+000.00 - 0+373.00	degraded forest	alignment of the route on the left side of the river Raec
0+373.00 - 0+439.00	degraded forest	alignment of the route on the left side of the river Raec
0+439.00 - 0+535.00	degraded forest, river, intersection with an earth road	bridging of the river Raec
0+535.00 - 0+580.00	degraded forest, intersection with an earth road	alignment of the route on the right side of the river Raec
0+580.00 - 0+685.00	degraded forest, hilly region	alignment of the route on the right side of the river Raec
0+685.00 - 0+707.00	degraded forest	alignment of the route on the right side of the river Raec
0+707.00 - 0+790.00	waterside vegetation, intersection with an asphalted road, river	bridging of the river Raec and the asphalted road Prilep-Rosoman
0+790.00 - 0+930.00	degraded forest	alignment of the route on the left side of the river Raec
0+930.00 - 1+020.00	waterside vegetation, river	bridging of the river Raec and the asphalted road Prilep-Rosoman
1+020.00 - 1+075.00	degraded forest	alignment of the route on the right side of the river Raec
1+075.00 - 1+258.00	waterside vegetation, river	bridging of the river Raec and the asphalted road Prilep-Rosoman
1+258.00 - 1+310.00	degraded forest	alignment of the route on the left side of the river Raec
1+310.00 - 1+390.00	degraded forest	alignment of the route on the left side of the river Raec
1+390.00 - 1+445.00	waterside vegetation	alignment of the route on the left side of the river Raec
1+445.00 - 1+520.00	waterside vegetation, river	bridging of the river Raec and the asphalted road Prilep-Rosoman
1+520.00 - 1+575.00	degraded forest, hilly region	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
1+575.00 - 1+615.00	degraded forest, hilly region	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
1+615.00 - 1+635.00	degraded forest, hilly region	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
1+635.00 - 1+660.00	degraded forest, hilly region	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman

Chainage	endangered habitat	location
1+660.00 - 1+880.00	degraded forest, hilly region	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
1+880.00 - 2+030.00	degraded forest, hilly region	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
2+030.00 - 2+107.00	waterside vegetation	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
2+107.00 - 2+260.00	waterside vegetation, river	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
2+260.00 - 2+338.00	degraded forest, hilly region	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
2+338.00 - 2+380.00	degraded forest, hilly region	parallel alignment of the route with the river Raec and the asphalted road Prilep-Rosoman
3+830.00 - 3+935.00	waterside vegetation, dry ravine	parallel alignment with the asphalted road Prilep-Rosoman on its right side
4+680.00 - 4+975.00	arable surface and degraded forest	parallel alignment with the asphalted road Prilep-Rosoman on its right side
4+975.00 - 5+178.00	degraded forest, individual facilities	parallel alignment with the asphalted road Prilep-Rosoman on its right side
5+318.00 - 5+543.00	degraded forest	parallel alignment with the asphalted road Prilep-Rosoman on its right side and limestone basin
5+543.00 - 5+643.00	earth road, waterside vegetation, river	bridging of the river Raec and the road Prilep-Rosoman
5+643.00 - 5+915.00	meadow, un-arable surface	approaching on 50 m of a gas station on the right side
5+915.00 - 5+939.00	earth road, waterside vegetation, river	bridging of the river Raec and the road Prilep-Rosoman
5+939.00 - 5+995.00	degraded forest	parallel alignment with the asphalted road Prilep-Rosoman and the river Raec
5+995.00 - 6+085.00	degraded forest, rocky region	parallel alignment with the asphalted road Prilep-Rosoman and the river Raec
6+085.00 - 6+150.00	rocky region	parallel alignment with the asphalted road Prilep-Rosoman and the river Raec
6+150.00 - 6+271.00	intersection with an earth road, waterside vegetation, river	bridging of the river Raec and the road Prilep-Rosoman
6+271.00 - 6+360.00	rocky region	parallel alignment with the asphalted road Prilep-Rosoman and the river Raec
6+360.00 - 6+559.00	hill, degraded forest	parallel alignment with the asphalted road Prilep-Rosoman and the river Raec
6+559.00 - 6+629.00	rocky region	parallel alignment with the asphalted road Prilep-Rosoman and the river Raec
7+001.00 - 7+020.00	waterside vegetation, river	bridging of the river Raec
7+210.00 - 7+235.00	waterside vegetation, river	parallel alignment with the asphalted local road and the river Raec
7+235.00 - 7+279.00	degraded forest	parallel alignment with the asphalted road Prilep-Rosoman
7+279.00 - 7+415.00	hilly region, degraded forest	parallel alignment with the asphalted road Prilep-Rosoman
7+519.00 - 7+559.00	dry ravine, shrub plants	parallel alignment with the asphalted road Prilep-Rosoman
13+087.00 - 13+233.00	waterside vegetation, dry ravine	passing through the village Kamen Dol

Chainage	endangered habitat	location
13+233.00 - 13+449.00	inhabited place, waterside vegetation, dry ravine	passing through the village Kamen Dol and near a siphon
14+182.00 - 14+217.00	dry ravine with waterside vegetation and fallows	
14+511.00 - 14+548.00	earth roads, dry ravine with waterside vegetation and fallows	
14+548.00 - 14+691.00	earth roads, dry ravine with waterside vegetation and fallows	approaching a siphon (70m)

3.5 Impact on protected areas

3.5.1 Impacts during the construction phase

The road corridor passes thorough the gorge Drenovska Klisura, which is a protected area from the category Monument of Culture and it has a scientific and research, as well as botanical significance.

The area is protected because of the presence of relic vegetation communities, rare vegetation species, insects and birds, as well as due to the presence of the endemic snail *Carinigera drenovoensis*. The route passes through two ornithological localities, Gradsko-Rosoman-Negotino and the valley of the river Raec, as well as through the vegetation area Raec- Lake Tikvesh.

Small area of the route enters the Emerald area of Raec. Therefore, **the valley of the river Raec, especially the gorge Drenovska Klisura, represents a significant area, and a negative impact may be expected during the penetration of the road and the exploitation of the access roads in respect of the fragmentation of habitats and destruction of the populations of some vegetation species.**

Therefore, it is necessary to undertake specific measures at this part of the route in order to minimize the negative impact on the habitats and species.

3.5.2 Operational phase

No specific negative impacts are expected.

3.6. Impact on the soil

3.6.1 Construction phase

The activities of construction and setting on the expressway will directly damage the quality of the soil and it will reflect on the change of the specific geological characteristics. This disruption consists of localized changes in the profile of the soil in the immediate surroundings of the excavations and soil compaction as a result of the manipulation of vehicles and equipment for construction.

The soil works, that will potentially have an impact on the soil characteristics and thus on to the quality of the soil, are:

- Removal of the surface layer of the soil (humus)
- Smoothing of the surface
- Compaction to the necessary density
- Performance of quarries and landfills for removal of the remained excavated soil material

All of the listed works result in disruption of the quality of the soil in the zone of the expressway and in the surroundings where the construction works are conducted, i.e. for the surface area encompassed with temporary facilities for the needs of the construction site and the execution of the access roads.

It is not expected for the compounding to be a serious risk for the environment. It is expected that most of the land that will experience this impact to reclaim its agricultural productivity after the construction has been finished.

The soil may be polluted by inappropriate storing, handling and depositing of waste, as well as by potential leakage of oils during the construction activities.

The impact during the construction phase on soil pollution is assessed as negative with insignificant size and of temporary character.

3.6.2 Operational phase

During the period of exploitation characteristic are effects related to the disruption of the quality of soil as a result of emissions from traffic pollutants. Heavy metals, as the main traffic pollutant, are relatively immobile and heterogenic distributed within the area around the road, especially as a consequence of drainage in the ravines next to the road. The soil next to roads usually contains the highest concentrations. There are increased concentration levels in the grass tissues on 5-8 m from the road. Trees are more sensitive to damage by chlorides in comparison to more wide spread bushes and grasses near the road. The accumulation of sodium in the soil, mostly within a distance of 5 m from the road, changes the structure of the soil, which on the other hand affects the plant growth.

Along the route of the expressway, there is agricultural land. A specific zone along the route of the expressway will be endangered due to pollution caused by traffic. Moderate frequencies and speeds are expected for the road. Therefore, it is expected the emissions of heavy metal in the tight zone along the expressway to be low to moderate.

3.7. Impacts caused by waste management

3.7.1 Construction phase

The waste created during the construction of the expressway stems from the construction activities and the construction execution. The primary forms of solid waste, which will be generated during construction phase, will be:

- Excess excavated soil and sand

- Packing waste
- Debris and construction waste
- Waste tires (from constructional mechanisation)
- Waste oils and greases (from construction mechanisation)
- Communal waste of working site camps (construction sites).

In most part, the soil from the excavations and notches shall be returned back in the embankments. The excess will be transported away from the location with trucks to the nearest landfill, or it will be distributed to agricultural fields (it may potentially be used for remediation of existing dumping grounds, remediation of excavation slopes during the execution of the expressway into a rocky terrain etc.). The excess of land and construction waste (for example concrete/asphalt) are inert materials. The inappropriate depositing of such material may have negative effects on the location of depositing.

The landfill locations for the disposal of the excess excavated material are defined according to the geomechanical inspections conducted for the needs of the Main project.

The Law on Waste Management prescribes that the construction debris should be deposited on places determined by the local authorities in order to minimize the negative effects on the area and the visual effects of the internal waste.

The technical maintenance of the construction mechanization and the other vehicles will most likely be conducted within the construction zones. Therefore, it is expected that this will create waste characteristic for this type of activities (used tires, batteries, vehicle oils etc.). If such waste is generated, then it will be given to licensed operators, who will handle its appropriate transport and depositing/recycling (if it is possible).

Waste tires and oils are considered as special types of waste and they are handled according to the principle “responsibility of the producer”.

During the construction of the expressway the following types of waste, according to the Waste registry may be generated:

Group 15- Packing waste	
15 01	Waste from packing of paper and cardboard, plastics, wood, metal, composite packing, glass etc.

