Roads Department of the Ministry of Regional Development and Infrastructure of Georgia

Rustavi-Red Bridge Road Section of E-60 East-West Highway Construction and Operation Project

Environmental Impact Assessmenemt (EIA)

Tbilisi 2019

Report Structure

In line with Article 10 of the Law of Georgia On „Environmental Assessment Code“ and requirements of Scoping Opinion № 13 (25.06.2018) issued by the Ministry of Environment Protection and Agriculture of Georgia, the present EIA Report incorporates the following information:

CONTENTS

1. INTRODUCTION

One of the most important components of the economic policy of the Government of Georgia is the implementation of strategically important infrastructural projects and upgrading and development of the road network. This priority is shown in a 4-point Reform Plan developed by the government recently. The priority objective of the spatial development under the Plan is the International East-West E-60 Highway Improvement Project what will significantly promote the establishment of Georgia as a regional transport and logistics center.

Consequently, the Georgian Government, assisted by the international organizations, started to implement the program envisaging the improvement and upgrading of the main roads in Georgia. This program is controlled by the Roads Department of the Ministry of Regional Development and Infrastructure of Georgia.

The present document is about Rustavi-Red Bridge Road Section under East-West E-60 Highway Improvement Project. The Road connects Georgia with Azerbaijan and is also an important connecting chain to Europe across the Black Sea and Central Asia across the Caspian Sea. Following its great importance, the upgrading of the said Road is more than merely an ordinary infrastructural project.

The present environment scoping report was developed by “Eco-Spectri” Ltd. for the Roads Department of the Ministry of Regional Development and Infrastructure of Georgia. See the Table 1 below for the contact information.

Table 1.1.Contact Information

Implementing agency:	Roads Department
Legal address:	#12, A. Kazbegi Ave., Tbilisi 0160, Georgia
Implementation location:	The city of Rustavi, Marneuli Municipality
Type of activity:	Upgrading Rustavi-Red Bridge section of E-60 Highway
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Legislative basis and goals of the document development:

The procedures to provide an Environmental Impact Assessment (EIA), make relevant environmental decisions and for public participation and expertise during the implementation of various kinds of activities in Georgia are regulated in line with the requirements of the Environmental Assessment Code, the Georgian law adopted on June 1, 2017. The activities of different contents are prescribed in the I and II Annexes to the Code. The activities provided for by Annex I are subject to the EIA procedures, while those in Annex II must be subject to the screening procedure thus necessitating the EIA procedure.

The project to consider in the present document is among the activities under the I Annex:

- Clause 11. Construction of motor roads of international or intrastate significance.
- Clause 12. Reconstruction and/or modernization of motor roads the entire section of which is 5 km or more in length.

- Clause 13. Construction of tunnels and/or bridges located on the motor roads of international or intrastate significance.

Following the above-mentioned, the project is definitely subject to the EIA procedure.

The main stages of the EIA are given in Article 6 of the Code, suggesting that at the initial stage, a scoping procedure is necessary. As the Code defines, scoping is the procedure, which determines the list of the information needed to obtain and study for the EIA purposes and means to reflect this information in the EIA Report. Following the said requirements, the project Scoping Report was developed and submitted to the Ministry of Environmental Protection and Agriculture of Georgia.

In line with the requirements of the Code, the Ministry held the public hearing of the Scoping Report. Based on the scoping report, scoping opinion №13 of 25.06.2018 was issued, which gives the list of studies and information to obtain and study as necessary for the EIA Report development.

Following the above-listed procedures, the present EIA Report was developed. As the Code explains, the EIA Report is a procedure to identify and study possible environmental impact based on relevant studies for the planned activity, which may have a significant impact on the environment. The purpose of an EIA is to identify, study and describe direct and indirect impacts resulting from the planned activities on the following factors:

- human health and safety;
- biodiversity (including species of plant and animal species, habitats);
- water, air, soil, land, climate and landscape;
- cultural heritage and material assets, and
- any interaction between the factors provided for above.

The present EIA Report was developed in line with Article 10 of the Law of Georgia On „Environmental Assessment Code“ and requirements of scoping opinion №13 of 25.06.2018. Based on the EIA Report, the Ministry of Environment protection and Agriculture of Georgia issue an environmental decision, what is the necessary precondition for implementing the activity in question.

2. LEGISLATION AND NORMATIVE ACTS EFFECTIVE IN THE FIELD OF ENVIRONMENTAL PROTECTION AND ASSOCIATED WITH THE PLANNED ACTIVITY

Under Article 37 of the Constitution of Georgia, all citizens of Georgia have the right to live in harmless environment and to have use of the natural and cultural environment. Everyone is obliged to take care of the natural and cultural environment. The state, by considering the interests of the present and future generations, ensures environmental protection and rational use of natural resources, sustainable development of the country to provide the environment safe for human health in line with the public economic and environmental interests.

The basis for the environmental legislative and normative documents effective in Georgia is the Law of Georgia "On Environmental Protection". The Law regulates the legal relations between the state authorities and the physical and legal entities in the field of environmental protection and nature use on the whole territory of Georgia, including its territorial waters, air space, continental shelf and economic zone in particular.

Following the requirements of the above-mentioned Laws, a number of by-laws and normative documents are in force in Georgia, which regulates the legal relations in the field of environmental protection (the list of the legislative and normative documents is given in Tables 2.1 and 2.2).

Table 2.1. List of Environmental Laws of Georgia

Year	Final version	Law	Registration Code
1994	14/06/2011	Georgian Law on Soil Protection	370.010.000.05.001.000.080
1996	06/09/2013	Georgian Law Environmental Protection	360.000.000.05.001.000.184
1997	06/09/2013	Law of Georgia on Wildlife	410.000.000.05.001.000.186
1997	06/09/2013	Law of Georgia on Water	400.000.000.05.001.000.253
1999	05/02/2014	Law of Georgia on the Protection of Atmospheric Air	420.000.000.05.001.000.595
1999	06/09/2013	Forest Code of Georgia	390.000.000.05.001.000.599
1999	06/06/2003	Law of Georgia on Compensation for Harm Caused by Hazardous Substances	040.160.050.05.001.000.671
2003	06/09/2013	Law of Georgia on Red List and Red Book of Georgia	360.060.000.05.001.001.297
2003	19/04/2013	Law of Georgia on the Conservation of Soils and Restoration and Improvement of Their Fertility	370.010.000.05.001.001.274
2005	20/02/2014	Law of Georgia Licenses and Permits	300.310.000.05.001.001.914
2007	25/03/2013	Law of Georgia on Ecological Examination	360.130.000.05.001.003.079
2007	06/02/2014	Law of Georgia on Environmental Permit	360.160.000.05.001.003.078
2007	13/12/2013	Law of Georgia on Public Health	470.000.000.05.001.002.920
2007	25/09/2013	Law of Georgia on Cultural Heritage	450.030.000.05.001.002.815
2007	03/06/2016	The Law of Georgia on Rules for Expropriation of Ownership for Necessary Public Needs	370.060.000.05.001.003.003

2008	06/09/2013	The Law of Georgia on Rules for Expropriation of Ownership for Necessary Public Needs	020.060.040.05.001.000.670
2014	01/07/2014	Law of Georgia on Civil Security	140070000.05.001.017468
2014	01/06/2017	Waste Management Code	360160000.05.001.017608
2017	05/07/2018	Environmental Assessment Code	360160000.05.001.018492

Table 2.2. Major environmental protection normative documents

Adopted on:	**Name of the Normative Document**	**Registration code**
15/05/2013	Decree #31 of the Minister of Environment and Natural Resources of Georgia "On Approving the Provision on Environmental Impact Assessment".	360160000.22.023.016156
31/12/2013	Decree №425 of the Government of Georgia Technical Regulation – "Protection of Surface Water Contamination".	300160070.10.003.017650
31/12/2013	Decree №435 of the Government of Georgia Technical Regulation – "Methods of calculating the actual amount of emissions according to instrumental methods for determining the actual amount of emissions in ambient air from stationary sources of pollution, list of special measuring and controlling equipment for determining the actual amount of emissions in ambient air from stationary sources of pollution and technological processes from stationary pollution sources".	300160070.10.003.017660
31/12/2013	Decree №408 of the Government of Georgia. Technical Regulation – "Methods of calculation of maximum permissible emission of hazardous substances into ambient air"	300160070.10.003.017622
31/12/2013	Decree №415 of the Government of Georgia Technical Regulation - provisions on "Determining Levels of Soil Fertility" and "Soil Conservation and Fertility Monitoring".	300160070.10.003.017618
31/12/2013	Decree №424 of the Government of Georgia Technical Regulation – on "Topsoil Removal, Storage, Use and Cultivation".	300160070.10.003.017647
03/01/2014	Technical Regulation – "Operation of Dust-Trapping Devices approved by Decree №21 of the Government of Georgia.	300160070.10.003.017590
03/01/2014	Technical Regulation - "Radiation safety standards within the territory of Georgia", approved by the Decree №28 of the Government of Georgia.	300160070.10.003.017585
03/01/2014	Decree №8 of the Government of Georgia Technical Regulation - "The unfavorable weather conditions for Protection of Environment".	300160070.10.003.017603
03/01/2014	Decree №17 of the Government of Georgia Environmental Technical Regulation.	300160070.10.003.017608
06/01/2014	Decree №42 of the Government of Georgia. Technical Regulation - "Method for inventory of Stationary Sources of Air Pollution"	300160070.10.003.017588

14/01/2014	Decree №54 of the Government of Georgia Technical Regulation - "Environmental Damage Determination (calculation) Method".	300160070.10.003.017673
15/01/2014	Decree №65 of the Government of Georgia. Technical Regulation – "On asfe exploitation of oil depots"	300160070.10.003.017683
15/01/2014	Order №70 of the Government of Georgia Technical Regulation – "Maximum Allowed Concentrations of harmful substances at work places".	300160070.10.003.017688
17/02/2015	Decree №61 of the Government of Georgia „The rule of implementation of state control by the Environmental Supervision Department of subdivision agency of the Ministry of Environment and Natural Resources Protection of Georgia".	040030000.10.003.018446
04/08/2015	Decree №211 of the Minister of Environment and Natural Resources Protection of Georgia Technical Regulation - "Rules of reviewing and coordinating the company's waste management plan".	360160000.22.023.016334
11/08/2015	Decree №422 of the Government of Georgia on "Waste Recording, Form and Content."	360100000.10.003.018808
17/08/2015	Decree №426 of the Government of Georgia. Technical regulation "On Determination and classification of the list of waste according to their types and characteristics".	300230000.10.003.018812
01/04/2016	Technical Regulation - Decree №159 of the Government of Georgia "On the rule for the collection and treatment of municipal waste".	300160070.10.003.019224
29/03/2016	Decree №144 of the Government of Georgia "On the rule and terms of registration of the collection, storage, transportation, pretreatment and temporal disposal of waste".	360160000.10.003.019209
29/03/2016	Decree №145 of the Government of Georgia Technical regulation "On special requirements for the collection and treatment of hazardous waste".	360160000.10.003.019210
29/03/2016	Decree №143 of the Government of Georgia Technical Regulation "On approving the rule of waste transportation".	300160070.10.003.019208
01/04/2016	Decree #160 of the Government of Georgia „On approving the waste management national strategy for waste management of 2016-2030 and national action plan of 2016-2020"	360160000.10.003.019225

3. ANALUSIS OF ALTERNATIVE OPTIONS

The proposed project envisages the construction of a new four-lane highway from the city of Rustavi (car fair) to Georgian-Azerbaijan border (Red Bridge). The project corridor will cross the territories of two self-governing unit: the city of Rustavi and Marneuli Municipality.

Within the scope of the EIA, various alternative options of the project were considered, including non-project (no action) alternative and alternative routes of the road corridor .

3.1.1 Non-project alternative – substantiation of the project need

At present, Rustavi-Red Bridge section of the existing road (E-60) starts in the south-western part of the city of Rustavi. A sharply uprising relief after Rustavi has resulted in a circular route of the road.

A route length of approximately 17kms was traversed to reach Algetis Meurneoba and from there a largely straight road alignment was followed to reach Red bridge, at the border with Azerbaijan. This highway links the Black Sea ports in the west of Georgia to the eastern parts of the country and to the border with Azerbaijan. The present traffic on the road in Rustavi is about 10000 vehicles per day and at the borders of the Azerbaijan is 2000 vehicles per day.

At present, Rustavi-Red Bridge section of the existing road (E-60) starts in the south-western part of the city of Rustavi. A sharply uprising relief after Rustavi has resulted in a circular route of the road.

When analyzing no-action alternative, attention must be paid to the option of free movement of within the highway: on the background of successful cooperation between Georgia and Azerbaijan in various fields (including tourism, trade, etc.) the demand for exploiting the given section of E-60 road main (See the following sub-chapter – “Results of the study of vehicle flows”). The existing situation and forecasted data increase the risks associated with traffic safety and prolongs the travel time. Increased traffic flows due to insufficient road sizes, has a negative impact on the living conditions of the local population (the action of disturbing factors, such as noise, dust, etc. increases). In the future, simultaneously with the increased traffic flows 9what is quite possible in case of realization of such announced tourism development projects, as the construction of Anaklia Deep Sea Port, etc.), the situation described above is expected to aggravate further.

At the same time, it must be said that no-action alternative will fiercely decrease the positive social-economic effect gained at the expense of modernized sections of the highway and will have a negative impact on the expectations of the country population and businesses.

The goal of East-west E-60 highway improvement project, including Rustavi-Red Bridge section is to reduce the cost of transportation of the existing roads and give the opportunities for sustainable growth of the road network. The economic development brought by the existing road is in compliance with the long-term development strategy of the Government of Georgia.

The improvement of the state of the road will support the economic development. Reduced costs of transportation and/or improved access to them ensure high competence for the economic activity in the region:

- Field of road service: the improvement of the state of the road may result from an increased traffic intensity what will increase the local incomes of the roadside businesses, such as gas fueling station, hotels, restaurants, etc.
- Tourism: similarly, the road improvement will result in the increased number of tourists interested in the region what will increase the incomes and general well-being in the region;
- Social benefit: by improving the state of the road, the access to health, education, cultural improvement and other social needs may increase;
- Employment: local population will be engaged in the construction works what will have a positive impact on their incomes.

Following the above-mentioned, it may be said that the modernization project of E-60 highway will significantly support the sustainable development of the country. The reduction of the scales and area of the expected negative impacts on the environment caused by the implementation of the project will be possible by taking relevant compensation and mitigation measures.

3.1.1.1 Results of the study of traffic flows

The study of traffic flows was accomplished at the stage of the feasibility study of the project. The vehicles were counted in April of 2017, near Rustavi, Red Bridge and Algeti. Future trade potential of the project are and generated traffic estimates were modeled in HDM-4 during the feasibility study.

The results of the vehicle count and predicted traffic volumes are shown for 2040, 2050 in Table 3.1.1.1.