Group 17 – Construction and demolition debris	
17 03	Waste from bituminous mixtures, tar and tar products *)
17 04	Waste from metals
17 05	Waste from land excavations
17 06 04	Insulation material (which do not contain asbestos and dangerous substances)
17 09 04	Other construction waste (mixed waste)

*) Categorised as dangerous waste

Group 20 – Communal waste (+ similar waste from the industrial activity), including the fraction of selected waste	
20 01	Separately collected fractions (dissolvers, colours, glues etc.) *)
20 03 01	Mixed communal waste
20 03 07	Bulky waste

The earth works can cause a medium/large negative impact, since it is expected large amounts of material to be excavated, transported and deposited. The inappropriate management of fluid waste from vehicles and heavy machinery (fuel and oil), may also cause a significant negative influence. In respect of waste from the dwelling facilities, the negative impact is estimated as insignificant.

The management of all waste fractions should be conducted according to the legislation on waste and individual waste currents, having in mind that some of the fraction can be recycled (metals, paper, glass), reused (earth, rope cuts), the inert waste is disposed to separate dumping ground for inert waste, while the communal waste and the other non-dangerous waste are transported to an appropriate dumping ground.

3.7.2 Operational phase

Generating waste is not expected during the exploitation due to the fact that resting sites or any other constructions in the area of the road, which could be the cause for passengers stopping and having a short stay in these zones, is not planned. Waste can be generated during the exploitation as a result of inappropriate behaviour of passengers (illegal disposal).

3.8. Effects of increased acoustic noise and vibrations

3.8.1 Construction phase

Construction of the Expressway is linked with a series of activities which are the cause of noise. Noise is generated from the equipment used.

During the activities related to the construction of the Expressway increased levels of noise generated due to the operation of the construction machines are expected. The noise levels can be associated with the levels on typical construction sites, i.e. similar activities such as cleared, trench digging, setting up a tampon and vehicle movement.

The noise generated by the construction activities on set locations will be temporary, and the levels will vary and be of increased intensity during the operation of the motors of the vehicles, i.e., the noise will be unequal and intermittent, reaching its maximum during the operation of the construction machines at the time of excavations.

Chart 37 lists the mostly frequently used machines in construction and their noise level at a reference distance of 15 metres form source. The values noted in the table are based on data from available literature

Chart 1 Noise level of construction equipment

Source	Noise level at a distance of 16 m from source in dB (A)	Noise level at a distance of 1 m from source dB (A)
Compressor	87	111
Bulldozer	81	105
Cement mixer	85	109
Cement pump	70	94
Cement vibrating machine	77	101
Mobile crane	81	105
Dumper	83	107
Diesel generator	75	

Most of the work will be done outside populated areas and sensitive spots. In addition, the nature of the noise during construction is of temporary (short term) inconvenience so that the impact is not significant except in the immediate surroundings of the construction sites. The overnight work intensity will be minimized, by which the impact on the fauna will be reduced.

The influences on the work force hired for the construction is expected to be significant, because the workers will be exposed to relatively high levels of noise for longer periods of time.

The noise can make their life unpleasant and expose them to stress and influence their psychological health if it should exceed the standard levels. However residents of surrounding populated areas are secondary recipients of increased noise levels, because the noise will be relatively disperse and with a decreased intensity at those locations. Significant impact points are to be expected only on few locations along the route of the Express way. During construction in the vicinity of populated areas, no negative consequences to the residents as a result of ambient noise are to be expected, only a certain degree of inconvenience and disturbance of peace is to be expected.

The traffic jams which can be caused by operating construction and transportation machines in the course of the terrestrial works can increase the intensity of ambient noise, but it is considered that no significant traffic jams along the roads in the surrounding area of the project location are going to arise.

Construction of the Expressway is linked to a series of activities that cause vibrations as a consequence of using construction mechanisation.

It is expected that the impacts from vibrations will be insignificant, mostly localized, at the construction sites and limited to the local workers as well as the local species.

3.8.2 Operational phase

Considering the fact that the road does not come near sensitive receptors (hospitals, recreational areas, protected areas, schools etc.) during the course of the exploitation, the noise will mostly impact the avian population settled on the agricultural land.

The elevated noise levels caused by the frequency of traffic will have a potential impact over the avian population in several ways.

These are several ways in which the noise caused by increased traffic frequency of the Expressway could reflect on the avian population. The acoustic obstacles caused by the traffic noise could impede the ability of birds to recognise their tunes, establish and maintain territories, attract females in the mating season and/or mutually care for the existing offspring. Reijnen and Foppen 1994, Habib et al. 2007, Swaddle and Page 2007). This could have a direct negative effect on the mating ability of birds that nest in the noisy habitats by the road. When they signal their parents that they are hungry, the hatchlings may be forced to make louder sounds in order to get fed (Leonard and Horn 2005), this way they increase their expenditure of energy and worsen their health.

The high traffic levels may have a negative effect on the ability of birds to recognize distress calls which signal that a predator is approaching. This can lead to high hunting success rate of predators. Empiric evidence show that the traffic noise directly influences on the reduction of avian population density (Reijnen et al. 1995, 1996, Foedman et al. 2002), however more research is needed to determine the general applicability of the observed tendencies. These studies correlate the avian population density and the traffic noise levels by way of observing population density at gradually distancing from the noise source (Reijnen et al. 1995, 1996, Forman et al. 2002). It has been established that the by increasing the distance from the road, you will find a higher density of avian population.

Excess noise levels are not expected along the Expressway, due to the relatively low traffic which is not expected to increase by large factor in the near future. However the Expressway is nearing (entering) the populated area of Kamen Dol and his location may be potentially endangered from damaging noise. The road section potentially endangered of noise is depicted in the following chart.

Chainage	Use of land	Endangered populated area
13+233.00 - 13+449.00		passing through the village of Kamen Dol and vicinity of siphon

In case of significant increase of traffic frequency, the noise impact will be more apparent and appropriate reduction measure would be needed.

3.9. Impact on the area and visual effects

3.9.1 Construction phase

The area within the construction zones established along the Expressway will be noticeably modified during the course of constructing. The number of construction zones, their size and locations shall be determined in the technical construction documentation.

During the construction of the Expressway corridor, the visual appearance of the area will be temporarily modified as a result of the activities performed on site in the form of clearance, trench digging, arrival and presence of large transportation vehicles, trucks and other mechanisation necessary for transportation of materials, clearance of the field and creation of waste as a result of this activity. The presence

and movement of workers will also impact the area. The construction of the Expressway will modify the visual appearance, but that will be only for a short period of time and only locally, lasting as much as the time needed for construction.

The construction of the Expressway will require construction material, its transport and storage. It is estimated that the construction of the Expressway will require a relatively short time period, and upon completion of the construction work as well as the disposal of construction waste and other waste, the short term impact caused by the construction will cease.

In general, the construction of the Expressway is situated on an exposed location, which during the construction phase is visible from a distance of up to 5 km. Because of this, in the phase of setting up for construction the local population and the travellers passing through the local roads will be mostly affected by the new appearance of the area.

3.9.2 Operational phase

While used, the visual effect from the Expressway is expected to be insignificant. Namely, in spite of the careful route planning, there will be a need for it to be cleared from vegetation, trees and the like, however due to its small width the extent of the work and consequently the visual changes will be negligible.

3.10. Impact on the archaeological and cultural – historical heritage

The planned route of the Expressway does not pass in the immediate surroundings of the noted protected cultural – historical natural heritage.

Along the planned route within the location chosen for the construction of the Expressway, more specifically on locations where the Expressway will be laid out, no archaeological sites and localities with cultural heritage exist, which could signify a limiting factor in the process of planning and designing of the Expressway.

However, a World War I monument exists on the location planned for construction of the Drenovo junction near the construction works. The following chart depicts the location of the stated monument.

Chart 2 Location of the World War I monument

Chainage	Land to be used	Endangered populated area
8+620.00 - 9+250.00	arable irrigated land- vineyards, agricultural facilities	Junction Drenovo, connecting to Kavadarci, near the cultural – historical monument of World War I, gas pump and agricultural facilities

The existence of this monument is significant for the local population or another social group. For these reasons preserving this monument will be significant in reducing the impact on the cultural – historical heritage.

3.10.1 Construction phase

During the preparation of the design documentation and during the detailed designing

of the expressway, the investor shall respect the requirements regarding the protection of the registered natural heritage incorporated in the Macedonian legislation and international multilateral agreements regarding the preservation of nature. This approach entails avoiding possible construction activities, penetrations, i.e. using access roads, as well as setting of the route in areas around registered protected areas, which shall eliminate any potential direct effects on them.

If the existence of artefacts is determined during the execution of the earth construction works or if there are potential archaeological items on the location, the construction works will be stopped and the Office of Cultural Heritage within the Ministry of Culture will be timely notified.

3.10.2 Operational phase

During the operational phase, no impacts on cultural-historic and natural heritage are expected.

3.11 Impact on the social elements of the environment

3.11.1 Construction phase

Each developmental project has short-term and long-term impacts on different local communities (settlements), especially those along the route of the expressway. The population is always the one that can benefit or suffer because of the implementation of developmental projects. Usually, no project causes only positive or only negative effects. Therefore, it is crucial to investigate all potential effects on the population and to point out the groups that can be affected by the implementation of this project.

The following posing effects on the population are expected from this project:

- Possibility for employing qualified and unqualified workers
- Purchase (expropriation) of the land in private ownership

Job positions will be offered to:

- Participants in construction works- contractors and subcontractors
- Local communities: craftsmen (welders, metal scrapers, locksmiths etc.);
- Employees in restaurants and taverns in the construction area; transporters; construction workers; owners of small markets and supermarket in the surrounding area etc.

During the construction phase, a positive impact on the population is expected as a result of creating work possibilities, which leads to a better living standard.

Taking into consideration that in most parts, the route of the expressway passes outside a settlement, the construction activities on the construction locations themselves, won't have any direct impacts on the human health.

Negative impact is possible only as a result of traffic accidents caused by the frequency of transport vehicles. Furthermore, negative impact on the population has

the increased emission of exhaust gasses and increased noise from vehicle passing through the inhabited placed for the transport of equipment and materials.

It is expected that no changes in the demographic situation or traditional live style of the communities around the expressway will occur.

It is possible that some properties will have a limited accessibility during the construction activities. There will be no need for them to leave their residence for the purpose of the construction or expropriation.

Several potential social impacts during the construction phase have been analyzed.