Table 3.1.1.1.1 Results of the study of traffic flows

Year	Destination	Average number of vehicles a day						
		Motorcycle	car	Minibus	Large bus	Small truck	Truck	Total
2017	Red bridge	0	1350	183	55	36	394	2019
	Algeti	0	2235	199	30	301	577	3342
	Rustavi	4	9720	977	36	457	727	11921
2040	Red bridge	0	4800	600	200	100	2600	8400
	Algeti	4	24600	3300	300	3900	5700	37800
	Rustavi	17	47800	5800	300	4400	6100	64300
2050	Red bridge	0	5600	800	200	200	2900	9700
	Algeti	5	28900	3900	300	4500	6400	44000
	Rustavi	20	56100	6800	300	5100	6900	75100

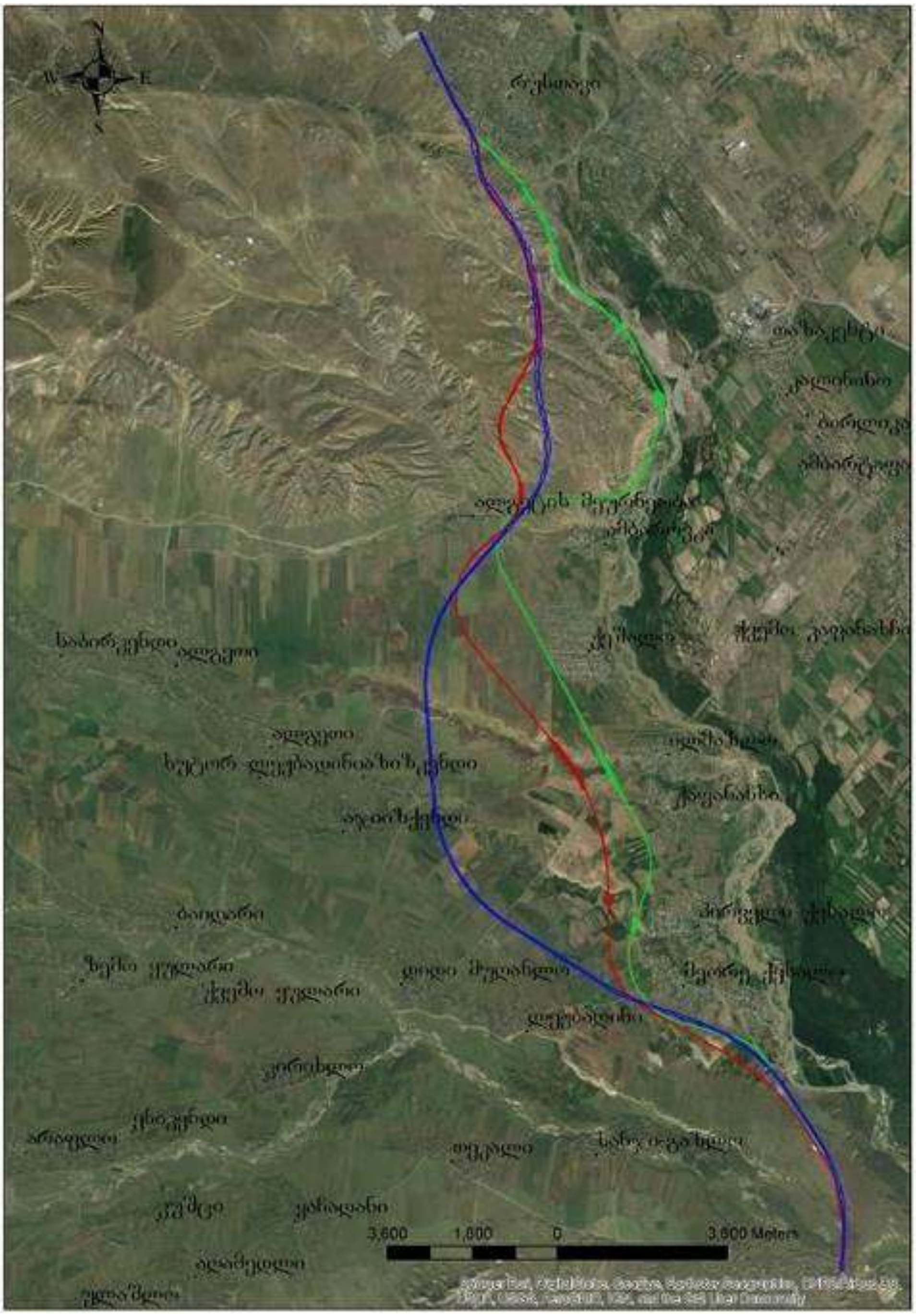
3.1.2 Alternative corridors of the highway

Within the scope of the feasibility study, four technically realizable and financially more or less beneficial alternative corridors were considered:

- Alternative 0 – widening the existing road.
- Alternative 1 – so called Red Alternative.
- Alternative 2 – so called Blue Alternative.
- Alternative 3 – so called Green Alternative.

All three alternatives are plotted in Figure 3.2.1 and the following paragraphs give the comparative analysis of the alternative corridors both, in the financial-economic and environmental respects.

Figure 3.1.2.1. Alternatives of the highway alignment



3.1.3 Description of the alternative corridors of the highway

3.1.3.1 Alternative 0 – widening the existing road

An alternative of expanding the existing road was rejected right at the initial stages of the feasibility study, the reason for which was named a number of insuperable barriers. The unacceptability of this alternative was further proved within the scope of environmental scoping as follows:

First of all, a non-linear alignment of the existing road must be considered, in particular, the fact that the road turns by 90 to 180º at some places. Such an alignment fails to give the expected major benefit of the project implementation (reduced driving time and distance, driving safety, etc.). At the designing stage, it will be virtually impossible to observe TEM Standards, what was presumably the major cause to reject this alternative at the stage of the feasibility study. The length of this alternative much more than those of other considered alternatives will increase the exploitation expenses of the road.

Besides, with this alternative, important social-economic and environmental gaps were identified, with the near location of the residential houses in the villages of Marneuli Municipality (Algetis Meurneoba, Keshalo, Ilmazlo, Kapanakhchi, Pirveli Kesalo, Meore Kesalo) to the alternative corridor as one of the major disadvantages. Due to this fact, this alternative option will be associated with several tens of physical resettlements, while virtually, the considered corridor alternatives do not entail such risks and/or such risks are very low with them.

The near location of the residential houses will boost the noise and emission impact on the local population (at both stages of the project). In this respect, particularly at the exploitation stage, it will be necessary to apply expensive mitigation measures (making noise attenuating barriers). The risks associated with the population safety, scales of visual-landscape impact, etc. increase.

By considering the above-mentioned, the alternative of the road widening is not acceptable by considering the impact on the natural and social environment. It is purposeful to select a new corridor, which will be distanced from the sensitive objects (residential areas in the given case) to the extent possible. In addition, the technical parameters specified by the international standards for highways will be possible to observe and the expected benefit will be obtained to the maximum extent.

3.1.3.2 Alternative options of the new highway corridor

As mentioned above, 3 alternative options of the new highway corridor were considered: Alternative 1-so called Red Alternative, Alternative 2 – so called Blue Alternative and Alternative 3 – so called Green Alternative.

The initial section for all three alternatives to approximately km 2.5 from Rustavi junction runs in the same direction See Figures 3.1.3.2.1.).

Figure 3.1.3.2.1. Design corridor up to 0,0-2,5Km, in parallel with the existing road

From this point, the Red and Blue Alternatives continue in the same direction, in parallel to the existing road, to approximately km 5.7 (to the location where the existing road turns by 180º). As for the Green Alternative, it runs eastwards and crosses a relatively fragmented relief to reach the bank of the river Mtkvari.

Up to Algeti diamond interchange planned near village Algetis Meurneoba, all three alternatives have different directions, in particular: the Red Alternative runs across the elevated levels of Iagluja mountain in the west, the Blue Alternative runs across the eastern slopes of Iagluja mountain farther east (See Figure 3.1.3.2.2.) and the Green Alternative follows the right bank of the Mtkvari River almost repeating its configuration.

The alignments of the Red and Blue Alternatives from design Algeti diamond interchange run across the agricultural plots of field (See Figure 3.1.3.2.3.) with the only difference of the first alignment being more linear, while the latter runs westwards, near village Aziskendi, joins the road junction of perspective Sadakhlo highway and continues towards village Pirveli Kesalo. As for the Green Alternative, its corridor coincides with the existing Rustavi-Red Bridge Road corridor almost up to the final point (it goes round villages Pirveli Kesalo and Meore Kesalo from the west).

From village Meore Kesalo, the corridors of the alternative corridors show no significant differences between them. All three alternatives end at Red Bridge (Figure 3.1.3.2.4.), which is located on the Georgian-Azerbaijan border. Up to the checkpoint, the bridge across the river Khrami is the part of the present project for all three alternatives.

Figure 3.1.3.2.2. Design corridor within the limits of Iagluja Plateau

Figure 3.1.3.2.3. Design corridor running across the agricultural plots of field

Figure 3.1.3.2.4. The Final section of the corridor, near the Red Bridge

3.1.3.3 Comparative analysis of alternatives

Technical and financial-economic respect:

The table below compares the proposed alternatives based on their principal geometrical parameters. The comparison is done for one design speed and accepted typical cross sections. So, the number of lanes and other values are the same and are not given in the comparison table.

Figure 3.1.3.3.1. Table of comparison of the technical properties of the alternative options

Element	Red Alternative	Blue Alternative	Green Alternative
Length km	30,63	32,16	33,43
Minimum horizontal radius, m	800	1200	600
Minimum vertical radius, m	20000	20000	20000
Length (m) of the section with the gradient of:			
3-4%	1920	4140	-
4-5%	3290	-	2280
5-6%	-	-	-
Number of large bridges:	5	5	5
Cut volume, m^3	5317650	3889760	7249090
Fill volume, m^3	3293759	2763340	2769720
Difference between the cut and the fill (potential waste rocks, topsoil layer), m^3	2023891	1126420	4479370

The principal disadvantages of the Red Alternative is large volume of earthwork in the area of Iagluja mountains and a long section with gradient of 5% (4,99).

The principal feature of the Blue Alternative is that it has very favorable geometrical elements both, horizontally and vertically. Besides, this alternative entails large volume of earthwork in the area of Iagluja mountains. However, the structures with this alternative are moderate.

The Green Alternative runs along the eastern edge of Iagluja mountains, at the Mtkvari River. At this location, a number of problems may occur due to unfavorable geotechnical conditions. In addition, the River has negative impacts and coast-protection measures are very important. Besides, a part of this Alternative has a gradient of over 4%.

In respect of environmental protection:

Some technical parameters considered above also make for the environmental advantages and disadvantages of the alternative options, e.g.:

Table 3.1.3.2.1. shows that with the Blue Alternative, the expected amount of waste rock is much less what makes this alternative definitely advantageous in respect of small land areas needed to make dumpsites and less scales of transport operations. It is due to these circumstances, the risks of impact on the geological environment are also low. Better technical parameters of the Blue Alternative and its compliance with TEM standards mean less risks of impact on the local population safety.

Among other environmental issues, the following issues are worth mentioning:

- In view of the impact on the protected areas, the Red and Blue Alternatives are preferred.
  The Green Alternative runs the closest the border of the protected area.

- In view of emission and noise propagation and vibration, preferable are Red and Blue Alternatives. The Green Alternative runs too close to the residential areas and has much higher risks of impact both, in the construction and exploitation phases.
- Besides, less risks of impact on the water environment are entailed by the Red and Blue Alternatives. A long section of the Green Alternative runs near the Mtkvari River.
- In view of the impact on soil, Green Alternative is a little more advantageous than the other two alternatives, as a long if its section coincides with the existing road and crosses the agricultural plots at some places only. However, its increased length compensates this advantage more or less.
- In view of the impact on social environment (mostly, the development of the privately-owned lands is meant), a minor advantage can be given to the Red and Green Alternatives. However, with them, one important circumstance is to be considered: only Blue Alternative runs near village Azizkenda, where the alignments towards Sadakhlo and Red Bridge are planned to divide in the future. This alignment significantly reduces the total length of the highway (by approximately 5,8 km) and total need for resettlement accordingly for both perspective highways. Therefore, Blue Alternative must be preferred in view of resettlement as well.

In the final run, it may be said that all three alternatives are feasible. Their geometrical elements comply with TEM standards, except the Red Alternative, where the gradient along one section is more than 4%. This exception is admissible, though not desirable. In a geometric view, the Blue Alternative has the most favorable parameters. Besides its geometrical parameters, the advantage of this option lies in the little volume of civil works and various environmental aspects. Consequently, the most preferable option for Rustavi-Red Bridge alignment is the Blue Alternative both, in technical and environmental respects.

4. PROJECT DESCRIPTION

4.1 Introduction

Rustavi-Red Bridge and Rustavi-Sadakhlo Roads are a motorway of an international importance with design speed of 120 kmph. The road project is prepared by company „M/s Antea Group“ in collaboration with local companies, in particular „Policy and Management Consulting Group“ (PMCG) and Ltd „Sakgzametsniereba“. In technical respect, the project properties are as follows::

- Total length of the road – 32 km;
- The road configuration is constructed with the rigid pavement width of 22˜ 25m average with hard shoulder;
- The drainage system of the road will be provided in the middle of the road section;
- The motorway is 4x3.75m width with hard shoulder of 2.5m wide;
- All in all, 7 viaducts will be provided within the scope of the project
- Five (5) hydraulic bridges and eight (8) bridges will be constructed for the grade separator. The bridge span is 33m with an average bridge length of 99m. The viaduct on Rustavi hill is having seven span (33m).

The road is design as per the accepted international standards such as Trans-European Motorway Standards, AASHTO, European standards.

In the process of designing, Rustavi-Red Bridge road is divided into two sections:

- section 1 (LOT 1) - The section from Rustavi to the Sadakhlo intersection (LOT-1) is 21.0 km long;
- section 2 (LOT 2) - from Sadaklo interchange to Red Bridge is 10.9 km

The maps of both sections are given in Drawings 4.1.1. and 4.1.2. the Drawings show all principal project communications, while the general layout is given in Drawing 4.1.3.

Figure 4.1.1. General map of Rustavi-Red Bridge highway (Rustavi-Sadakhlo section, km 21.0)

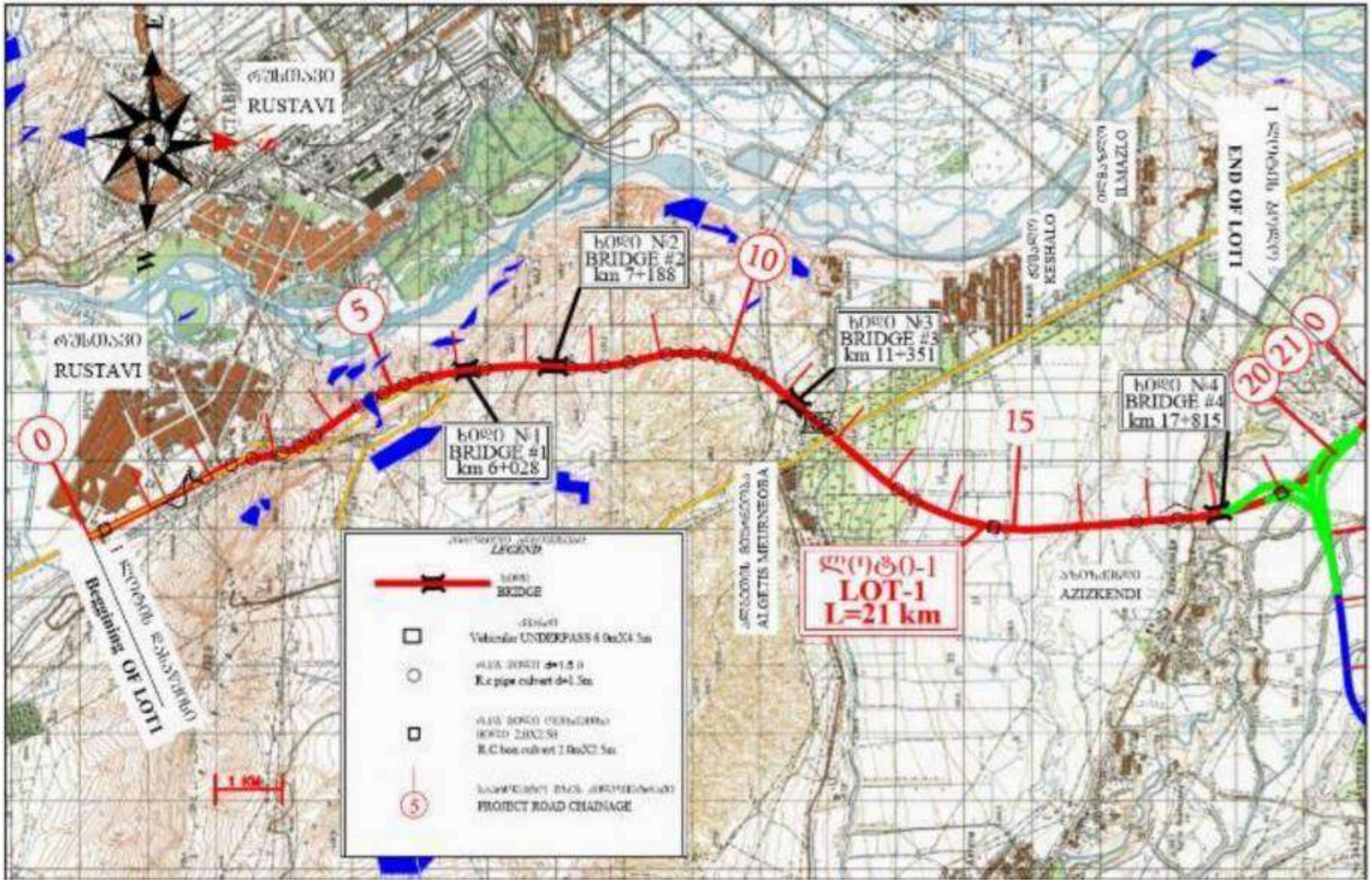
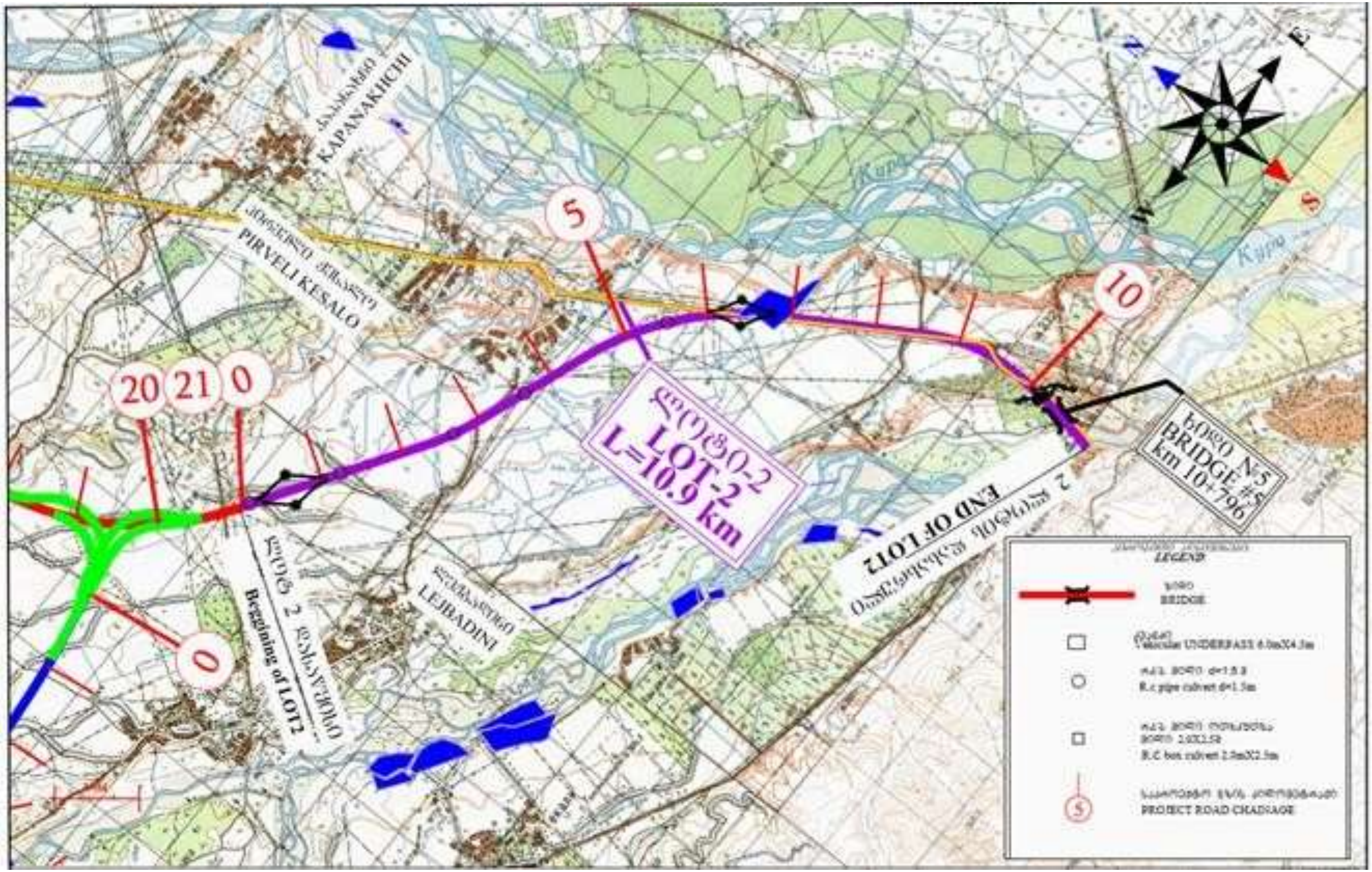
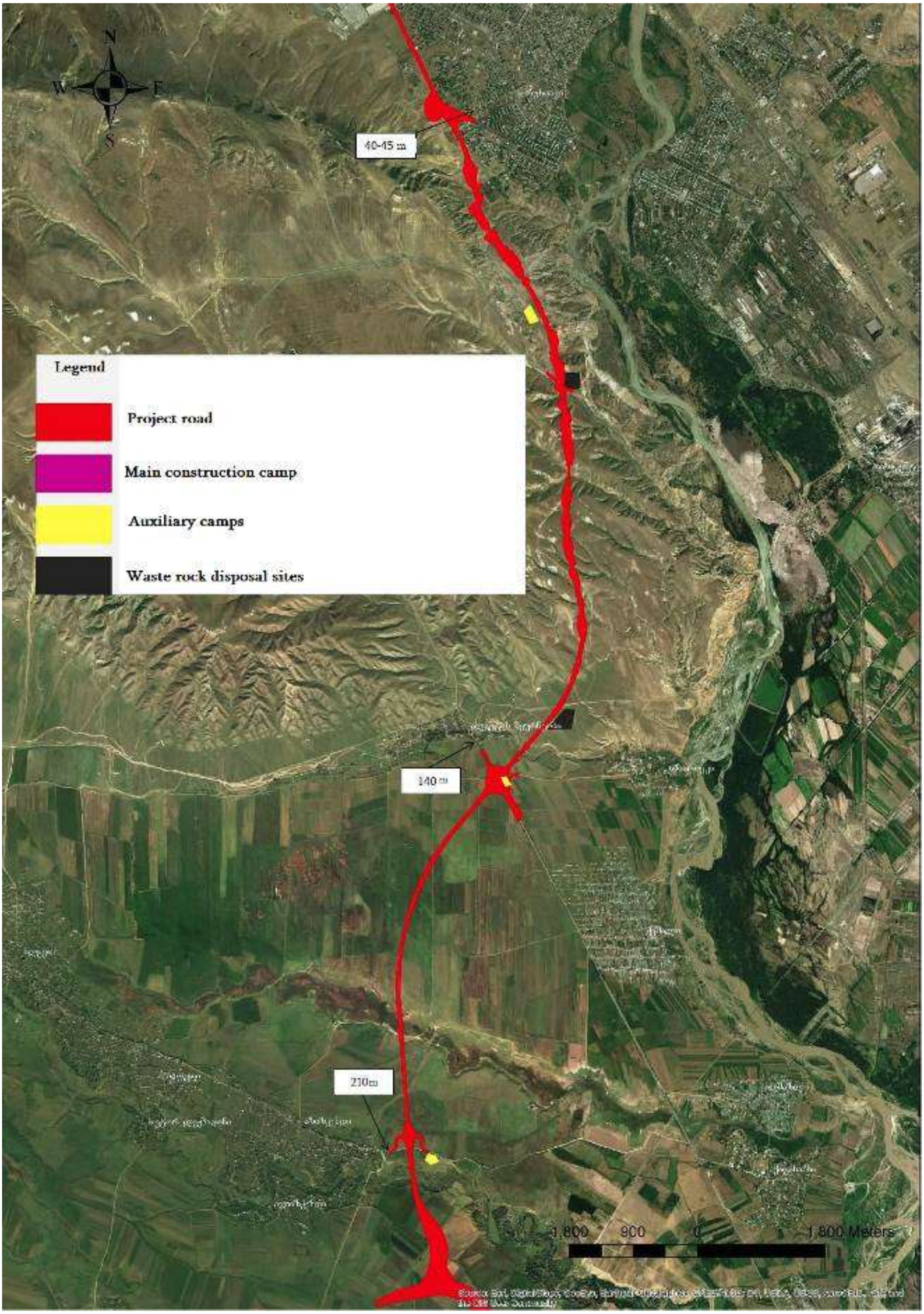
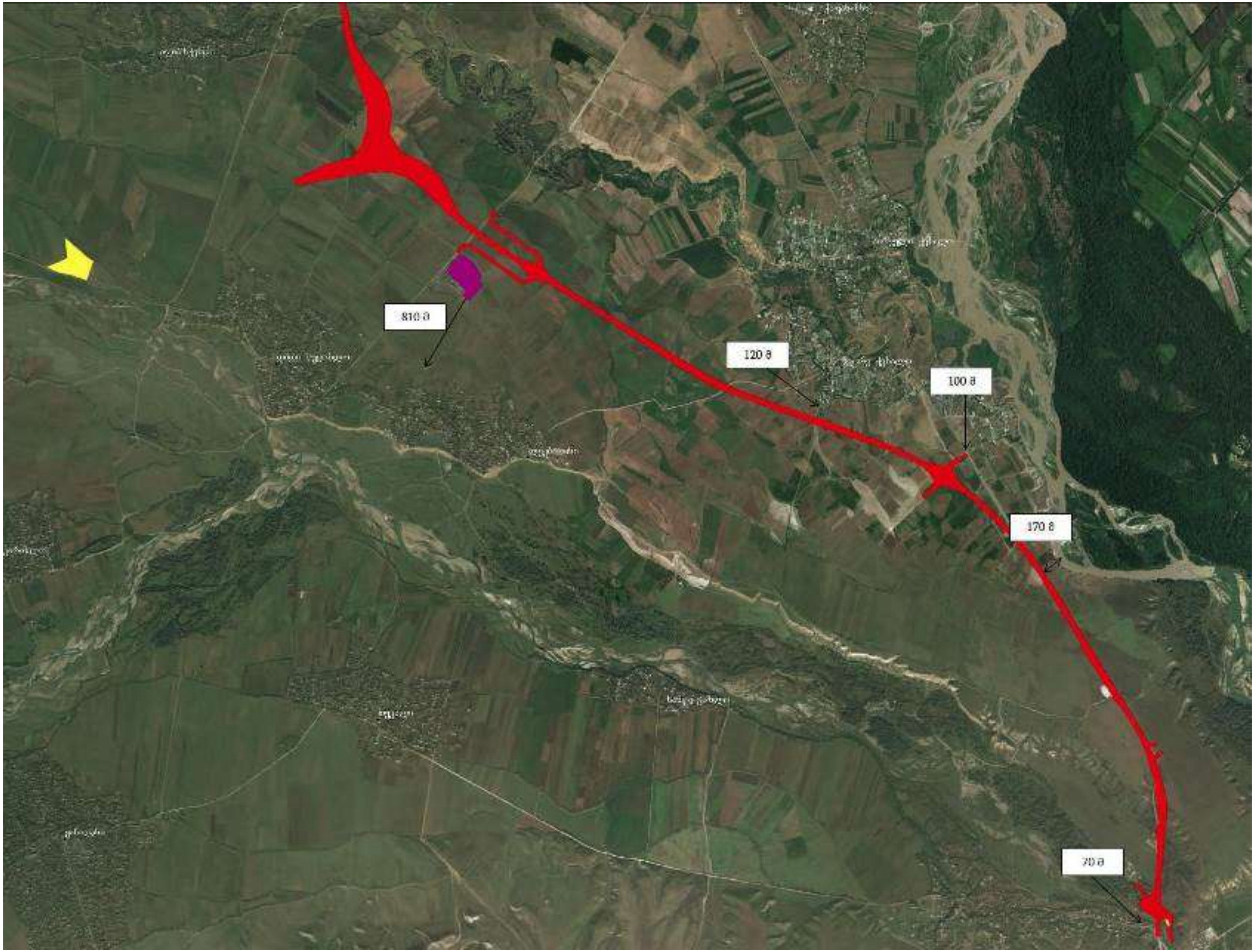


Figure 4.1.2. General Map of Rustavi-Red Bridge Highway (Sadakhlo-Red Bridge section, km 10.9)



Drawing 4.1.3. General layout of the project area




810 მ
120 მ
100 მ
170 მ
70 მ

4.2 Geometric parameters of the Road Alignment

The geometric design of the new motorway alignment has generally followed the requirements of the TEM standards.

Table 4.2.1. shows the design parameters required for the main carriageway, connector and slip roads, at the selected design speed of 120 kph.

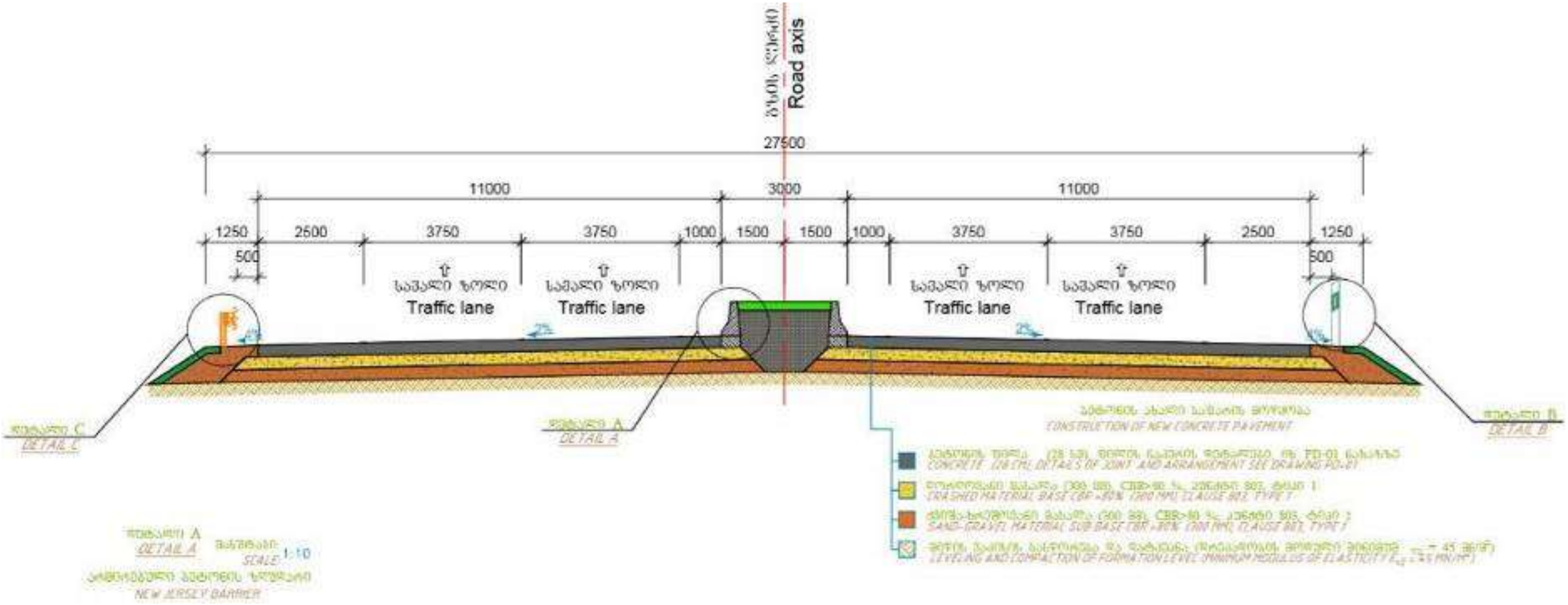
Table 4.2.1. Geometric design parameters

Horizontal and vertical alignment (main carriageway)	Minimum horizontal radius Min. Convex vertical radius Min. Concave vertical radius Maximum longitudinal gradient Min. longitudinal gradient Min. crossfall in straight sections Max. cross fall in curved sections Minimum transition length Min. radius requiring the same cross slope as for straight sections Stopping distance Stopping distance in curves Minimum vertical clearance	650 m 12 000 m 8 000 m 5 % 0,3 % 2.5 % 7 % 70 m 3 500 m 200 m 250 m 4.7 m
Horizontal and vertical alignment of interchange	Minimum horizontal radius Min. Convex verticalradius Min. Concave vertical radius Maximum longitudinal gradient Min. longitudinal gradient Min. crossfall in straight sections Max. cross fall in curved sections	650 m 12 000 m 12 000 m 5 % 0,3 % 2.5 % 7 %
Horizontal and vertical alignment of other interchanges and slip roads	Min. Design speed Minimum horizontal radius Min. Convex vertical radius Min. Concave vertical radius Maximum longitudinal gradient Min. longitudinal gradient	40 კმ/ს 50 მ 800 მ 400 მ ↑ 6% ↓ 6% 0,3 %
Cross section (main Alignment)	Platform Carriageway Traffic lanes (2 per carriageway) Shoulder Central reserve Verges	27.5 m 11 m 3.75 2.5m 3.0m 1.25 m
Cross section (two lane connector)	Carriageway Shoulder Verges	3.5m 1.0m 0.5m
Cross section (slip roads)	Carriageway width Shoulder width Verges	4.0m 1.0m 0.5m

4.3 Typical cross sections of the motorway

As mentioned above, TEM standard was used for the highway to design. Therefore, the cross sections are defined according to TEM standard. Typical motorway cross section is presented in Figure 4.3.1.