A temporary negative impact on agricultural workers is expected because of the temporary expropriation of land and potential damage of the cultures. Agriculture is in most cases the sole source of income for the individual agricultural workers. It is not possible to estimate the number of potentially affected agricultural workers during this phase of the project. This will only be possible before the construction of the project and upon determining the exact route. Compensation plan should be prepared before the implementation starts. The Plan should contain full inspection and estimation for the compensation that will be paid.

The construction phase will require temporary or permanent expropriation of the arable land and the urbanized land in private property (residential areas in the suburb of the settlements, weekend houses etc.).

3.12.2 Operational phase

The expressway can seem a significant barrier for the local population due to the fact that it cuts the existing local roads that potentially have a value from the aspect of traditional communication and/or access to the agricultural arable lands.

In order to overcome this effect, enough intersections are planned with the expressway. However, always a certain number of connections cannot be re-established due to the fact that earth roads are not recognized as a valid road infrastructure and a for many of them it will not be possible to be revitalized upon the construction of the road.

The following chart shows the location where the expressway intersects with the existing roads. This information can be important during the preparation of the so-called Compensation plan for the local population.

Chainage	Potentially endangered existing roads
0+439.00 - 0+535.00	degraded forest, river, intersection with an earth road
0+535.00 - 0+580.00	degraded forest, intersection with an earth road
0+707.00 - 0+790.00	waterside vegetation, intersection with an asphalted road, river

Chainage	Potentially endangered existing roads
2+593.00 - 2+616.00	asphalted road
3+545.00 - 3+730.00	arable land, intersection with an earth road
4+013.00 - 4+280.00	fallow land, earth roads, arable surface
4+280.00 - 4+360.00	fallow land, earth roads
5+543.00 - 5+643.00	earth road, waterside vegetation, river
5+915.00 - 5+939.00	earth road, waterside vegetation, river
6+150.00 - 6+271.00	intersection with an earth road, waterside vegetation, river
6+629.00 - 7+001.00	intersection with an earth road, arable land, waterside vegetation
7+210.00 - 7+235.00	waterside vegetation, river
8+620.00 - 9+250.00	arable irrigated land- vineyards, agricultural facilities
9+250.00 - 9+379.00	irrigation channel, road with sub base, vineyard
10+197.00 - 10+468.00	intersection with an asphalted road, earth road, and irrigated land- vineyard
11+477.00 - 12+157.00	fallow land, arable surfaces and earth roads
12+937.00 - 13+037.00	intersection with an asphalted road, fallow land and agricultural auxiliary facilities
13+037.00 - 13+087.00	asphalted road, fallow land
13+529.00 - 13+737.00	intersection with an asphalted road and exposed rocky region
14+548.00 - 14+691.00	earth roads, dry ravine with waterside vegetation и fallow land
15+463.00 - 16+037.00	irrigated land- vineyard, earth roads
16+237.00 - 16+892.00	intersection with earth roads, arable irrigated land
16+892.00 - 17+062.00	earth road and arable irrigated land
17+062.00 - 17+095.00	earth road, intersection with dry ravine and arable land
17+432.00 - 18+084.00	earth roads and arable irrigated land- vineyard
18+084.00 - 18+726.00	arable land, fallows и intersection with earth roads
18+726.00 - 19+162.00	arable and earth roads and dry ravine
19+162.00 - 19+948.00	irrigated land, intersection with an asphalted road

Chainage	Potentially endangered existing roads
19+948.00 - 20+741.00	irrigated land and intersections with earth roads
20+741.00 - 21+717.00	irrigated land and intersections with earth roads
21+717.00 - 21+825.00	irrigated land and intersections with earth roads
21+825.00 - 21+909.00	irrigated land and intersections with earth roads
21+909.00 - 22+537.00	irrigated land and intersections with earth roads
22+537.00 - 22+697.00	irrigated land and intersection with an asphalted road
22+697.00 - 22+817.00	irrigated land and intersections with earth roads
22+817.00 - 23+677.00	irrigated land, earth road and irrigation channel
23+677.00 - 24+137.00	irrigated land and intersections with earth roads
24+137.00 - 24+257.00	irrigated land and intersection with an asphalted road
24+257.00 - 24+357.00	irrigated land and intersections with earth roads
24+357.00 - 24+517.00	irrigated land and intersections with earth roads
24+517.00 - 24+817.00	irrigated land and intersections with earth roads
24+817.00 - 25+477.00	irrigated land and intersections with earth roads
25+477.00 - 25+705.00	irrigated land and intersections with earth roads

3.12 Cumulative impact

During the construction of the expressway several cumulative impacts will appear. They are expected to be the result of traffic in the operational phase, due to:

- Emissions of polluting matters in the air though the combustion of fuel of vehicles, which causes sedimentation of the polluting material on the road surface and the surrounding land with a width of 8-10 m along the road.
- These polluting matters then have a negative impact on the quality of soil, surface waters and groundwater;
- Emissions of harmful noise, which may result in the reduction of bird population settled in the agricultural land and may affect the health of the population of the inhabited place Sirkovo, and especially in the village Kamen Dol though which the route passes;

The above stated cumulative effects have been identified in detail and explained in the corresponding paragraphs regarding the impacts on quality of water, air, soil, biodiversity and noise.

5. MEASURES FOR REDUCING THE NEGATIVE IMPACT ON THE ENVIRONMENT

Appropriate measures determined with this Study will be applied in order to reduce the negative impacts caused by the construction of the planned Expressway.

Significant impacts on the environment caused by this project are expected mostly in the course of construction rather than in the operation phase. These impacts can be avoided on a broader scale if proper methods and good construction practices such as the following are applied:

- preparation of the locations planned for storing fuels: they should be kept in appropriate tanks and on a non permeable surface in case of leakages.
- Only the land determined for use by the projects should be used for the construction site
- Uncontrolled access ways to the construction site should not be opened; only the existent field roads covered by the projects should be used.
- Special attention should be paid to forming asphalt bases. Protective measures should be taken on the areas where asphalt will be used, in order avoid the possibility of asphalt getting into the ground, occasional water flows and underground waters.
- The mechanical equipment which will be used on the construction site needs to be previously serviced to make sure it will be completely functional, so that there would not be unwanted consequences on the construction site.
- Constant presence of fire fighting vehicles should be provided to prevent possible fires.

5.1 Measure for the reduction of the effect on the topography and geology

5.1.1 Construction phase

Most of the measures for reducing the impact on the environment referring to the possible effect on the topography and geology in the construction phase have been determined in the Main design. These measures refer to the appropriate access road planning in accordance with the local conditions, the management of loans and landfills for the excess excavated road material, as well as preventing landslides and rock-fall during the construction.

During the excavations all the measures planned to secure the stability of the embankments and which were determined with the geo-mechanic examinations and the Main Project will be taken.

If it is possible the excavated material needs to be used once again in the construction or as a layer for creating embankments. The loans will be appropriately re-cultivated.

The remaining excess material will be removed from the landfills determined with the geo-mechanical researches, which should be approved by the Investor. In the course of re-cultivation of the landfills the following criteria will be taken into consideration:

The landfills determined as a potential danger to the surrounding agricultural land due to the possibility of erosive sediment transporting to the nearby fields during heavy rainfall, will also be subject to re-vegetation. Re-vegetation will be performed within 6 months upon the formation of the disposal site.

The following measures will be taken in order to prevent erosion of a larger scale during the re-cultivation of the landfills :

- Careful planning of the construction works with the purpose to reduce the negative effects and to secure the prevention of erosion.

- Reduction of the size of the location, due to minimizing the land which will endure the negative effects and preventing erosion and pollution of the land
- Restriction of vehicles movement and use of mechanical equipment with has a smaller pressure over the surface.
- Precise performance of the construction works, avoiding leakages from the vehicles. The vehicles need to be constantly serviced in order for leakages to be prevented.
- Appropriate removal of the material spilled on the site.
- Minimizing the loss of vegetation on the area along the construction site
- The construction works must not take place under the conditions of heavy rainfall
- reduction of the speed and extent of pollutant surface leakage
- Introduction of prevention measures for the landslides, stabilizing the embankments if necessary.

The construction debris needs to be transported and deposited to an inert waste disposal site.

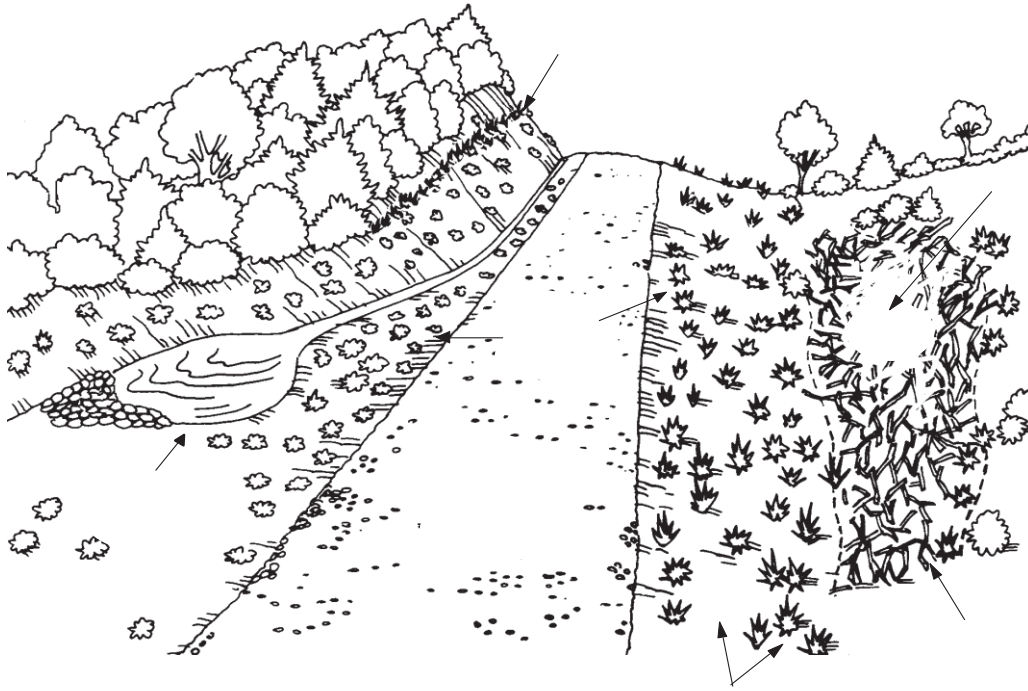
For the purpose of preventing the transportation of erosive washout from the embankments, an **Erosion Protection Plan** needs to be prepared, which in addition to the previous geo-mechanical analysis made to determine the areas with a high probability of erosion, will have the purpose to protect the water flows and other waters from the erosive washout.