Figure 4.3.1. Typical motorway cross section



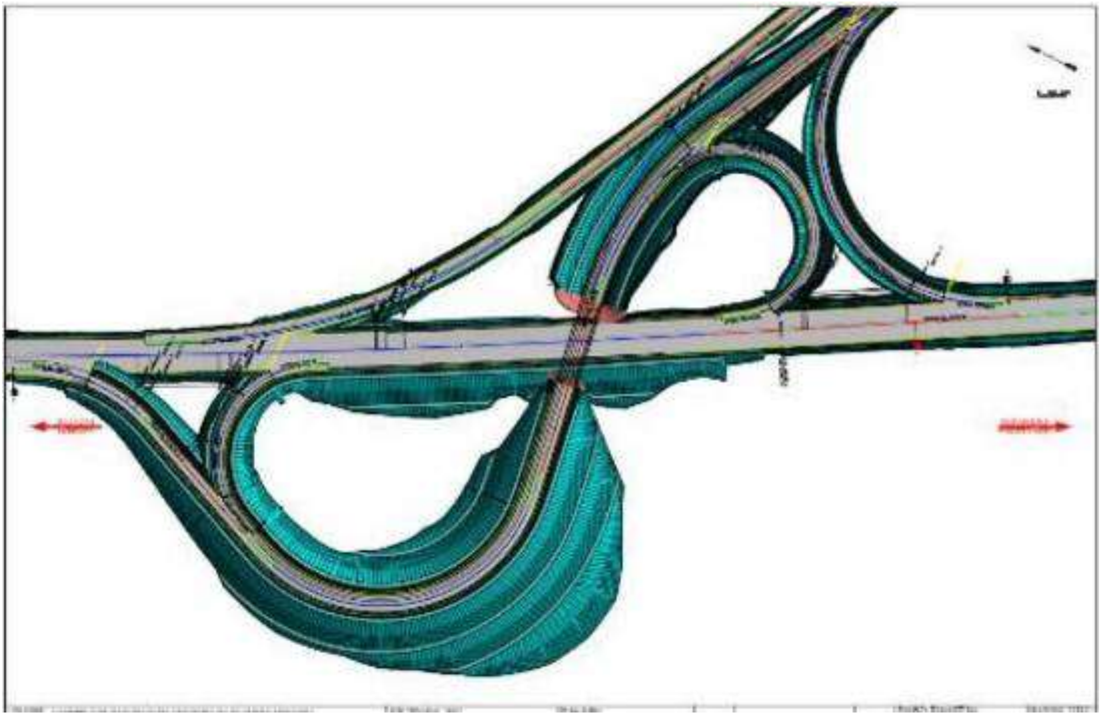
4.4 Viaducts

Within the scope of Rustavi-Red Bridge, total 7 viaducts are designed, including 4 viaducts along section 1 (including Rustavi-Sadakhlo viaduct and 3 viaducts along section 2 (from Sadakhlo viaduct to red Bridge). Their description is given below.

Underpass at km 2+975 approx, Rustavi interchange.

This underpass allows the existing E-60 single carriageway road to cross the proposed motorway alignment in a box culvert, through the motorway embankment. This will ensure that local traffic wishing to maintain access to locations along the existing road will be able to do so.

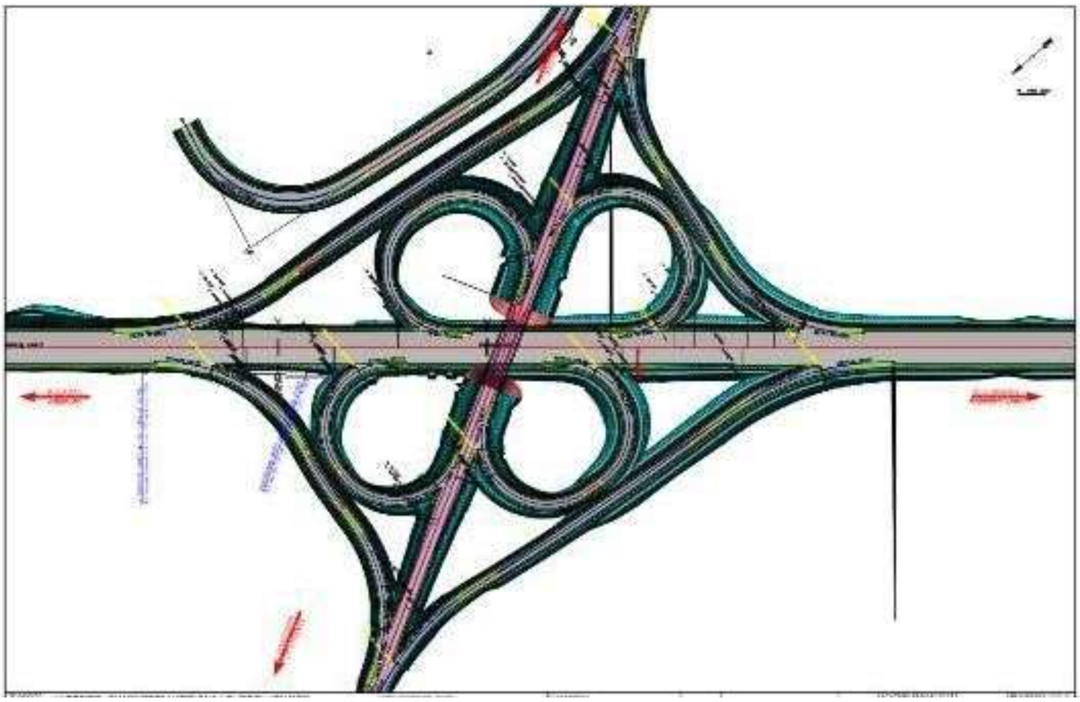
Figure 4.4.1. Underpass km 2+975, Rustavi Interchange



Interchange at km 11+900 approx.

This location marks where the proposed motorway alignment crosses the existing E-60 road near to Algetis Meurneoba. The clover leaf interchange with one additional minor road joining it, will occupy a rectangular area of approximately 21 hectares. The interchange will eliminate all crossing traffic movements and in so doing will incorporate a high degree of road safety into the design.

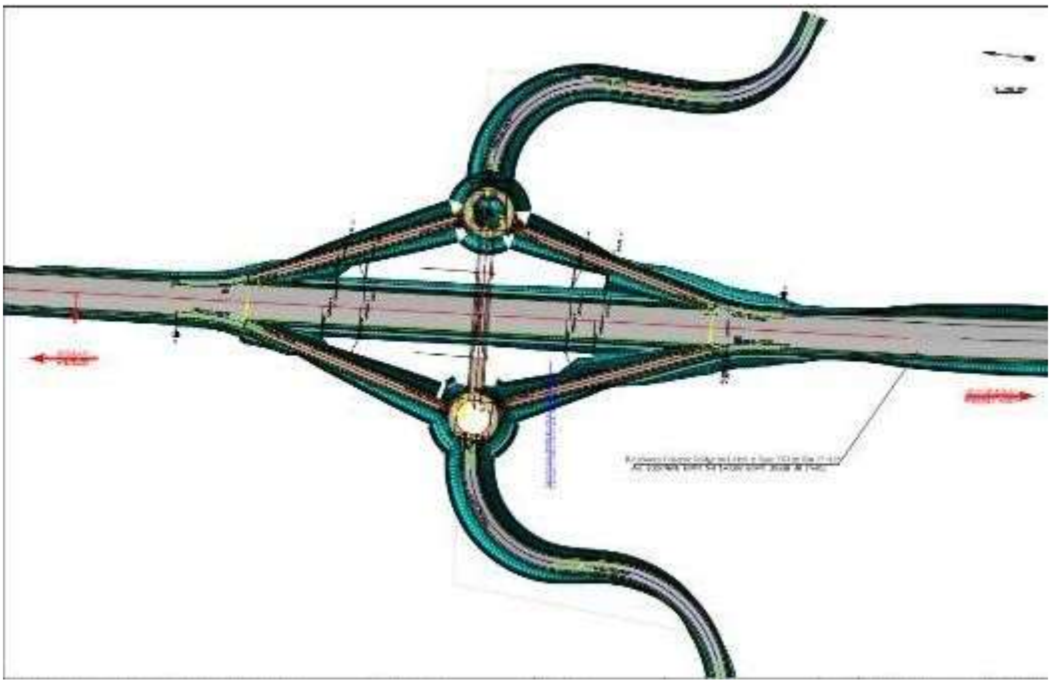
Figure 4.4.2. Algeti Interchange 11+900



Interchange at km 17+305 approx.

At km 17+495 approximately, an existing minor road is crossed by the proposed motorway alignment. Because this minor road was lightly trafficked a small diamond shaped interchange was designed which firstly re-aligned the minor road to a location at 17+305 approximately where ramps were able to be conveniently placed to/from the proposed motorway and sufficient height could be gained to cross the motorway alignment with an overpass. At each end of the overpass, roundabouts were designed to be provided adequate turning space for truck and trailer motor vehicles so that all turning movements could be accommodated and access and egress to/from the motorway from/to the minor road could be accomplished with the minimal use of land.

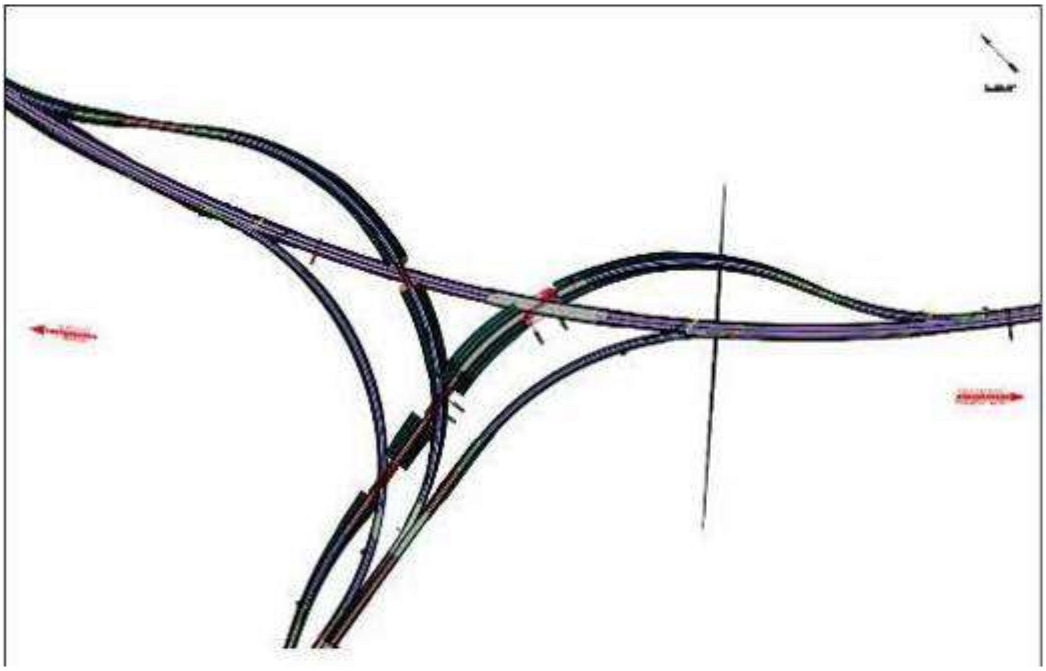
Figure 4.4.3. Azizkendi Interchange 17+305



Interchange at km 19+370 approx.

This interchange was designed to allow free flowing movement of traffic along three separate sections of the proposed motorway. The three legs of the interchange, north, south-east and south-west join at an open location between Azizkendi, Didi Mughanlo and west of Pirveli Kesalo. Each of the three legs of the intersection branches out to the left and right for a distance of approximately 1 to 1.5 kms. The intersection design permits left or right turning without crossing movements or speed loss. Super elevation is maintained at the maximum permitted throughout the curved sections of each branch of the intersection.

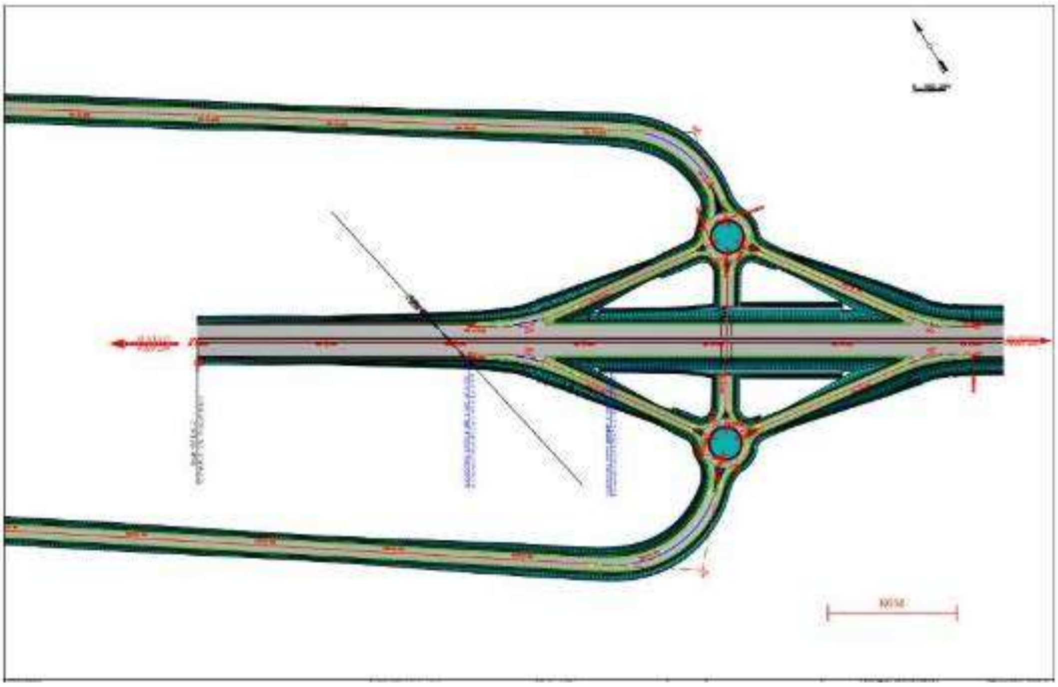
Figure 4.4.4. Sadakhlo Interchange at the 19+370 (starting point of Sadakhlo motorway)



Underpass at km 0+410 approx.
(Starting point is at Sadakhlo viaduct).

A diamond shaped intersectionwasdesignedatthislocation,whichincorporatestworoundabouts(oneoneachside of the motorway) capable of allowing all necessary turning movements and access and egress to/from the motorway. This underpass interchange maintains existing traffic flow across the motorway and also, importantly, allows traffic emerging from the Algeti Interchange the opportunity to make a 180 degree turn. Without this facility a distance of approximately 10 kms would have to be travelled by vehicles wishing to make such amaneuvre.

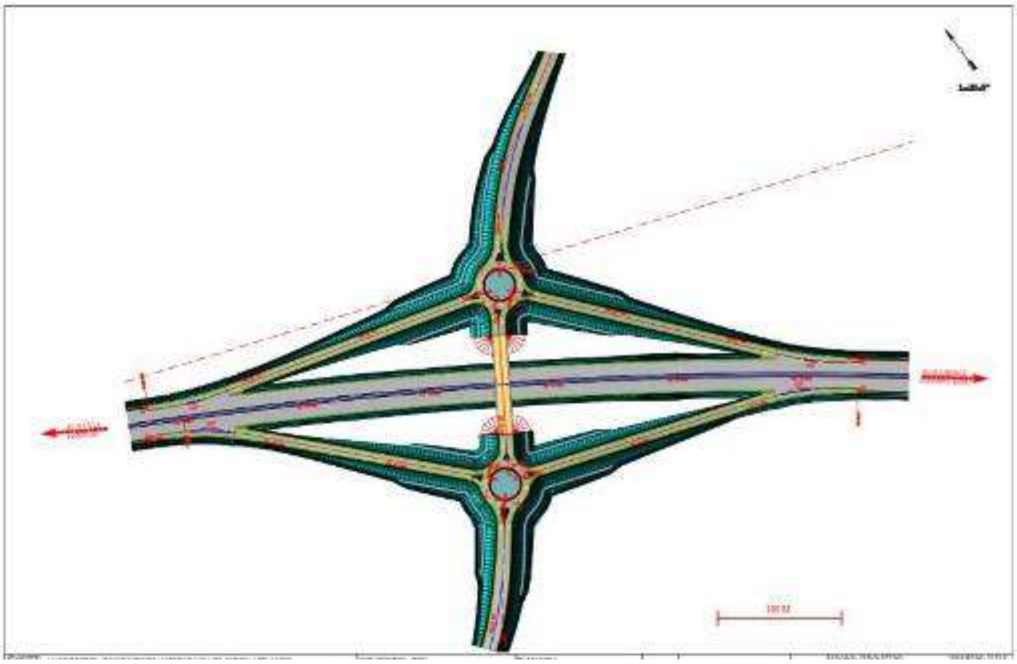
Figure 4.4.5. Mukhanlo interchange, 0+410



Overpass at km 5+260 approx.
(Starting point is at Sadakhlo viaduct).

At km 5+260 approx. the motorway alignment is crossed by a relatively heavily trafficked "field road" which links directly to the existing E-60 road. To maintain this traffic link and to also allow for motorway traffic to make 180 degree turns, if necessary, a diamond shaped intersection with overpass was designed at this location, which incorporates two roundabouts (one on each side of the motorway) capable of allowing all necessary turning movementsandaccessandegress to/from the motorway.

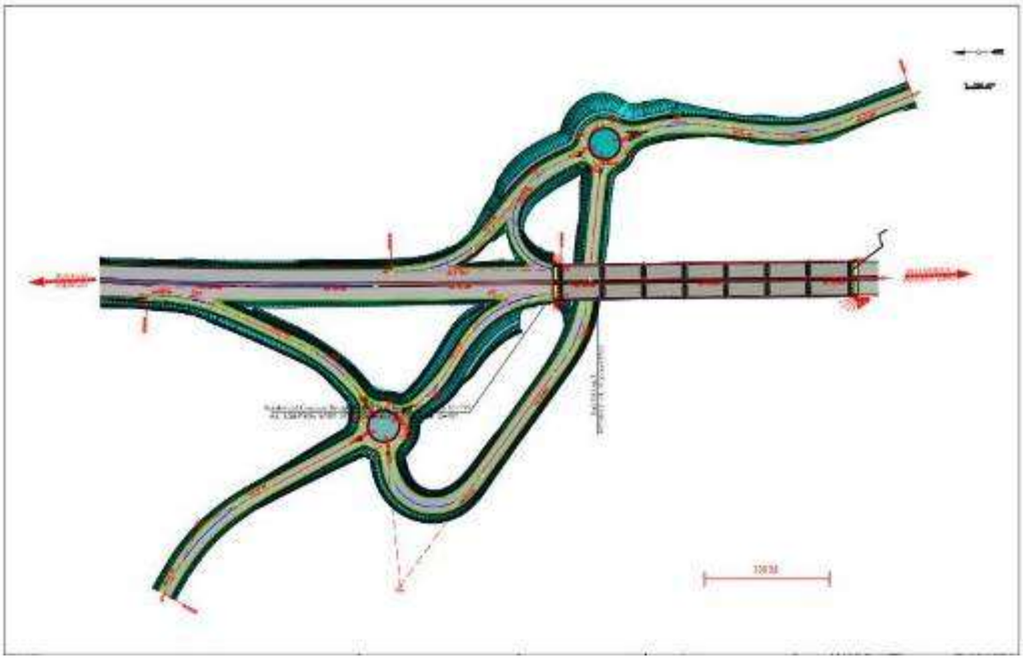
Figure 4.4.6. Second Kesalo interchange, 5+620



Underpass at km 10+705 approx.
(Starting point is at Sadakhlo viaduct).

At km 10+705 approx., as part of a network of local roads linking two proposed roundabouts near Red Bridge (one on each side of the motorway) a new road was proposed to pass under the first spanofthenewbridge. Thisroadlinksupplementsanarrangementofroadswhichactinthesame way as a small diamond shaped interchange, thereby permitting motorway traffic to access Red Bridge and traffic from Red Bridge to access the motorway. Also, access is maintained to other local roads and vehicles which wish to make 180 degree turns at Red Bridge, may do so.

Figure 4.4.7. Red Bridge interchange, 10+705



4.5 Bridges

Total 5 bridges are planned to construct within the scope of Rustavi-Red Bridge highway, including 4 bridges along section 1 (Rustavi-Sadakhlo interchange) and 1 bridge along section 2 (Sadakhlo interchange-red Bridge). The principal parameters of the bridges are given in table 4.5.1.

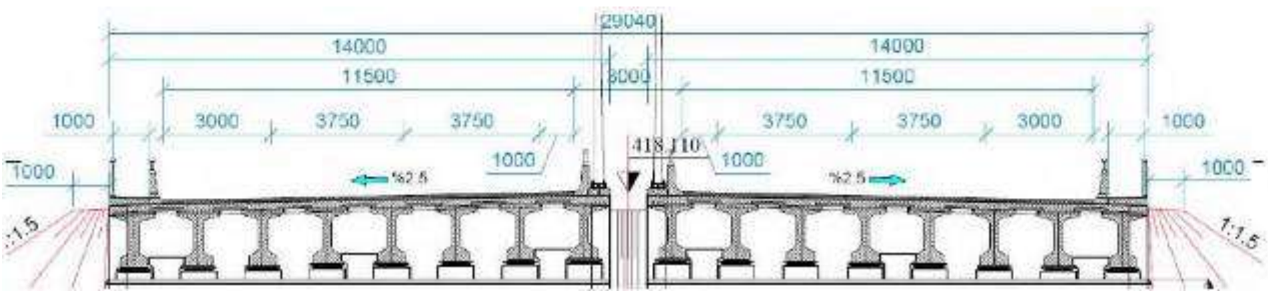
Table 4.5.1. Principal parameters of the bridges planned to construct on the project highway

Bridge №	Chainage, km	Length, m	Deck Dimensions BxL	DeckArea m2
Bridge 1	6+028,32	111,3	(2*14)*(3*33)	2772
Bridge 2	7+188,43	243,6	(2*14)*(7*33)	6468
Bridge 3	11+351,61	111,3	(2*14)*(3*33)	2772
Bridge 4	17+815,31	111,3	(19,5*14)*(3*33)	3317
Bridge 5	10+796.94	243.6	(2*14)*(7*33)	6468

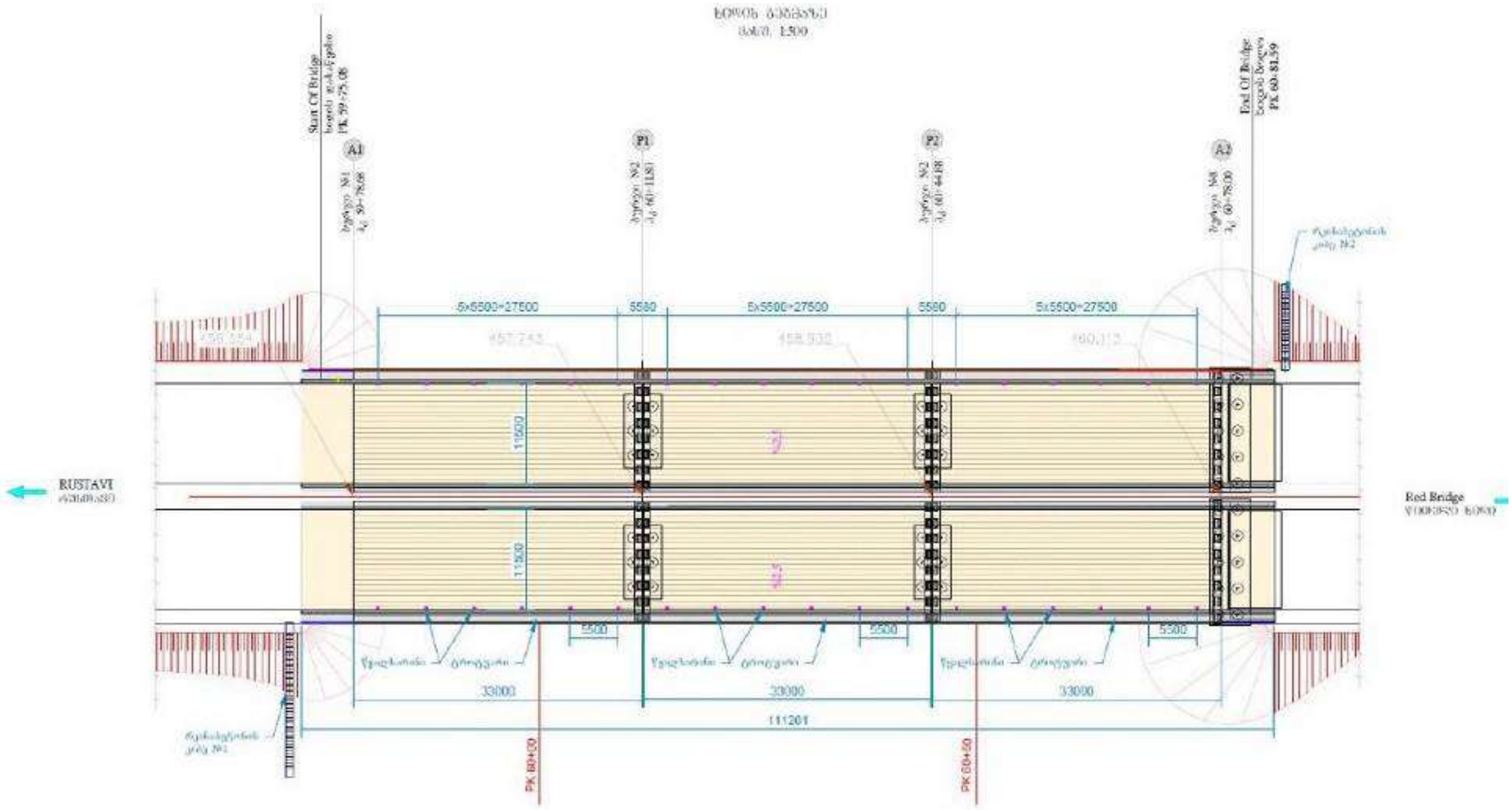
The bridges are double bridges with one traffic lane in each direction crossing surface water. The length of each bridge span is 33 m. The width of the carriageway is 14 m. The bridge carriageway was designed with prestressed, T-shape concrete beams and in-situ cast decks. The substructures are designed with in-situ reinforced concrete abutments and in-situ two-column type pier. Foundations consist of cast in place concrete bored piles.

Typical cross sections of the bridges are given on Drawing 4.5.1. The following drawings show the plan and section of bridge #1 and bridge #5.

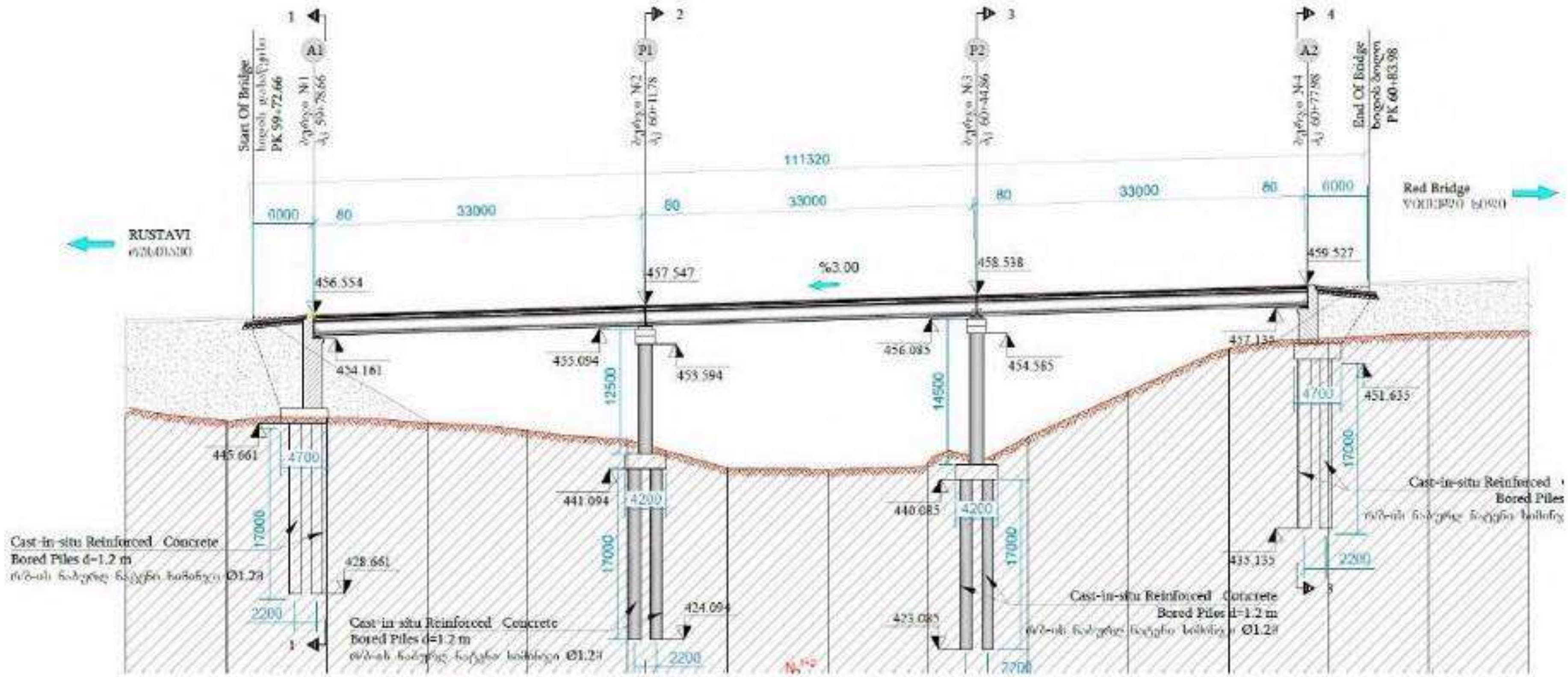
Figure 4.5.1. Typical cross section of the design road