Several techniques will be used to control the erosion and sedimentation processes, which will prevent the sediments entering the natural water flows. Among them are the following:

- Regulation of drainage along the route of the road;
- Stabilising the soils along the route of the road
- Sedimentation and removing the sediment from the waters before they are drained from the road.

The erosion control plan represents an integral part of the construction project of the Expressway. It is far more effective and economical to prevent the erosion instead to work on reducing the already caused damage or to remove the sediment from the water flows and groundwater. The erosion control plan will achieve the following:

- Minimize the surface area of the construction site
- Minimize the natural drainage of the area next to the road and perform sedimentation of the atmospheric waters before they are drained in the surrounding area
- The surface humus will be removed together with the organic matter contained in it. The humus will be stored on locations where it will not lose its water-air characteristics and afterwards it will be applied to degraded areas with the purpose to support the development of autochthon vegetation.
- Seeds of grassy plants will be applied combined with straw mixed with wood shavings and other organic matter, which will provide protection to the seeds and at the same time it will reduce the erosive processes of the non-vegetated terrains.
- The eroded materials on the borders between the road, the drainage paths for the rain waters and the surrounding terrain will be covered with tree branches and other wooden leftovers.



Picture 1 Example for the application of a mixture of seeds, saturated with the placement of straw, wood shavings, small pieces of chopped paper etc

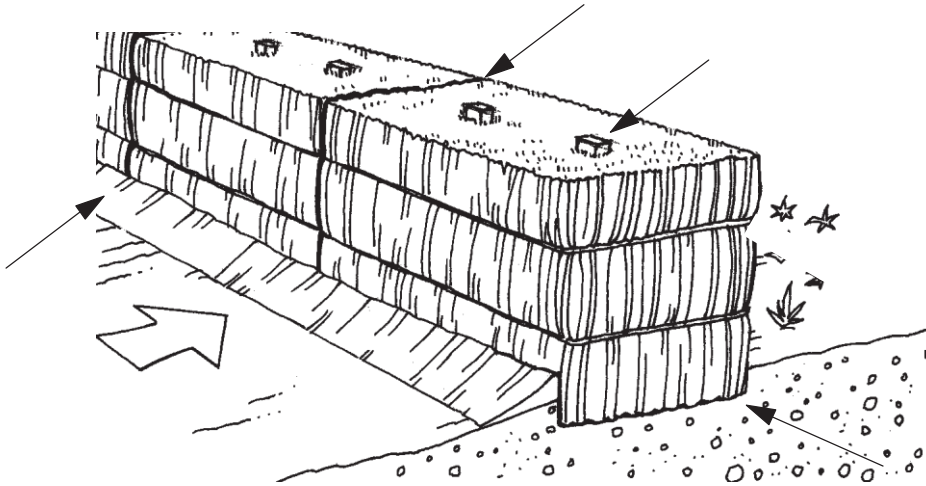
Objects for prevention of sedimentations will be installed on all locations where there are atmospheric water leakages into other waters and/or into sensitive eco systems. These forms may include rock embankments, sedimentation pools, straw bales etc.



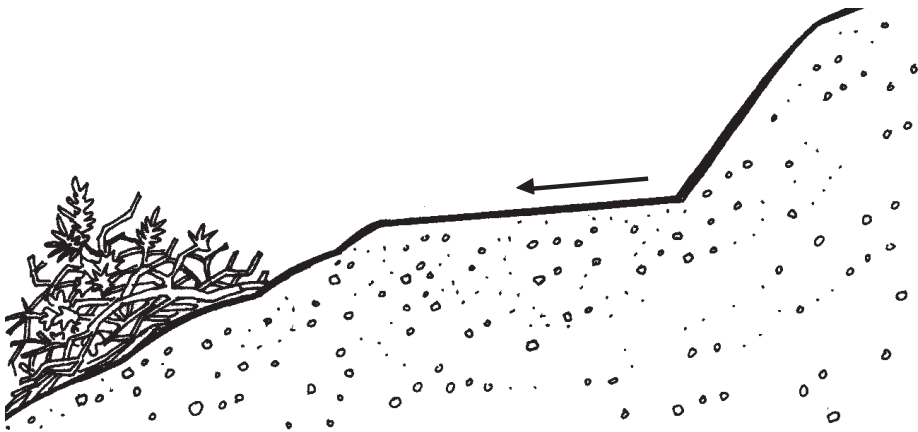
Picture 3 Application of branches for the prevention



Picture 2 Application of barriers for the prevention of erosion of the terrain caused by construction works



Picture 4 Application of straw bales for the prevention of erosion



Picture 5 Twisted branches help to retain the soil and sediment before they enter the water flows



Picture 6 Cladding an embankment with gravel and stone

Cladding an embankment with gravel and stone is proposed as a measure for retaining and filtering rain waters and erosion prevention. This measure may be used

to prevent infiltration of pollutants into the surrounding terrain, the groundwater and the water flows, which may appear from the wash out road waters.

Parts of the route have notches more than 20 meters high, at which the drainage should be solved with several parallel canals for different heights, as a measure for avoiding erosion.

The project planner also proposes protection measures for maintaining the stability of the embankments by using nets (if necessary, which will be determined on site according to the degree of fractures of the rocks and other parameters stated in the project) and by planting vegetation.

Planting the vegetation is part of a special **horticulture project** which will be prepared in the course of the Working design. According to the study of EIA prepared by those implementing the Horticulture phase, which need to be implemented in the course of the Main design, the use of autochthon species is recommended instead of exotic and decorative plants.

For the purpose of re-vegetation of the embankments the use local species is advised due to the fact that they can be grown in the nearby areas of the route thus reducing the expenses for the construction (see the picture below).



5.1.2 Operational phase

If the measures for erosion prevention and sediment management are properly executed in the course of the construction phase, no effects will be expected in the Operational phase and accordingly measures are deemed unnecessary.

On the other hand, surfaces by the road which may be subject to erosive processes need to be maintained. It would be of great importance to provide vegetation on the larger notches, because it will have a positive effect on the stability of the slopes.

The drainage system of the surface waters under the notches i.e. embankments will also need to be maintained. These measures are provided with the Monitoring plan for implementing measures reducing the impacts caused by the construction and exploitation of the Expressway.

5.2. Measures for reduction of the impact on the superficial and groundwater Мерки за

5.2.1 Construction phase

The measures for the protection of the surface waters and groundwater can be reduced to the appropriate application of the project solutions regarding the waste waters and waste management during the construction works related to the express way.

That implies: collection of faeces waste waters on the route of the septic systems, their timely emptying, as well as timely removal and depositing of communal waste. The removal of the fuel waste or oil waste from the vehicles and the construction mechanisation will be handed over to a local company for managing hazardous waste.

All the measures foreseen with the Main design for the prevention of any type of possible pollution of the river beds and banks as well as contact with the groundwater, need to be completely observed and implemented during the construction. Filling gas or servicing on the construction site needs to be performed to the strictly designated locations impermeable to water, and the oils need to undergo a special treatment. Special measures need to be foreseen for the prevention of flows and leakages, and adequate practises for erosion control and soil protection need to be applied.

5.2.2 Operational phase

Protection of the quality of superficial and groundwater will be accomplished by application of an appropriate drainage system for the wash out waters form the road surface. This system will provide the following functions:

- prevent flooding, i.e. water retaining on the surface of the road
- protect the durability of the asphalt, i.e. the lower layer of the road
- prevent erosion of the surrounding area which may be subject to inappropriate drainage of the rainfall waters coming from the road
- prevent migration of pollutants in the soil, surface waters and groundwater near the road

Drainage systems which can be applied depending on the location and morphology of the terrain:

- Open canals and gutters
- Closed pipe systems
- The so called French drainage

In the so called rural areas (characteristic for the observed route), open canals and gutters and French drainage are mostly applied. In cases when the road passes through sensitive areas, a closed pipe system can be applied; the end of this system must contain an oil collector or another type of purification system for the wash out waters coming from the road and which are collected by the drainage system. When the route is lead into an embankment the so called French system is applied, it represents a combination of a closes pipe system (perforated pipes or half open pipes) filled with sand and gravel which serve as a filter to prevent clogging the pipes.

Open canals and gutters will be applied to the sections of the route leading through a low notch. The following image depicts an example of an open canal used for draining wash out water from the road.



Picture 7 Construction of an open canal on areas where the route

Gutters will be applied on sections on the route leading into a notch. The following figure is an example of gutter construction for draining rain waters from the road surface.



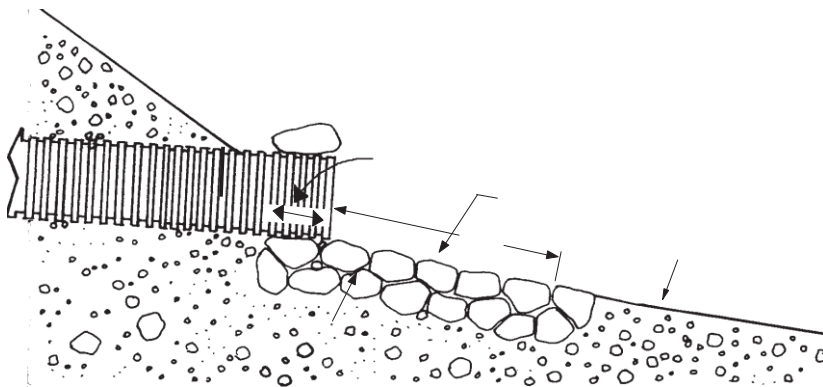
Picture 8 Drainage system composed of gutters

In the process of leading the route into embankment the French drainage may be used. Example of this type of drainage is depicted in the following figure.



Picture 9 Example of application of the so called French drainage

When the waters drained from the road surface are led into an embankment, a belt of tampon materials (stone and gravel) needs to be constructed in the foot of the embankment, for to the protection of the agricultural land from pollutants. This way the further migration of the waste waters from the road surface in the surrounding terrain will be prevented. The following figure is an example for the construction of such a belt of tampon material.