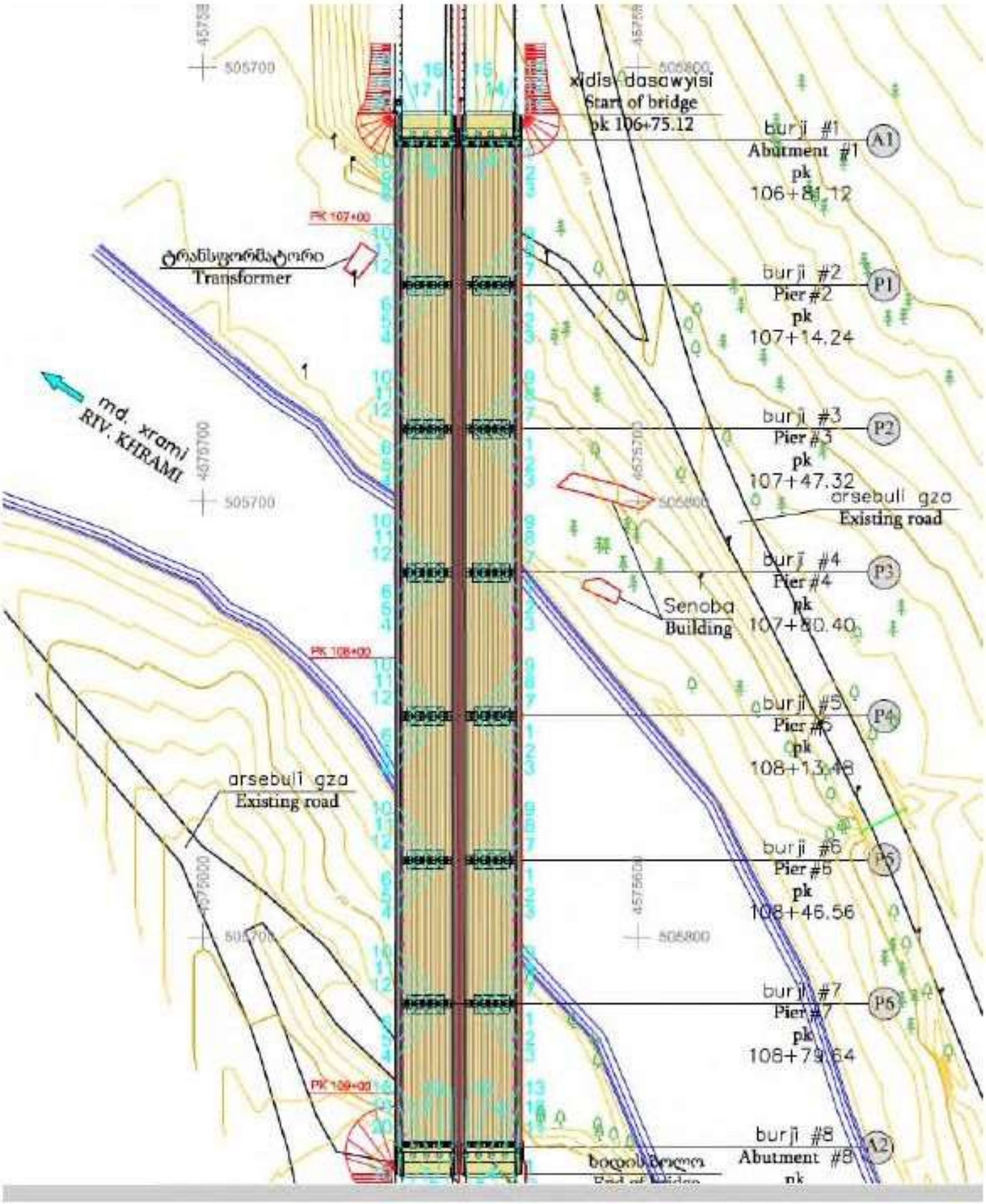
Drawing 4.5.2. Plan of Bridge №1



Drawing 4.5.3. Section of bridge №1



Drawing 4.5.4. Plan of bridge №5



Drawing 4.5.5. Section of bridge №5

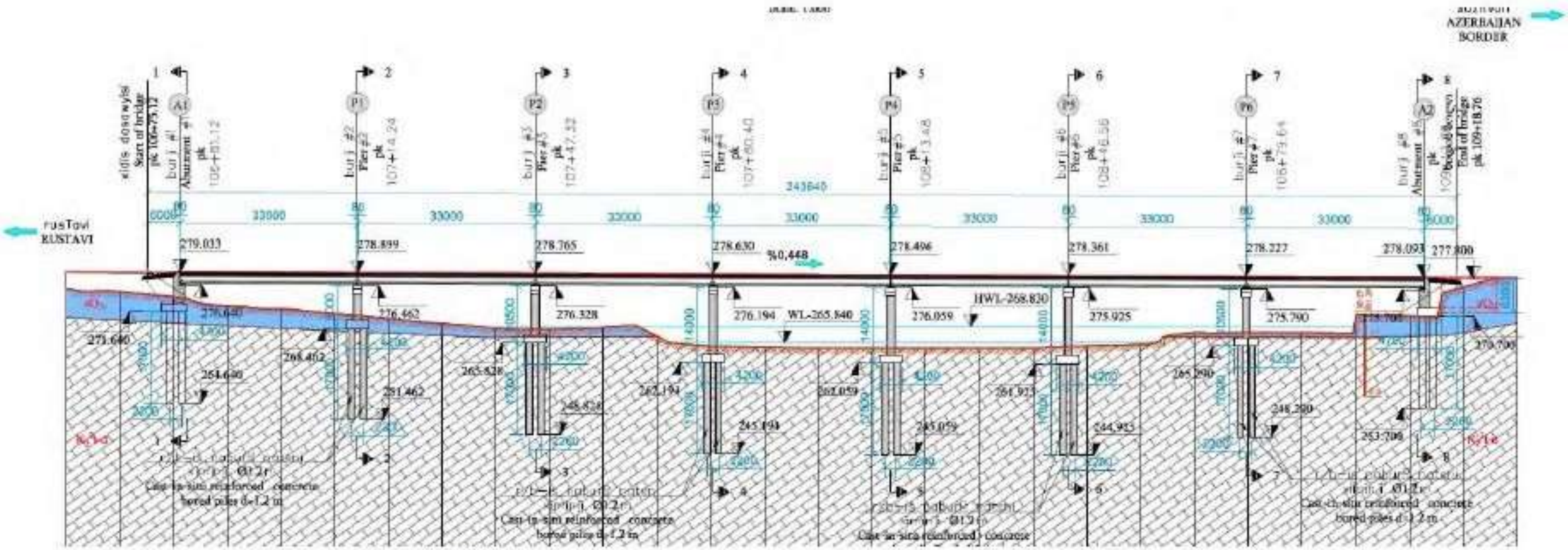


Figure 2-3. Longitudinal section

In addition to the above-mentioned, a bridge of a viaduct type crossing the project highway is planned to provide on 8 sites. Their parameters are given below, in Table 4.5.2.

Table 4.5.2. Principal parameters of the road bridges crossing the project highway

Bridge №	Chainage, km	Length, m	Deck Dimensions BxL	DeckArea m2
Overpass 9	17+49,42	79,8	(1*14)*(2*33)	924
Overpass 10	1+190,88	79,8	(1*14)*(2*33)	924
Overpass 11	1+737,66	78,2	(1*12,2)*(2*33)	805
Overpass 12	19+213,26	81,2	(1*14)*(2*33)	924
Overpass 13	19+537,33	81,7	(1*14)*(2*33)	924
Overpass 14	0+640,63	49,5	(1*14)*(2*33)	462
Overpass 15	0+822,1	49,5	(1*14)*(2*33)	462
Overpass№16	5+258.75	78.2	(1*12,2)*(2*33)	805

The bridges crossing the project highway are single bridges with one traffic lane in each direction. It overpasses the designed highway.Thesesingle bridgeshave2spansof33m length;bridgedecksareeach from 12.2- to 14 minwidth. Bridge decks are designed as reinforced concrete inverted-T pre-stressed girders and have in-situ cast decks. The substructures are designed with in-situ reinforced concrete abutments and in-situ one-column type pier. Foundations consist of cast in place concrete boredpiles.

4.6 Box culverts

Reinforced concrete box culverts were designed for drainage purposes and also for the provision of access from one side of the motorway to the other, particularly for farm vehicles and animals. Box culvert underpasses were also provided where effective land use would otherwise have been affected, or where land was effectively severed by the Motorway alignment.

The principal parameters of the box culverts for both sections of the project road are given in table 4.6.1.

The main parameters of the box culvets for both sections of the project are given in the table below.

Table 4.6.1. box culverts

Chainage on CL	Underpas Description	Culvert Length
Section 1 (Rustavi-Sadakhlo Interchange)		
2+945	Major underpass. Size 8x4,5	30 m
13+200	Major underpass. Size 8x4,5	43 m
15+772	Major underpass. Size 3 times 8x4,5	3*54 m
Section 2 Sadakhlo Interchange –Red Bridge)		
0+410	Main underpass, Size 8 x 4,5 m	36 m
2+101	Traffic underpass, 6.0 x 4.5 m	36 m
2+773	Main underpass, Size 8x4,5 m	36 m
3+857	Main underpass,Size 8 x 4,5 m	30 m

Pipe culverts

Reinforced concrete pipe culverts were designed principally for drainage purposes and the preservation of irrigation ditches/channels which otherwise would have been severed by the motorway embankment.

The main parameters of the pipe culvets for both sections of the project are given in the table 4.6.2 below.

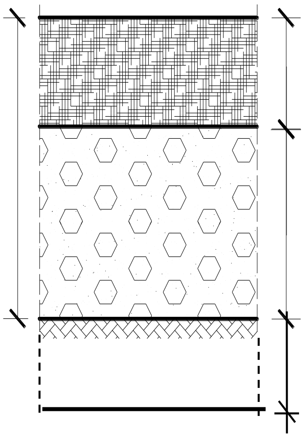
Table 4.6.2. pipe culverts

Chainage	**Culvert Description**	**Culvert Length, m**
Section 1 (Rustavi-Sadakhlo Interchange)		
1+915	R C pipe culvert 1.5m dia.	35m
2+418	R C pipe culvert 1.5m dia.	36m
2+787	R C pipe culvert 1.5m dia.	32m
3+006	R C pipe culvert 1.5m dia.	32m
3+272	R C pipe culvert 1.5m dia.	49m
3+507	R C pipe culvert 1.5m dia	32m
4+600	R C pipe culvert 1.5m dia	32m
4+750	R C pipe culvert 1.5m dia	45m
4+831	R C pipe culvert 1.5m dia	46m
5+118	R C pipe culvert 1.5m dia	32m
5+503	R C pipe culvert 1.5m dia	32m
6+307	R C pipe culvert 1.5m dia	56m
7+757	R C pipe culvert 1.5m dia	32m
8+097	R C pipe culvert 1.5m dia	32m
8+528	R C pipe culvert 1.5m dia	37m
9+062	R C pipe culvert 1.5m dia	57m
9+137	R C pipe culvert 1.5m dia	35m
9+628	R C pipe culvert 1.5m dia	39m
9+847	R C pipe culvert 1.5m dia	50m
10+242	R C pipe culvert 1.5m dia	42m
10+587	R C pipe culvert 1.5m dia	38m
11+726	R C pipe culvert 1.5m dia	32m
11+885	R C pipe culvert 1.5m dia	34m
13+132	R C pipe culvert 1.5m dia	43m
13+400	R C pipe culvert 1.5m dia	38m
14+791	RC box culvert 2.0m x 2.5m	36m
16+738	RC pipe culvert 1.5m dia.	32m
17+507	R C pipe culvert 1.5m dia	32m
19+000	RC box culvert 2.0m x 2.5m	32m
Section 2 (Sadakhlo Interchange –Red-bridge)		
0+195	R C pipe culvert 1.5m dia.	36m
1+168	R C pipe culvert 1.5m dia.	32m
2+772	R C pipe culvert 1.5m dia.	32m
3+633	R C pipe culvert 1.5m dia.	49m
5+400	R C pipe culvert 1.5m dia	32m

4.7 Road pavement

Two types of road pavement are planned to use for design Rustavi-Red Bridge highway: non-rigid concrete pavement will be used for bridges, interchange ramps and roundabouts, while rigid pavement will be used along other sections of the highway. The types of the pavements are shown below:

Drawing 4.7.1. Schematic section of the rigid pavement

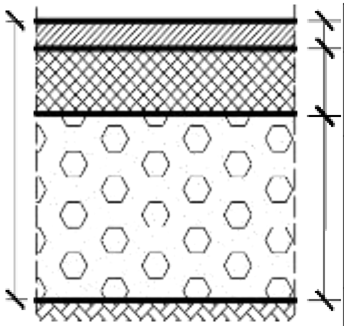


28 cm non-reinforced slab (C35/45) (E1=30000 MPa)

30 cm unbound granulated stone material 0/63mm (E_3=350 MPa)

30 cm *Road foundation [Ms≥35 N/mm², K>0,11N/mm³] – natural ground or, if the requirements are impossible to meet, material replacement with sand gravel material (in cuts)*

Drawing 4.7.2. Schematic section of the rigid road pavement



5	cm	Asphalt concrete AC 16 surf, bitumen 50/70
7	cm	Bituminised crushed stone AC 32 base, bitumen 50/70
30	cm	Unbound granulated stone material0/63mm (M_s≥100 MN/m²)
Road foundation (CBR= 10%) (M_s≥35 MN/m²)		

4.8 Drainage systems and protection against erosion

ThetasksunderHydrologyandDrainagearethedefinitionofallthedrainagearrangementsalong the road, for both ditches and gutters along the alignment, and pipes, box culverts or bridges crossing the alignment. A preliminary sizing of the culverts has been done in the Feasibility Study stage.

Calculation of design peak discharge

Two different methods have been applied to the calculation of the flood peak discharges, depending on the size of the catchments.

(a) Catchments less than 200 square kilometres have been computed with the Rational Formula,

$$Q = 0.278 * C * I * A$$

where:

Q peak flow at catchment outlet (culvert)[m³/sec]
C runoff coefficient[-]
I rainfall intensity [mm/h] of the Tcduration
A catchment area size[km²]

(b) Catchments greater than 200 square kilometres have been evaluated by employing a hydrologicalmodel.

The calculation provided at the stage of designing the facilities crossing the surface water are compliant with the results of the hydrological calculations accomplished in the course of the EIA procedure. The design facilities ensure safe transfer of the peak discharges.

Drainage system on the surface of the highway

In order to provide a safe traffic operation it is important to keep the surface of the motorway free of rainwater in case it is raining

Since the Georgian motorway design standard SST72 2009-Public Motor Roads Geometric and Structural-Requirements does not provide design guidelines for the installation of motorway surface drainage facilities the Consultant adopted the German design standard RAS-Ew.

AccordingtoRAS-Ewadrainageareaof600m²canbeconnectedtoaninletresultinginamaximum drain pipe length of 50m.

The pipes have to be installed with bottom slopes ranging from 0.04% to 2.78%.

Roadside Drain Design

Roadside drains have been foreseen in order to collect rainfall discharge in cases where this runoff water cannot be collected by the motorway surface drainage pipeline.

In general trapezoidal ditches with a bottom width of b= 0.5 m and a side slope of vertical to horizontal(v/h=1/1.5)areproposed.Thecapacityoftherequiredroadsidedrainswasdetermined by employing the Manning-Stricklerequation.

$$Q = A * k_{St} * r_{hy}^{2/3} * I_S^{1/2}$$

Where:

Q flow(m³/s),
A wetted cross section area of the drainage ditch(m²),
k_{St} Manning's flow coefficient($m^{1/3}/s$),
r_{hy} hydraulic radius (m), and
I_S slope of the bottom(-).

The hydraulic radius is defined as ratio of flow cross section area by wetted perimeter:

where

$$r_{hy} = \frac{A}{l_U}$$

r_{hy}	hydraulic radius(m),
A	cross section area (m^2),and
l_U	wetted perimeter(m).

In addition the shear stress was calculated by employing the following formula

$$T = r * g * r_{hy} * I_S$$

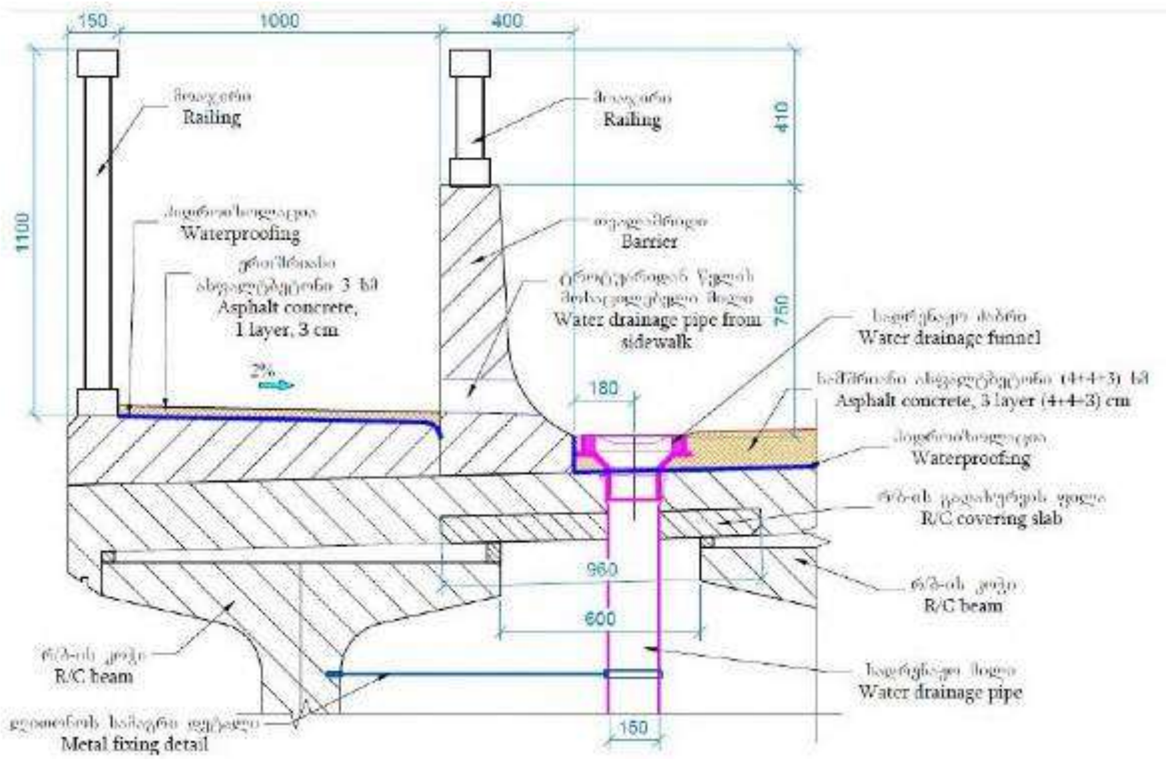
Where:

T	shear stress in N/m^2
r	density of water ($r = 1000\ kg/m^3$)
g	gravitational acceleration ($g = 9.81\ m/s^2$)
r_{hy}	hydraulic radius of the wet cross section
I_S	bottom slope of the roadsidedrain.

The calculated shear stress indicates whether the roadside drain has to be protected against erosion.Ifthecrosssectionoftheroadsidedrainiscoveredwithgrassthentheroadsidedraincan withstand shear stresses of up to $T = 30N/m^2$. The calculated shear stresses are varying between 6 N/m^2 and 39 N/m^2.

The water from the bridges will be drained by means of an inclination of 2,0-2,5% both, in the pedestrian and road lanes. The plan of the drainage system of the bridges is shown in Drawing 4.8.1.

Drawing 4.8.1. Drainage system of bridges



Erosion Protection

Iftheflowattheoutletoftheculvertissupercriticalthenahydraulicjumpoccursshortlyafterthe outlet. The hydraulic jump is associated with a high energy conversion. The energy conversion produces erosion which should beavoided.

Erosion protection in the form of gabion boxes has been provided at culvert outlets when the Froude number exceeds 1 indicating a hydraulic jump to be occurring. Gabion boxes have been selected due to the following reasons:

- it is relativelycheap;
- it is a flexible protection and often finds its own effectivelevel
- it is easy to install and repair byhand.

However, the length of the hydraulic jump and thus the length of the gabion boxes have to be calculated.

In the first step the correlated tail water depth has to be calculated with the following formula:

h tail= hout *(0.5 ((Fr out 2 +1)0.5 -1))

Where

htail correlated tail water depth inm
hout water depth at the outlet in m (result ofHY8)
Frout Froud number of the flow at the outlet (-) (result of HY8).

After having calculated the correlated tail water depth the length of the hydraulic jump can be calculated with the following empirical formula

L = 6 * (htail – h out)

Where,

L length of the hydraulicjumphtail
htail correlated tail water depth in m
hout water depth at the outlet in m

Expected washing depths near the design piers

Bridge piers are susceptible to scour. There are some procedures available to calculate the excepted pier scour depth. However, most formulas are based on laboratory tests and it is well known that these estimates are very conservative. However, the Consultant employed the Colorado State University equation (CSU Equation) to obtain an estimate of the scour depth to be expected. The CSU Equation is recommended by the FHWA and it is published in the Hydraulic Engineering Circular 18 (HEC 18) of the FHWA.

$$tSc = h * (2 * K1 * K2 * K3 * h^{0.35} * (D/h)^{0.65} * Fr^{0.43})$$

where :

t_{Sc} the expected scour depth inm
K_1 Correctionfactorforpiernoseshape.K1=1forpierswithcylindricalshapeorfor a group of piers with cylindricalshape.
K_2 Correction factor for angle of attack offlow.

$$K_2 = (\cos (a) + L/D * \sin(a))^{0.65}$$

where:

a angle of attack in degrees
L pier length in m
D pier width in m

K_3 correction factor for bed condition. K3 ranges from 1.1 to1.3
h flow depth directly upstream of the pier in m (result of HEC-RAS)

D pier width inm
Fr Froude number directly upstream of the pier (result of HEC-RAS)

The above formula is also implemented in the software package HEC-RAS

The calculations showed that the expected washout depth at the bridge piers varies within 1.93-2.65 m.

4.9 Road Safety

Road safety design was done in accordance with the Georgian design standards and good engineering practice generally. The project road was planned as a motorway with a main carriageway design speed of 120 km/h. Road safety considerations were therefore given high priority in the design of the high-speed road with the aim of minimizing the occurrence of road traffic accidents of all kinds.

Road signs, pavement markings and safety barriers at the central median, along the roadside verge, and alongside and at approaches to structures, were considered and incorporated within the design in accordance with TEM Standards or the appropriate recommended international standard for traffic safety. Road lighting was also considered to be an important safety feature for the project road.

4.10 Construction Organization

Prior to the onset of the core works, the organization and technical issues will be solved to provide a field of construction operations. Preparatory works envisage arranging a temporary infrastructure (construction camps) necessary for the highway construction works and mobilization of relevant construction machines/mechanisms (crusher and sorting plant, asphalt plant, etc.). An issue of water- and power-supply of temporary objects and the like will also be solved.

After the preparatory stage, the construction corridor will be prepared for construction meaning the relocation of existing engineering and communication lines, cutting trees and plants.

Afterwards, earthworks are planned (including the striping and storage of top soil). Sections and fills will be provided at relevant locations in the project corridor; roadbeds will be prepared and the topography will be put in order.

At the same time, the road infrastructure will be provided and viaducts, bridges and other communications will be constructed.

After the construction of the road and bridges is over, certain improving works will be accomplished, including the installation of the road marks, painting lanes, etc.

An important stage of the project implementation is the management of different types of waste originated in the course of the construction. After the construction works are complete, the building camps and other temporary facilities will be demobilized, the cultivation works will be done and the landscape will be harmonized.
The proposed motorway is the new construction expecting the longer serviceability and durability. The consultant considered geophysical condition for existing road, construction operation factors, budget and disbursement plan, and miscellaneous condition such as weather, custom conditions, urgent condition for implementation, and community events to evaluate construction period.The construction period for Rustavi-red bridge is estimated to be 30months.

The works of the project highway will be realized as a single plan, i.e. the earthworks will be accomplished all along the corridor and the viaduct sections and bridges will be constructed simultaneously. As the works are finished, improvement and recultivation works will be accomplished all along the road. The preparatory works will take approximately 1 to 2 months. The improvement and recultivation works will take approximately the same time. The remained time of construction (26-28 months) covers major works, including earthworks and concrete works.

Approximately 90-100 people will be employed in the construction phase, with minimum 70% local people.

4.10.1 Construction Camp

The present chapter considers and proposes the territories, where the construction camps can be provided, which are profitable for the implementing agency in an environmental respect so that to cause minimum harm to the environment and people.

The consultation company has proposed several options where the construction camp can be provided. When identifying the potential sites for the construction camps, the following issues must be taken into account:

- Near location of the highway to the construction corridor.
- Availability of communications (water- and power-supply, existing roads, etc.).
- Satisfactory natural conditions (plane relief, less vegetation, less soil cover).
- Sufficient distance to the sensitive receptors (houses, protected areas, etc.) so that the expected impacts caused by noise, emissions and vibration are minimized.
- Category of the site owner and land plot (state lands must be preferred; however, relevant agreements with private entities are also an option).

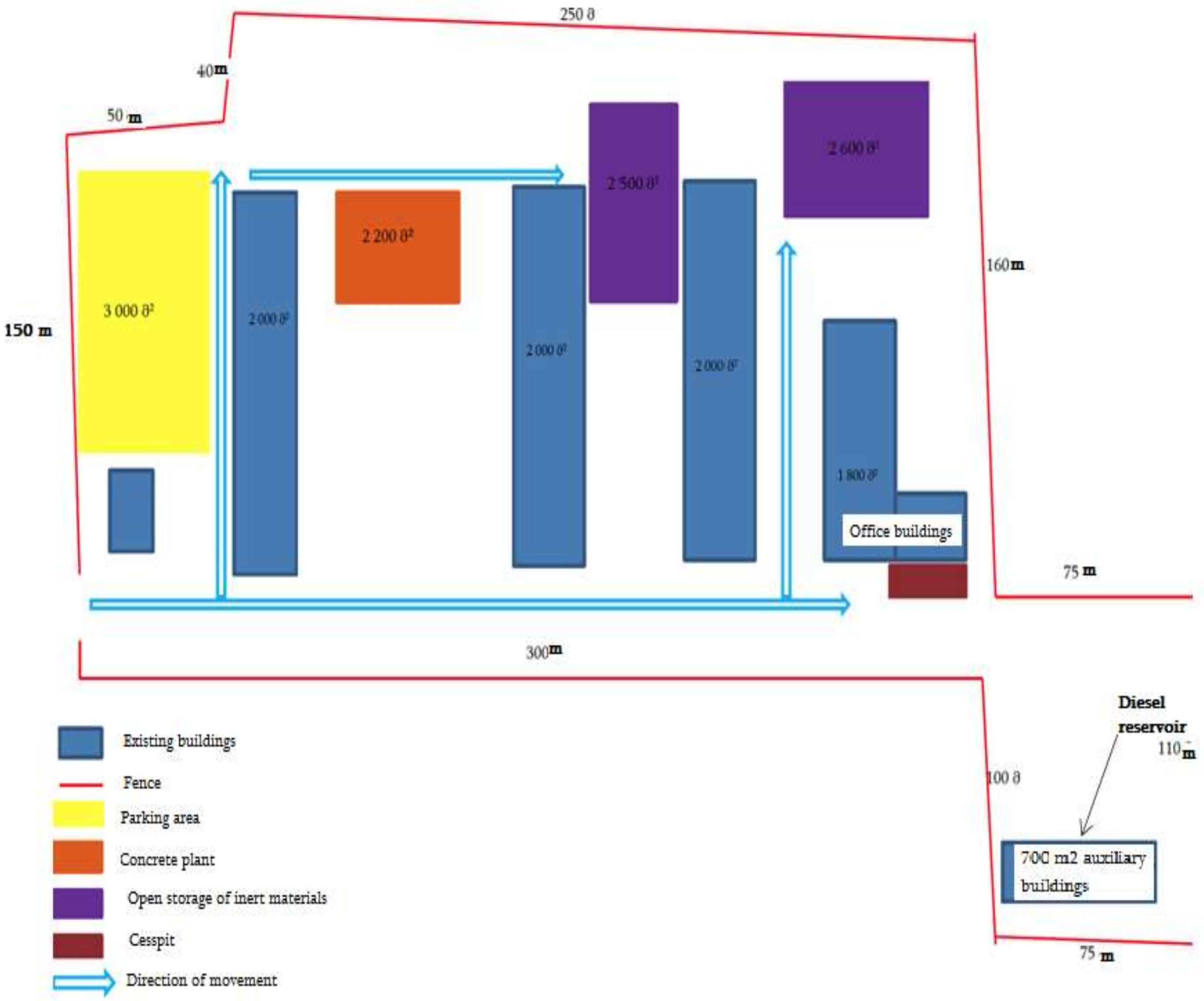
Following the above-mentioned, it is proposed to accomplish the highway construction works in the construction phase mainly from one construction camp, which will be provided along the middle section of the territory. It should be noted that following its location, the planned construction works for Rustavi-Sadakhlo highway will be suitable from the same territory. This territory is a land plot owned by the state Approximate coordinates: X – 498353; Y – 4582495. Plot cadastre code: 83.07.08.708 (See Figure 4.10.1.1.). The proposed territory is approximately 7 ha and is totally fenced with a concrete enclosure of 2-2.5 m height. There are also premises with no function on the given territory, which can be freely used for various activities, e.g., for storing materials, installing equipment, etc. The given territory also has areas free from any premises, which can be used by considering the existing needs. The territory is under high anthropogenic impact and virtually, has no topsoil. The selected plot is located east of village Didi Mughanlo, with the nearest residential, house located approximately 800 m in village Lezhbadini. The given territory can be accessed by the existing road. There is an irrigation channel near the plot. The plot has all types of communication, such as electrical power and gas supply.

Figure 4.10.1.1. Proposed camp site

On the territory of the selected construction camp, a vehicle parking area, concrete plant and approximately 5 ton-capacity diesel reservoir will be provided. The diesel reservoir is planned to place in the existing building. The sites of open and close storage of inert materials will also be provided on the territory. No crushing and sorting equipment for inert materials is planned to provide on the territory. Besides, wet patches and relevant cesspits will be provided on the territory of the camp. The cesspits will be cleaned regularly. See the plan of the construction plan in Figure 4.10.1.1.

Boreholes will be drilled on the territory of the construction camp and the pumped water will be used for different purposes. As already mentioned, 5-ton cesspit is planned to provide on the territory. At the given stage, no discharge from the construction camp is planned into the surface water objects.

Figure 4.10.1.2 Construction Camp Layout



Besides, 5 additional areas are proposed, which can be considered as auxiliary construction camps, which will be mainly used for storing different materails during the construction works.

The construction materials necessary for the initial section can be stored on the tritory, which is located on the land plot owned by the state, cadastre code: 83.02.03.607. There runs E-60 highway near the area, which is distanced from the settled area by approximately 5 km. there is no topsoil on the territory.

Another auxiliary construction camp can be made on the area at approximately km12 of the construction corridor, which is located south of Algeti Farm, approximate coordinates: X – 498354; Y – 4590911. Plot cadastre code: 83.06.10.447; the nearest residential zone is located in approximately 300 m; the territory can be accessed by the existing roads. Approximately 15-cm-thick topsoil is presented in the area. If considering that the area of the selected territory is 1200 m^2, the topsoil to strip wil be approximately 150 m^3 , which wil be temporarily stored wihtin the limits of the selecetd plot to b used later for recultivation works.