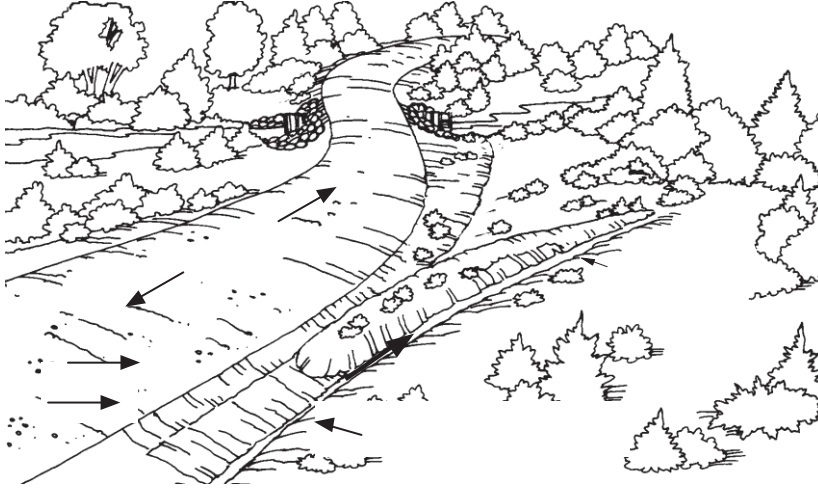


Picture 10 Setting a gravel and sand filter in the foot of the embankment in which the road was formed.

In general, due to the collection of the wash out waters from the road surface, **oil receptors are applied by placing them on an appropriate distance in accordance with the Main design.** However, on areas where the route leads to an embankment,

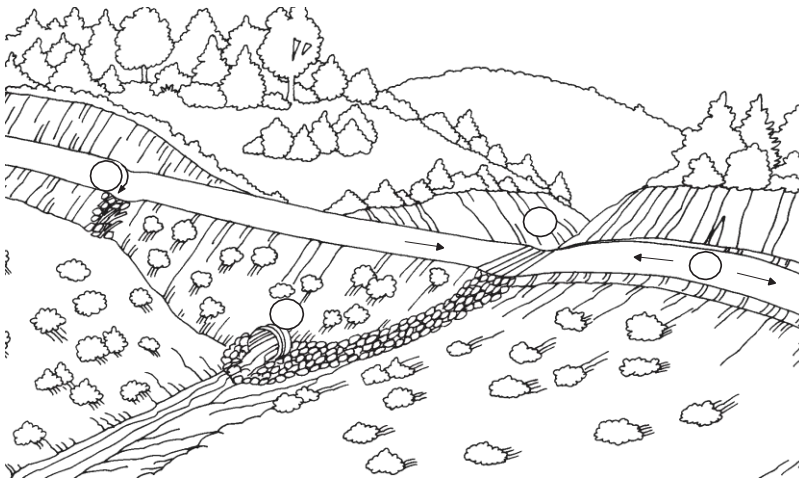
non engineering methods can be applied, i.e. measures such as biological systems for the purification of these waters.

Namely, the locations where the diverting of the wash out road waters can be performed toward a field overgrown with bushy vegetations, it would be enough for the waters to be directed toward these terrains. This is illustrated on the picture below:



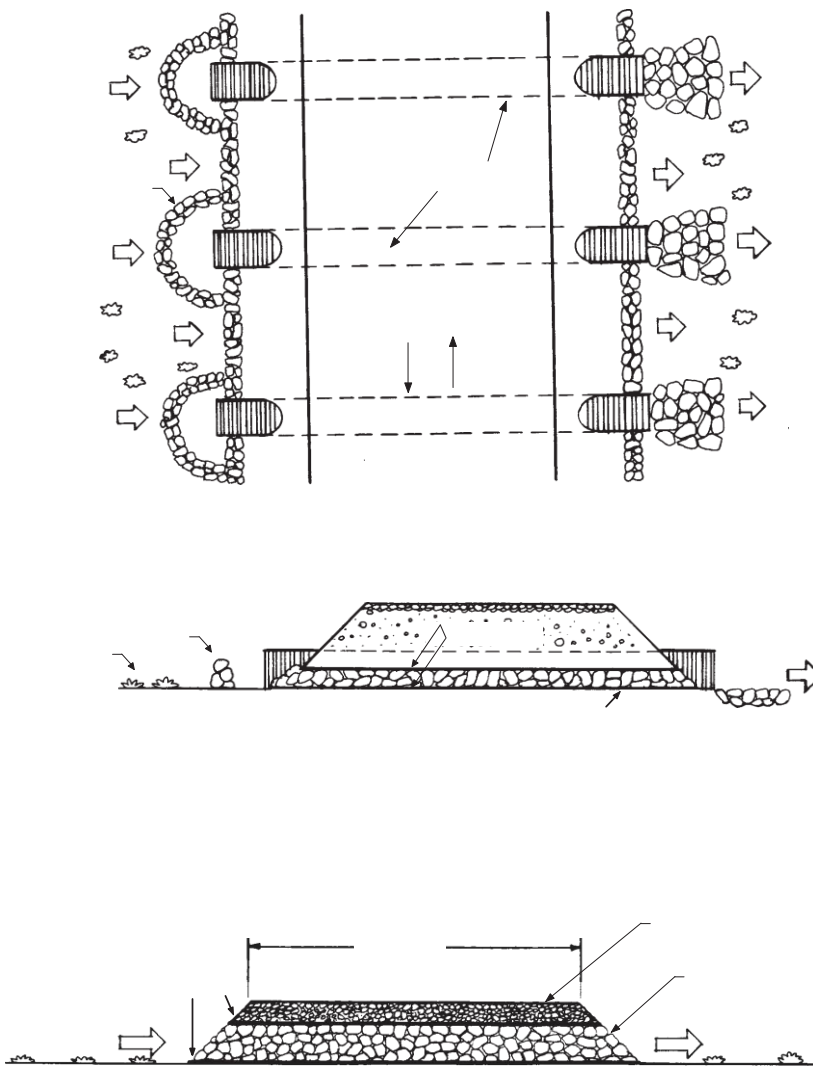
Picture 11 Diverting waste waters from the roads toward a

When the route leads to an embankment toward a location passing over an omission (placed for securing a pass way for temporary water flows) it is possible for a stone gravel and sand belt to be applied, through which the waste waters from the road would be led to the recipient - the temporary water flow. An example for this procedure is show in the picture below.



Picture 12 Example of leading wash out waters toward a temporary water flow, regulated with an omission under the body of the road

Another example of leading waste waters from the road when the route is led into an embankment is depicted on the picture below.



Picture 13 Leading wash out waters from the road when the route is led toward an embankment

5.3. Measures for the reducing the impact on the air

5.3.1 Construction phase

The following measures have been proposed in order to reduce the impact on the environment, which can also reduce the air pollution during the construction of the expressway:

- Strict control of the construction methods and the mechanical equipment and other equipment used;
- Careful planning of the construction works including the works in the populated areas (prohibition of construction in certain periods of the day);
- Speed limitation of the construction vehicles on the construction site and in the populated areas;

- Sprinkling water or other appropriate material on the construction site in order to reduce the emission of dust;
- proper maintenance and covering of the vehicles delivering construction materials due to the reduction of the emission and dispersion of pollutants.
- providing safety measures for the safety and health at work of the workers on the construction site.

5.3.2 Operational phase

In the course of the exploitation the parameters that influence the air quality are themselves dependent of the movement of traffic, and cannot be controlled. The only potential safety measure is the creation of a protective green belt which will partially absorb pollutants, such as suspended particles and other.

5.4. Measures for the reduction of the impact on the flora and fauna

5.4.1 Construction phase

The following the measures will be applied in the course of construction of the expressway:

- careful planning of the construction works with the purpose to reduce the impact on the populated areas, the flora and fauna;
- Careful planning of the activities during the construction and seasonal work;
- Careful placement, harmonisation and designing of the accompanying facilities (access roads, camps for the construction workers, i.e. location for maintenance of the construction mechanisation) for the reduction of the impact (especially in the sensitive areas);
- Careful selection of the location for the construction materials, storage/disposal of construction waste, i.e. selection of a location which does not impact the protective green belt;
- **Designing natural passes for the animals passing over the access roads and trenches;**
- avoiding loud noises caused by vehicles and construction machines in the areas with habitats of special species;
- Clearing the construction site;
- After the construction the activities planned for rehabilitation need to be performed on the location, the trenches, the sand areas and the access roads, by planting grass and trees or other appropriate measures;
- compensation for the vegetation by planting trees, bushes and grass resistant to fire with the purpose to improve the visual effects;
- **Reforestation of bare surfaces with autochthon types of trees and bushes typical on that area. The reforestation will be performed according to the Ministry of agriculture, forestry and water supply, in accordance with the previously adopted plan and program for forestation, prepared on the basis of the loss on vegetation for the purpose of construction of the expressway.**

Access roads must not pass through the following habitats:

- alluvial deposits with willow trees
- gorge Drenovska

- Well preserved areas with oak –hornbeam trees

During the establishment of the construction site, selection of the construction site location and determining the locations for all facilities as well as the equipment on the construction site must be made. The general measures regarding the specific areas, localities and habitats are:

Locations for construction of working camps, storage areas or parking lots for the mechanisation need to be avoided on highly sensitive habitats such as:

- preserved fragments of oak - hornbeam woods – chainages KM 0+000 and 0+500, 0+800 and 1+400, 5+000 and 6+000 (see the habitat maps in Appendix 2).
- the riparian areas with willow trees and poplars near the Raechka River, as well as the streams near the village of Kamen Dol (see the habitat map).
- the hilly pastures – chainage KM 13+500 and KM 16+500, as well as on the small surfaces between the chainages KM 9+500 and KM 9+800 and around KM 19 (see the habitat map).
- the rocky hillsides with chasomophyte vegetations in the gorge Drenovska

The localities from the following habitats cannot be used as loans .

- Alluvial deposits with belts from willow trees and poplars (sand and gravel)
- Rocky hillsides on the gorge Drenovska
- Rivers and streams (sand and gravel)
- Fragments of oak - hornbeam woods (with the exception of the degraded ones)
- Localities with natural rarities

Constant or timely expert supervision (ecologist or biologist) is recommended for the following habitats:

-gorge Drenovska klisura

The pass ways for the animals will be planned though the omissions constructed for regulation of constant water flows. They will be placed by avoiding omissions completely covered by shadow, which could potentially deter the animals from using the pass ways.

During the protection of the areas with natural rarities, according to the Spatial Plan of the Republic of Macedonia the following principles need to be followed:

- preservation of the dominant characteristics in its one constant natural condition,
- optimal protection of localities with natural rarities (gorge Drenovska)
- promoting the values of the natural heritage
- planning and construction of minimal technical infrastructure.

The road corridor passes through the gorge Drenovska which is a protected area falling in the category - Monument of nature and has a scientific research and botanical significance. The area is protected due to the presence of relic plant communities, rare plant species, insects and birds, as well as due to the presence of the endemic snail *Carinigera drenovoensis*. The route passes though two ornithological localities, more specifically Gradsko – Rosoman – Negotino and the valley of the river of Raec, as well as though the area with significant plant communities - Raec – Tivesh – lake. A small part of the road route enters the Emerald area of Raec. Due to this reason the valley of the river of Raec and especially the gorge Drenovska represents a significant area. This is why a major negative impact can be expected during the construction of the road and the use of access roads. The communities will be fragmented and there will be a destruction of certain plant species

population. Because of this specific measures need to be taken in this part of route with the purpose to minimize the negative impact over the habitats and species.

- Periodical supervision from an expert in the field of environment or a biologist during the construction activities
- Avoiding the construction of access roads in the stated areas

If during the spatial management certain new information come to our knowledge, which could imply endangering the natural heritage due to the urbanisation of this area, measures for protection of the natural heritage need to be taken in accordance with the Law on protection of nature (Official Gazette of the R.M. no. 67/04, бр.14/06, бр.84/07 и бр.35/10).

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In order to protect the flora and fauna, the necessary special measures need to be taken:

- the clearance of the trees and bushes needs to be performed in winter, not in the nesting period of the birds. This is especially important for the hillsides and the areas with well developed oak - hornbeam woods.
- If the use of explosive is planned, it should be limited only to the period from August to February, in order to avoid the nesting period of the birds.

5.4.2 Operational phase

In the operation phase the most significant influence over the flora and fauna is the traffic noise. Considering that the noise protection barriers are planned mostly for the populated areas, it is possible that the traffic noise in the agricultural areas with avian population to also require placement of noise protection walls. However, due to the low frequency of traffic expected on this road corridor, it is considered that the noise level to be created will not bother the natural i.e. physiological activities of the birds, existing on the subject location.

5.5. Measures for the reduction of influence on the soil

5.5.1 Construction phase

The effects on the soil during the construction arise from improper management with materials, fuels, oils, and lubricants, construction debris and communal waste.

The following measures are foreseen:

- Careful panning of the construction works with the purpose to reduce the negative effects and prevent soil pollution
- Reduction of the location size due to minimizing the land enduring negative effects, and prevent soli pollution
- Restriction of vehicle movement, and use of mechanical equipment with lower pressure on the surface
- Precise performance of the construction works, avoiding leakages from the vehicles. The vehicles need to be constantly services so that the leakages prevented
- Appropriate clearance of the materials spilled on the site.
- Minimizing the loss of vegetation along the construction site

- The construction works cannot be performed in conditions of heavy rainfall, in order to reduce the speed and volume of the polluted superficial drainage
- Taking preventive measures for landslides, stabilizing the embankments (support walls etc.) if necessary
- Appropriate disposal of the construction waste
- Safe storage of the construction materials
- Provision of appropriate systems for managing sanitary waste waters from the camps
- Rehabilitation of access roads and other temporary structures by planting grass, trees and other (re-vegetation)
- Appropriate construction and installation of the drainages, cleaning the drainage canals with the purpose to minimize the risk of erosion and appearance of landslides
- Cleaning the construction site / rehabilitation of the damaged areas after the construction works are completed;
- Rehabilitation of eroded surfaces and bringing them to their natural condition/replanting the vegetation, if appropriate.

5.5.2 Operational phase

The measures for protecting the soil quality are identical to those applied for protection from erosion, leading waste waters away from the roads, as well as the measures for waste management.

5.6 Measures for reduction of the impact caused by waste management

The measures for reducing the impact on the environment regarding the waste refer to applying the best practices in the waste management process and waste removal on the designated locations.

5.6.1 Construction phase

For the protection of the environment (soil, waters and the area) application of the legal regulations referring to waste management is planned. In addition, preparation of **Plans for Waste and Material Management** is proposed for the construction locations, with the purpose to provide recycling of the recyclable matters, as well as separating of the most hazardous fractions so that they can be properly collected, stored and handed over to licensed companies which can manage this type of waste. The preparation of the following plans can have a significant contribution to the improvement of waste management.

Waste Management Plan for the Location (WMPL)

The implementation of WMPL is recommended so that the quantity of generated waste is reduced.

WMPL contains the following:

- Description of all types of waste which are expected to be generated in the construction of the project
- Estimation of the quantity of all types of waste expected to be generated
- Determining waste management measures for each special type of waste, as well as reuse, recycling, extraction and depositing.

Material Management Plan (MMP)

MMP can replace WMPL but it can present an integral part thereof with the purpose to identify the course of the special types of waste. MMP will contain the following:

- Description of the materials regarding their intention and the relative quantities.
- details on the location and the manner in which these materials will be stored
- details regarding the final disposal site and use of these materials
- details regarding the frequency and locations where these materials will be moved.

The waste generated from the construction of the access roads as well as the construction of the notches is recommended to be reused as a construction material for the embankments i.e. as a layer for re-vegetation of the embankments, if possible. The remaining material will be removed to the determined landfills approved by the Ministry of environment and spatial planning, as well as by the Investor. The locations of these landfills have been determined with geo-mechanical researches. These locations are beneficial from an aspect of the environment.

The humus and trees cut down during the preparation activities can be used by the local population for heating, construction materials and composting. The remaining waste will need to be removed to the determined location approved by the Ministry of the environment spatial planning and the Investor. During the transportation of the excess excavated materials, prohibiting overfilling the vehicles is recommended.

Repair work and charging mechanical equipment with fuel needs to be performed on impermeable surfaces such as plastic foil, whereby the empty tanks of the chemicals and oils need to be collected and removed to a location approved for hazardous waste disposal or to be stored in accordance with the law. The Constructor is obliged to note and document the management of such types of waste according to the legal obligations.

In order to avoid the negative effect of the liquid waste, the collection, treatment and disposal of this type of waste needs to be performed according to the national regulations for the appropriate type of liquid waste.

5.6.2 Operational phase

In order to avoid the pollution of the environment with construction waste and inert waste, depositing such waste along the route of the road will be prohibited during the exploitation of the express way. The National Inspectorate for Environment and the Public Enterprise for National Roads or a company responsible for road maintenance will be responsible for the implementation of these measures.

5.7. Measures for reduction of the impact caused by noise and vibrations

5.7.1 Construction phase

Measures for reduction for the impact caused by noise and vibrations in the construction phase include the following:

- Careful planning of the preparation works with the purpose to reduce the noise
- Avoiding equipment generating noise over 90dB is necessary;
- Control of the construction methods and use of mechanisation, as well as regular equipment servicing due to a possible minimisation of high levels of noise;
- Avoiding operation in under utilisation of the construction machines on the location, limiting the space for their manoeuvre etc.

- Careful planning of the time of operation in the populated areas (for example, prohibition for construction in certain periods of the day)
- Avoiding loud noises in settlements/minimising the disturbance of peace of the citizens;
- Limiting the speed of the construction vehicles especially in populated areas;
- Informing the local population for the period of execution of the construction works

5.7.1 Operational phase

In the phase of use of the express way noise will be caused as a result of the increased traffic frequency. This noise will not have a significant impact along the route, with the exception of the area where it will come near or enter a populated area. It is very likely that the maximum allowed values, determined with the legal regulation, will be surpassed (Rulebook on the border values for the level of noise in the environment. Official Gazette of RM no. 147/08, as well as the Resolution for determining in which cases and under which conditions it will be considered that the public peace of the citizens has been disturbed due to damaging noise, Official Gazette of RM no. 1/09) considering that the traffic frequencies along the express way will be increased.

The route of the Expressway will come near and pass through the village of Kamen Dol where it will be especially important protective noise measures to be applied for the population. **Noise protective barriers need to be placed on these locations.**

Planting vegetation high enough and thick enough could also reduce the noise. Still, in order to achieve a reduction of around 10 dB, the width of the protective belts needs to be at least 60 meters which is not always possible, as in the example of the village of Kamen Dol where the area from the road axis to the first houses is estimated at 30 meters.

For a proper selection of a noise protective barrier, the height, and the materials for its construction need to be determined. Beside the need to prevent the noise, the barriers need to fit in the surrounding area. The calculation of the noise indicators caused by the road traffic will be performed in accordance with Appendix 1 from the Rulebook on application of noise indicators, additional noise indicators, noise measuring methods and rating methods using the noise indicators in the environment (Official Gazette of RM no. 107/08).

The following chart depicts the parameters used during the selection of the type of noise protective barrier.

Chart 3 Review of types of noise protective barriers and their characteristic regarding the loss of noise transmission

Material	Thickness	Superficial thickness	Transmission Loss * -TL
Polycarbonat	8-12	10-14	30-33
Acryl [Poly-Methyl-Meta- Acrylate	15	18	32
Concrete block 200x200x400	200	151	34
Common concrete	100	244	40
Lightweight concrete	150	244	39
Lightweight concrete	100	161	36
Brick	150	288	40

Material	Thickness	Superficial thickness	Transmission Loss * -TL
Steel, 18 ga	1.27	9.8	25
Steel, 20 ga	0.95	7.3	22
Steel, 22 ga	0.79	6.1	20
+	0.64	4.9	18
Aluminium sheet	1.59	4.4	23
Aluminium sheet	3.18	8.8	25
Aluminium sheet	6.35	17.1	27
Plywood	25	18	21
Plywood	13	8.3	20
Plywood	25	16.1	23
Absorption panels with polyester	50-125	20-30	30-47
* Values for barriers without perforations and/or openings			

According to the experience we've had so far with the application of noise protective barriers in Macedonia, appropriate performances can be provided by lexan barriers placed on aluminium profiles.

Namely, we selected transparent walls from polycarbonate with the dimensions suitable for building in the horizontal profile of the express way when the route leads into an embankment, i.e. notch with small heights. "Lexan EXELL D (polycarbonate) noise panels thermoformed in "Z" with double UV protection can be used for sound reflection, depending on the calculations of the noise levels which will be performed as part of the Construction project. The height, vertical and horizontal cross-section of the noise protective barriers will also be determined with the constriction project based on the calculations.

The locations of the panels are 13+233.00 - 13+449.00

5.8. Measures for reducing the social impacts

5.8.1 Construction phase

Measures for reduction of negative impact in the social sphere will be taken in course of the construction phase, and which refer to

- reduction of the possibility for injuring at the job position, protection from car accidents caused by the frequencies of the transportation vehicles, protection from the emission of exhaust fumes as well as protection from the appearance of increased noise from the construction equipment as well as the vehicles for transportation of equipment and materials.
- Application of measures for compensating the citizens whose land will be expropriated for the construction of the road
- Application of measures for compensating the citizen - owners of land with reduced value due to the presence of pollutants caused by traffic movements

The proposed measures are related to the implementation of adequate measures for prevention of air pollution, noise and vibrations, as well as measures for protection against possible injuries of the local population and workers involved, and off course the use of adequate tools and equipment for personal protection of the employees

during the construction, all in accordance with the Law for safety and health at work. The measure for reducing the influence over humans' health is the appropriate waste management (collecting, transportation and depositing), with the purpose to prevent possible infections and illnesses.

In order to reduce the potential fires, full application of the safety measures and regular supervision of the location near the express ways is necessary.

The planned security measures for reducing of the impact on the environment in the immediate vicinity of the express way on the section Gradsko – bridge of the river of Raec, should be presented to the interested/concerned social actors and the broader public. This will be done by organizing campaigns to raise the awareness of the populations for the benefits of the project through public debates, round tables, flyers, educational workshops etc.

The compensation for the expropriated land needs to be performed according the **Expropriation Plan** as well as according to the legal regulations (stated in Chapter I), however first and foremost according to the Law on expropriation.

Appropriate monitoring and evaluation of the expropriation implementation also needs to be performed.

Periodical analysis and statistics of the accidents at the location need to be prepared, with recommendation that such risks are reduced in the consecutive construction works.

5.8.2 Operational phase

In the construction phase of the Expressway positive influences are expected on the population and humans' health, especially regarding the communication, the transportation of goods and people, and that is why security measures are not planned in this phase.

5.9. Measures for reducing the impact on the area and visual effects

5.9.1 Construction phase

Beside the recommendation for reducing the construction site size, the application of good planning and construction practices, careful maintenance and appropriate sanitary maintenance on the construction site, the measures reducing the impact on the environment, include the following:

- Fast disposal of the construction waste on the approved locations;
- If possible, the excavated material to be used to fill in the holes/loans created during sand digging;
- Repair of pedestrian crossings and sidewalks immediately after the construction works on the expressway and the re-vegetation of the slopes are finished;
- careful closing of the construction sites/waste disposal locations /cleaning the construction site after the construction works are completed/re-vegetation of the area;
- Completion of the construction activities by removing all obstacles.

5.9.2 Operational phase

In the phase of using the express way, negative influences are not expected, which is why it is not necessary for any measures to be taken.

5.10 Measures for the reducing the influences over the archaeological and culturally-historical heritage

When it comes to protection of monuments, the person responsible for the preparation of the spatial and/or urban plan is obliged to seek data on the existence of valuable cultural and historical localities, and then to ask for an opinion on the prepared plan. The practice we've had so far and during the preparation of planned documents, as well as the preparation of infrastructure projects (such as the subject project) the cooperation between the competent services consists of delivering a list or information of the existence, i.e. non existence of registered fixed cultural monuments on the subject area.

The general rule for protection of the fixed cultural monuments as a social responsibility toward the protected heritage is proscribed with the Law on protection of cultural monuments. The general rule under which protection is accomplished is preserving the monument in its original state and undamaged. Beside the general rule for protection, the law proscribes a possibility for proscription of separate technical – protective measures for each registered monument individually. When it comes to individual monuments, the protection measures are proscribed in an administrative procedure as a part of architecture projects. Considering that the route will pass near a monument from World War One, the Contractor will need to provide all the appropriate technical - protective measures determined by the Cultural Heritage Protection Office.

If off course during the construction works an object considered as cultural or historical heritage appears, the field work will be temporarily stopped and the Cultural Heritage Protection Office will be informed.

6.0. PLAN FOR MANAGEMENT OF THE ENVIRONMENT

The main goal of this Plan for management of the environment is to ensure that the measures planned with this Study on Environmental Impact Assessment are reflected in the working design of the expressway, as well as in the tender documentation.

The Plan determines the measures for reducing harmful impact, as well as the supervision/administrative prohibitions that will be conducted during the implementation of project (during the construction and exploitation). Also projected are the duration, frequency and the sequence of all measures in order for them to be integrated in the total planning of the execution of works.

The costs for the implementation of the measures are unknown in this phase of planning. They should be determined with the working design and included in the tender file. No costs are projected for administrative prohibitions or conducting of inspection supervision.

The following chart shows the measures for reducing the most significant impacts identified in respect of the project for each separate medium/area of the environment.

Chart 41 Plan for environment management

Impact / medium	Location	Activity	Responsible for the implementation	Period of implementation	Costs
Construction period					
Soil and land					
Topography and geology	Along the whole route	Avoiding work during unstable whether	Contractor	During construction	/
		Prohibition on storing of hazardous materials within the loan zone	Contractor	During construction	/
		Re-cultivation of loans and landfills for the excess excavated material	Contractor	Immediately upon finalizing the constructions works on the given section	To be determined with the tender file by the project designer
		Preparing a plan for handling waste and materials	Contractor	Before initiating the works	To be determined with the tender file by the project designer
Land Erosion / landslide	At larger notches and embankments	Preparation and application of plan for the control of erosion	Contractor	During construction	To be determined with the tender file by the project designer
		Re-vegetation of inclinations and	Contractor	Immediately upon finalizing	To be determined with

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Impact / medium	Location	Activity	Responsible for the implementation	Period of implementation	Costs
		slopes		the constructions works on the given section	the tender file by the project designer
Period of exploitation					
Wearing off of the road structure, pollution of the land alongside the road	Along the whole route	Automatic proportioning of salt for protection against frost, application of alternative means of defrosting	Makedonija pat or other authorized enterprise	In winter conditions	The costs include the supply and/or maintenance of the appropriate equipment for automatic proportioning of the defrosting means
Pollution of soil	Along the route in a 10 m zone	Avoiding agricultural production within a zone of at least 10 m	Public enterprise for state roads, Ministry of Finance and Ministry of Environment, the local population	During the exploitation of the road	Implementing compensational measures for the affected population
Pollution of soil with solid waste and debris	Resting sites (if they are constructed)	Prohibition on dumping waste and debris along the route and providing sufficient number of containers/bins	State Environmental Inspectorate and Public enterprise for state roads or the company authorized for the maintenance of the road	In the period of the exploitation of the road	Price of containers and bins for each resting site, as well as price for the transport of waste to the dumping ground
Surface waters and groundwater					
Construction period					
Removal of waterside vegetation	On sections where the route approaches the river Raec and at the bridges	Enclosing a zone of 5 m alongside the riverbank and preventing the removal of waterside vegetation; The enclosed zone should not be accessible for heavy construction machinery; interventions in and around the river bed should be strictly localized	Contractor	During construction	Price for the fence
Pollution of surface waters and groundwater due to construction works	On sections where the route approaches the river Raec and at the bridges	Managing sediments and erosion	Contractor	During construction	To be determined with the tender file
		Monitoring of the construction works by an Authorized environmental	<i>Authorized Environmental inspector</i>	During construction	/

Impact / medium	Location	Activity	Responsible for the implementation	Period of implementation	Costs
		inspector			
Compensation for the lost waterside vegetation	On sections where the route approaches the river Raec and at the bridges	Planting autochthon tree and shrubby species along the bank. This compensational measure will strengthen the retention capacity of the streamflows and will have a positive impact on the quality of surface waters and groundwater within the area of the route	Public enterprise for state roads, <i>Contractor</i>	Upon finalizing the construction	The costs will be determined by the project designer and shall be included in the tender file, i.e. the Contractor's offer
Preventing the pollution of surface waters and groundwater from washing out waters from the road	For sections of the route, whereby it is led into an embankment	Utilization of appropriate drainage and Utilization of gravel filters	Contractor	During construction	The costs will be determined by the project designer and shall be included in the tender file, i.e. the Contractor's offer
	For sections where the route is led into a notch	Utilization of oil binders			
Flora and fauna					
Construction period					
Loss of habitats: Agricultural land and degraded forest	Along the whole route	Limiting the surface area affected by construction	<i>Contractor</i>	During construction	/
Disruption of waterside vegetation	On sections where the route approaches the river Raec and at the bridges	Limiting the surface area affected by construction	<i>Contractor</i>	During construction	/
Landfills	Determined according to the geomechanical inspections and approved by MESP and the Investor	Avoiding areas with scenery value; re-cultivation ;	Public enterprise for state roads, <i>Contractor</i>	During construction, i.e. upon finalizing the construction	Costs for re-cultivation
Endangering animal habitats, river valleys	On sections where the route approaches the river Raec and at the bridges	Avoiding periods of nesting and mating of the animals	<i>Contractor</i>	During construction	/
Protection of SP Drenovska klisura	Chainage 4+000 to 7+000	Prohibition on mining in the period between August and February; constant supervision of	<i>Contractor, public enterprise for state roads, Ministry of Environment and Spatial Planning</i>	During construction	/

STUDY ON ENVIRONMENTAL IMPACT ASSESSMENT

Impact / medium	Location	Activity	Responsible for the implementation	Period of implementation	Costs
		the construction works by a biologist			
Period of exploitation					
Fragmentation of habitats	Locations where the route is led into embankments longer than 500 m	Providing opening for the migration of wild species	Contractor	During construction	The openings are constructed for the drainage of the terrain, no additional costs are projected
Air					
Construction period					
Pollution of air	Along the whole route	Synchronization of the construction machinery work, minimizing the time of use for each machinery and their optimization	<i>Contractor, Environmental inspector</i>	During construction	/
Pollution of air	Along the whole route	Sprinkling of water in order to reduce dust	<i>Contractor</i>	During construction	1,500
Period of exploitation					
Pollution of air	Along the whole route	Planting shrubby and tree species, which can absorb the polluting matter along the route	<i>Contractor</i>	Upon finalizing the construction	5,000
Noise					
Construction period					
Endangering of sensitive recipients-settlements	For sections where the route approaches the settlements (Sirkovo and Kamen Dol)	Synchronization of the construction machinery work, avoiding sound signalization	<i>Contractor</i>	During construction	/
Endangering of sensitive recipients-birds	For sections where the route passes through an agricultural land	Synchronization of the construction machinery work, avoiding sound signalization	<i>Contractor</i>	During construction	/
Period of exploitation					
Endangering of sensitive recipients-settlements	For sections where the route approaches settlements (Kamen Dol)	Construction of sound protection barriers	<i>Contractor</i>	At the end of the construction works or immediately upon their finalization	The project designer will project the costs and the type with the tender file

The exact locations of the measures (determined with chainages) have been individually determined for each medium/area of the environment.

In order to secure that the recommendations within this Study have been obeyed, it is necessary that there is supervision by the State Environmental Inspectorate. The inspector is a member of the supervision team and he participates in issuing of

approvals, signing of corresponding documents and sentencing appropriate penalties in case there is violation of the measures prescribed in the Study, and later in the Offer of the selected contractor.

The responsibilities of the Environmental inspector, additionally to his responsibilities according to the Law on Environment, are the following:

Supervising the implementation of the good construction practice in accordance with the principles for environment protection, and thus:

- supervision on fulfilling the obligations defined in the tender file
- approving all plans determined with this Study, before the construction works are initiated
- Notifying the Supervisory body and the Client/Investor
- Consulting when there are dilemmas or unpredicted issues on the terrain in respect of implementing the measures for environment protection
- Communicating with the population affected by the project
- Researching upon cases, such as claims/complains and similar by the local population.

The environmental inspector should have his deputy in case he is detained from involving in all phases of the construction works.

7.0. PLAN FOR MONITORING OF THE ENVIRONMENT

The implementation of the Plan for monitoring the environment will collect data which can serve for documenting the status of specific environment mediums (air, water, soil) and their areas, as well as monitoring the effects from the applied alleviation measures. Additionally, the plan enables the establishing of interactive connection between all involved parties and represents a foundation for the authorized institutions to control the process of implementing the legislation and reaching appropriate decisions.

The main goals of the plan are:

- To confirm during the approval of the project that the agreed and compulsory requirements are appropriately implemented,
- To confirm that the impact is within the frames of the projected and allowed value limits,
- To enable the managing of the not projected effects and changes and
- To confirm that the application of alleviation measures increases the benefits in respect of protecting the environment

The plan for monitoring includes monitoring all parameters of the mediums and areas of the environment:

- air,
- waste,
- biodiversity (flora and fauna) and
- noise.

The monitoring of the environment parameters is showed in a chart, where it is stated in which phase of the project the monitoring of the parameters has been conducted (construction phase and operational phase).

The proposed parameters for monitoring are given in Chart No. 42.

- the medium and the parameter that is monitored,
- the phase of the project,
- the location where the parameter is monitored,
- the mode of monitoring of the parameters and/or type of equipment that is going to be used,
- how often is the monitoring done
- the reasons for monitoring the parameter,
- who is responsible for monitoring the parameters.

Chart 4 Monitoring plan

Medium/ area	Project phase	Measured parameters	Location of the place of measurement	Mode of measurement / type of monitoring equipment	Frequency of measurements	Reason for measurements	Responsibility
Air	Construction	According to the legal regulations on the quality of ambient air, especially solid particles (PM10), gases: SO ₂ , CO, NO _x , VOC	On the location of construction and the immediate surroundings	Monitoring with appropriate measurement equipment /laboratory tests	Continuous, and so called spot measurements	Documenting the status of the air quality during the construction and providing implementation of the alleviating measures	Investor/Contractor/ Supervisory body/Inspector
Waste	Construction	Type and amount of waste, types and fractions of waste (hazardous, nonhazardous, communal, inert)	Along the route	By visual counting/measuring In respect of waste that is not communal, an authorised institution should be contacted.	Keeping records regarding the type and amount, as well as the mode of disposal of different types of waste.	Documenting the state of the waste and providing implementation of the Plan for handling waste and materials	Investor/Contractor (Authorised companies for collecting, transport and final disposal of waste)/ Supervisory body/Inspector
	Exploitation						
biodiversity (flora, fauna)	Construction	Number of land fauna of vertebrates if the construction is conducted during the reproduction phase	Along the route	Visual/ on-site observation	Every 10 days in the construction phase	Documenting the state of biodiversity	Investor/Contractor/ Expert in the field
		Intensity of the fragmentation of habitats of land and water flora and fauna	Habitats along the route	Visual/ on-site observation	Every 10 days in the construction phase	Documenting the state of biodiversity	Investor/Contractor/ Expert in the field
	Exploitation	Degraded ecosystems	Along the route	Visual/ on-site observation	March- October	Determining the realistic impact of the expressway on biodiversity	Investor/Contractor/ Expert in the field

Medium/ area	Project phase	Measured parameters	Location of the place of measurement	Mode of measurement / type of monitoring equipment	Frequency of measurements	Reason for measurements	Responsibility
		Number of bird nests	Along the route	Visual/ on-site observation	March- June	Determining the realistic impact of the expressway on biodiversity	Investor/Contractor/ Expert in the field
Is this monitoring only of the SP Drenovska klisura or the whole route, how will Drenovska klisura be separately monitored???							
Noise	Construction	According to the legal regulations on the level of ambient noise	For the section approaching the v. Kamen Dol	Monitoring with appropriate measurement equipment	According to the legal regulations- level of noise: once a month	Documenting the status of the level of noise during the construction and providing implementation of the alleviating measures	Investor/Contractor/Supervisor/Inspector
	Exploitation						
Waters	Construction	According to the legal regulation on water quality: colour, smell, temperature, HPK, BPK, suspended particles, oils, heavy metals	On the location of construction and the immediate surroundings (outlet of the construction site)	Monitoring with appropriate measurement equipment /laboratory tests	Continuous, and so called spot measurements	Documenting the status of the water quality during the construction and providing implementation of the alleviating measures	Investor/Contractor/Supervisor/Inspector
	Exploitation	Maintaining oil binders	For sections where the route is led into a notch	Using appropriate mechanization	Continuous	Reporting on the conducted works	Public enterprise for state roads and the corresponding public utility service
Soil	Construction	Stability of inclinations	On the location of construction and the immediate surroundings	Detailed terrain research with hydro-geological and geomechanical	Depending on the development of the expressway- when needed	Documenting the status of the soil quality during the construction and providing implementation	Investor/Contractor/Supervisor/Inspector

Medium/ area	Project phase	Measured parameters	Location of the place of measurement	Mode of measurement / type of monitoring equipment	Frequency of measurements	Reason for measurements	Responsibility
			(outlet of the construction site)	drilling		of the alleviating measures	

6.0. CONCLUSIONS

The construction of the Expressway section next to Gradsko to the bridge of the river Raec is part of the planned final shaping of the road network through the realisation of the secondary development axis in the Republic of Macedonia and it is an important section for connecting the west part of the state with the central and east part.

After the conducted analysis on the potential impacts resulting from the construction of the expressway (for the construction and exploitation periods), the following can be concluded:

- The project will have a long-term positive impact and it will contribute to improving the communication of the Pelagonia with the Vardar mountain region and intermediary the Skopje region, as well as the neighbouring countries that connect to corridor 10.
- The project will produce long-term positive effects on the population in respect of possibilities for fast economic development.

The project activities that are going to be undertaken during the implementation of this Project, especially during his construction, will affect the mediums and areas of the environment causing short-term and local negative effects:

- Disruption of the quality of soil, local geology and topography. These disruptions will be manifested through localized changes in the profile of the soil within the immediate surroundings of the excavations and soil compacting due to manipulation of vehicles and construction equipment, which can cause erosion as a result of the removal of the vegetation cover. This degradation may cause cumulative effects, such as impact on the water, air and biodiversity.
- Short-term temporary pollution of water with earth and other solid particles, which will cause blurring of the water if there is accidental leakage of oil or fuel from vehicles and equipment used on location in close proximity of water flows.
- The emissions in air during the construction will occur as the result of exhaust gases from the construction machinery. These emissions will consist of pollutants, such as SO_x, NO_x, CO, VOC etc. In general, low concentrations are expected. Dust is also expected, which will be generated during the construction of the expressway, as well as a result of earth works and activities during the preparation of the terrain, construction of access roads, clearing, excavations, flattening etc. The effects from this influence are expected to be of local and short-term character.
- The negative impact on the flora and fauna located in the area of construction due to the potential degrading of habitats and discontinuation of the ranges of movement. Mainly, the effects are expected to be more expressed during the construction, and thus locally and in short-term. In the operational phase, no significant negative impact is expected on vegetation species, vegetation communities and habitats of terrestrial animals (amphibian and reptiles) and most of the insects.

Corresponding to the effects, i.e. the reasons contributing for the Project to have a negative impact on the environment, the Study proposes measures for their reduction and neutralizing. They shall be included in the design and tender files, in order to protect, reduce and alleviate the negative impact on the environment and the health of people. The requirements for monitoring are in compliance with the legal regulations and the data received from the measurements shall be used for inspecting the achievements in comparison to the proposed measures.

Having the conducted analysis and observations in mind, using thereby the knowledge from the corresponding legal regulations, as well as the scientific and expert knowledge regarding the methods for assessing the impacts of the project on the environment, the *general*

conclusion is that **this project will not make a significant violation of the quality of the environment though his construction and the instalment of the planned equipment, as well as by full implementation of the measures for reducing (alleviating) the impact on the environment.**

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ANNEX I
List of types of flora and fauna

ANNEX II
Map of habitats

ANNEX III
Overview map of the route of the expressway