A suitable area at approximately km 17.5 of the project corridor, adjacent to it, east of village Azizkenda, is selected for the auxiliary construction camp, with approximate coordinates: X – 497395; Y – 4585480. Plot cadastre code: 83.03.10.424; the nearest residential zone is located in approximately 800 m from it; The territory shows the signs of a former river on it and has no topsoil. The upper ground layer is mixed with gravel. River Algetii flows in approximately 200 m from this area.

For the final section of the project corridor, approximately 600 m2 area with approximate coordinates: X –505866; Y – 4575681. Plot cadastre code: 83.06.08.027 is offered; The territory owned by the state located near Georgian-Azerbaijan border, on the left bank of Khrami river. There is no topsoil on this territory.

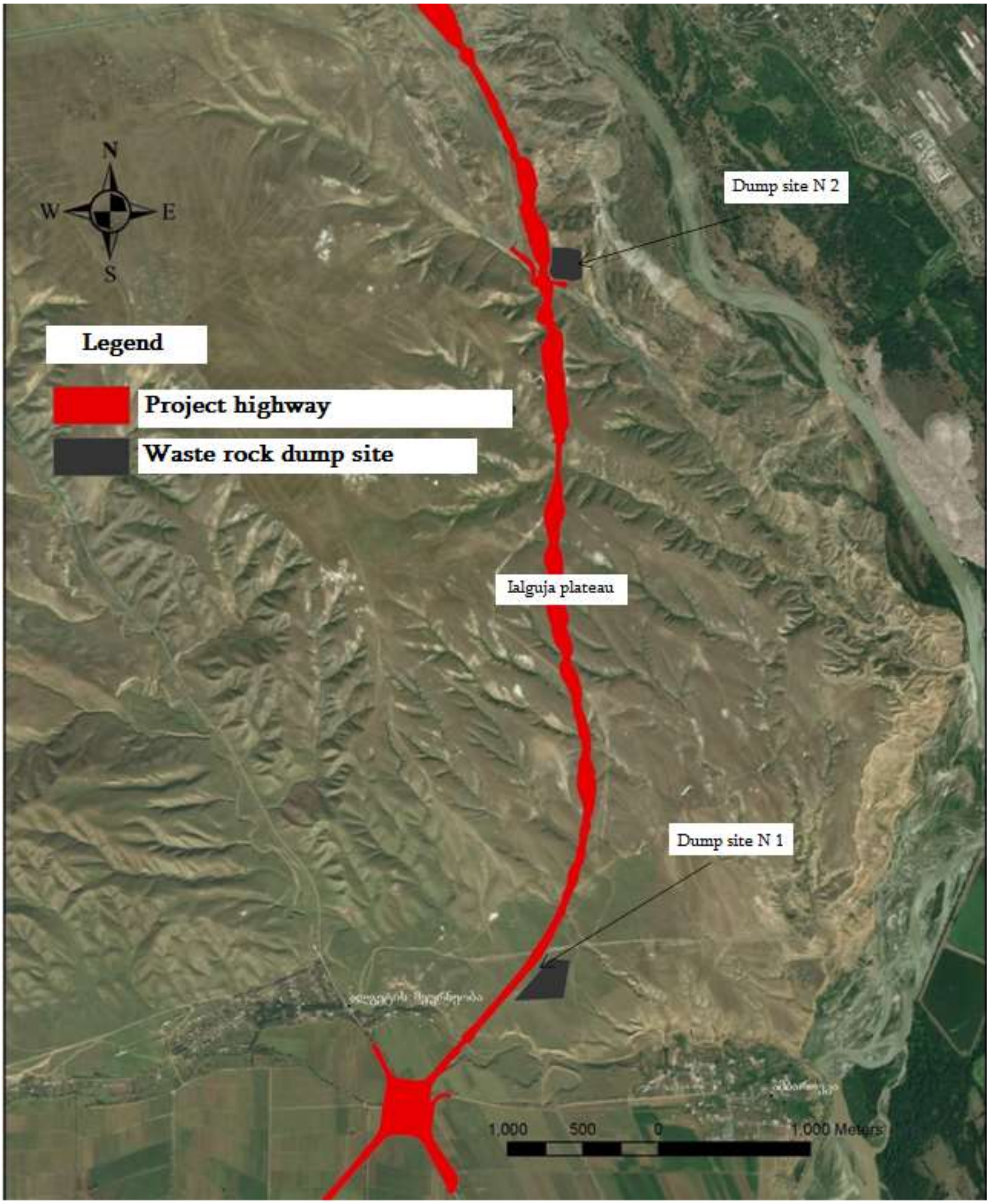
The fifth area for storing the construction materials is approximately 9 ha land plot on the territory of village Kutliari with cadastre code: 83.07.03.923; the nearest residential zone is located in approximately 800-900 m from it.

4.10.2 Dumpsites

The works to treat the roadway along the section running over Iagluja Plateau will involve a great volume of earthworks. Consequently, upper and lower levels of the plateau were selected for ground dumpsites so that the transportation of waste rock can be transported to as short distances as possible with no residential zones along the transportation route.

As per the preliminary forecast, approximately 4.5-5 mln m3 waste rock will be necessary to remove from this section, with 80-85% of it to be subject to permanent disposal to 2 plots selected in advance. By considering this, at km 11 of the project corridor, conventional dumpsite N1 was identified, which is an area of 6-6.5 ha and is owned by the state (cadastre code: 83.06.01.665, approximate coordinates: X - 499042; Y - 4591587) and dumpsite N2, which is an area of approximately 4-4-5 ha, a free land plot owned by the stat; approximate coordinates: X 499359 Y-4596490. See Drawing 4.10.2.1.

Drawing 4.10.2.1. Map of waste rock dumpsites



Conventional dumpsite N1 is located north of Algeti farm, at the bottom of Ialguja Plateau, adjacent to the project road. The distance of transportation of the waste rock will be 0,5 km to 3 km. The vegetation cover is minimal and of a low value (See Figure 4.10.2.1). The topsoil stripped from the territory will be temporarily stored in isolation of waste rock and will be used to recultivate the same territory after completion of the construction.

The area selected for conventional dumpsite N2 is located adjacent to the existing highway, on the slope south of Rustavi, nearly adjacent to Ialguja dumpsite. The territory can be accessed by the existing roads. The distance of transportation of the waste rock will be maximum 3-3.5 km. the territory is distanced from the residential zone. Only grass cover is presented on the territory and its topsoil is of a low value with the thickness of 5-7 cm. The topsoil stripped from the territory will be temporarily stored in isolation of waste rock and will be used to recultivate the same territory after completion of the construction.

Figure 4.10.2.1 Area selected for the dumpsite

N 1 Dumpsites **N 2 Dumpsites**

The waste rock will be disposed on the dumpsites with a safe height, by terracing the slopes as necessary. The topsoil stripped in advance will be provided on the fill surface and drainage channels will be provided along its perimeter. The issue to provide the dumpsites will be agreed with the local authority.

4.10.3 Supposed list of construction techniques

The construction works of Rustavi-Red Bridge will use typical construction machinery commonly used in similar types of projects. Table 4.10.3.1 gives the probable list of the principal construction machinery to be used during the construction works. The precise list will be provided before the construction works start.

Table 4.10.3.1. Main techniques to be used during the construction works

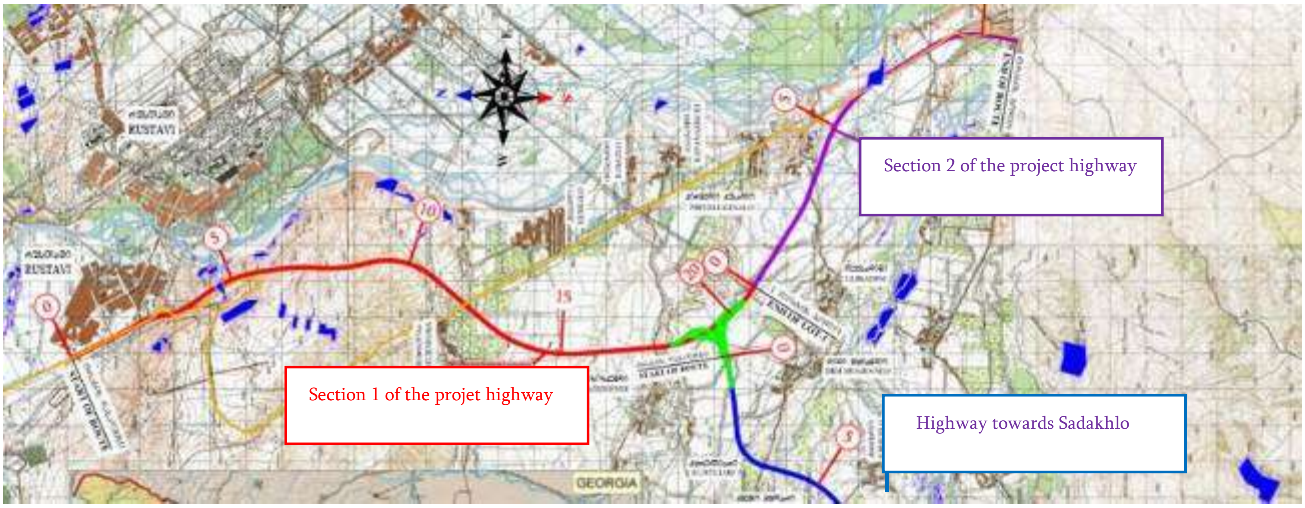
Item	Approximate qty
Grader	2-3
Excavator	5-10
Excavator-based pneumatic drilling hummers	2-5
Bulldozer	2-5
Tractor	2-5
Bush-cutting machine	2-3
Derooting machine	2-3

Tree cutting machine	1-2
Crane with motor motion	2-3
Smooth roller	2
Pneumatic roller	2-3
Asphalt/concrete distributor	1-2
Motor-truck concrete mixer,	10-15
Dump truck	20-30
Vibrator	7
Hand drill	2-3
Mobile compressor (with pnemautic hammers)	2-3
Watering and washing machine	3-5
Road marking machine	2-3
Fuel transporter	2-3
High-sided truck	2

4.10.4 Sources of Construction Material

The expressway construction needs many different types of materials, such as aggregate, sand, cement, steel, and bitumen.The project region is quite rich in the construction materials of inert materials (sand-gravel). There are several tens of duly licensed quarries operating in the region. Most of them are located in the Mtkvari River bed. Resources are also available in the gorge of Algeti river. Figure 4.10.4.1 shows the principal outcrops of sand and gravel near the corridor in blue (See also blue spots in Drawings 4.1.1. and 4.1.2). Mostly the carriers near villages Algeti, Azizkenda and Lejbadini will be preferred. It will not be necessary to transport the principal construction materials to far distances (the distance of transportation will mostly be 10-15 km maximum). Inert materials wil be extracted in line of the terms of the elevant license.

Drawing 4.10.4.1. Location of the main outcrops of inert materials/licensed carriers



Besides, as the project organization suggests, it should be noted that a major portion of the material cut down during the earthworks will be used in fills. In such a case, the amount of originated waste rock will decrease on the one hand and the need to use natural resources of the inert materials will be diminished on the other hand. The quality of the cut materials will be tested at the laboratory before they are used in fills. As per the available information, most of the cut material is clay grounds, which will be suitable to be used for construction works after stabilization.

Pozzolana Cement is produced widely throughout the country. Consequently, the cement for the project will be supplied from the local sources.

Steel materials for bridges/viaducts, as well as bitumen is not available in the country. They will be imported from the neighboring countries. The best sources of bitumen import is Turkey and Azerbaijan.

4.10.5 Water Supply-Sanitation

During the construction of the design highway, water will be used for drinking and economic purposes and presumably, for preparing various construction materials and for periodic watering of the corridor. Vehicles will be washed at the car washing services operating in the region. Consequently, no thcnical water will be used to wash the vehicles and techniques.

The principal sources of drinking and economic water supply in the region are artesian wells and boreholes. As mentioned above, the camp territory has water supply. Supply reservoirs with sufficient capacities will be provided at the construction camps. Tank-cars or bottled water can be used for water supply of individual sites. Technical water will be mainly taken from the surface water bodies found near the construction corridor.

The amount of drinking and domestic water supply depends on the number of the staff employed for construction. The water consumption is calculated according to the construction norms and rules SNiP 2.04.01-85 "Internal Water Supply and Sewerage", and is 25 l per worker in one shift (8 hours).

The number of staff employed for the construction works will be 100. If considering that the works are accomplished in one shift and the number of working days a year is 260, the consumed amount of drinking and domestic water will be:

100 x 25 = 2500 l/day, i.e. 2.5 m3/day.; 2.5 x 260 = 650 m^3/year.

The construction works will use technical water mainly to make concrete mix. Maximum rated capacity of a concrete mixer is 60 m^3/hr. Maximum expected annual capacity with a one-shift work (6 hours) is 900 hr/year. Maximum annual design production will be consequently: 55 m^3/hr* 900 hr/year = 49,5 thousand m^3/year. On average 0,3 m^3 water is used to produce one cubic meter of concrete mix of different grades. Thus, the consumed amount of water will be:

$$60 \times 0{,}3 = 18\ m^3/hr.\ 18 \times 6 = 108\ m^3/day.\ 18 \times 900 = 16\ 200\ m3/year.$$

During the intense traffic of vehicles and techniques, particularly in dry weather, the regular watering of the construction grounds will be considered. The construction grounds will be watered with a special vehicle filling its reservoir presumably from a surface water object. The number of dry days in a year is taken as 60 only and maximum amount of water needed for watering the construction ground is taken as 50 m^3. Consequently, the total amount of irrigation water will be 3000 m3/year.

As already mentioned, the inert materials will be ground and sorted by using the sub-contractors' operating plants, which will be installed on the material extraction sites. Thus, we do not take into account the amount of water used by the grinding and sorting plants.

Following the above-mentioned, the total amount of technical water to be used for the rehabilitation works will be:

$$650 + 16200 + 3000 = 19850\ m^3/year.$$

The approximate amount of technical water needed for various unforeseen cases (fires and the like) will not exceed 25000 m^3/year.

The calculation of approximate amount of the domestic-fecal effluents is done by considering 5-10% of the consumed drinking and domestic water. The amount of domestic-fecal waters originated during the construction works will be 617,5 m^3/year, i.e. 2,375 m^3/day.The domestic-fecal waters on the territories of the camps will be emptied into the cesspit with approximate capacity of 20 m^3. Mobile WCs will be used on the construction grounds. The accumulated fecal masses will be removed with a special vehicle and utilized in the nearest sewage systems (persumably the city fo Rustavi. Besides, the sewerage system of marneuli city is planned to rehabilitate in the near future).

The concrete unit ultimately uses the water to make a concrete mix and consequently, produces no effluent waters.

4.10.6 Relocating engineering and utility lines

Along the projectroadseveralpublicutilityconnectionssuchaswater,power,telephone,and gas were encountered. By contacting the relevant utility provider the network of utility lines were identified. Plan were developed for shifting the lines away from the projectarea.

The following technical solutions were suggested for the utility shifting:

- If the utility lines are running parallel to the road alignment, the line shall be shifted beyond the limits of the impact corridor, in parralel to the road.
- If the utility lines are crossing the road cross section utility ducts of diameter 1.2m is planed across the road cross section so that the lines could be run through without obstruction.
- The cross section of the utility ducts are similar to the normal culvets.
- The utility provider/ supplier shall be contacted by the nominated contractor to take their approval for the shifting to the comfortable zone away from the road right of way.

The consultant has addressed utilities interference in writing caused by rehabilitation work to the relevant agencies owned respective pipe utilities and received their official response including protective method. All requirements have been applied in detailed design drawing

Detail information for pipe utilities surveye disgiven in the Table 4.10.5.1.

Table 4.10.6.1. Engineering-utility lines in the project corrdior to relocate

Existing location, km of project corridor	To transfer to km of project corridor	Description	Note
Section 1 (Rustavi-Sadakhlo interchange)			
0+070		Water line	250 mm dia
0+090		Telecomm line	7 m high
0+730		Gas pipe line	
1+110		Gas pipe line	
1+120		Powerline	10m high
1+260	1+500	Powerline	8m high, 6 pylons
1+560	1+640	Powerline	7m high on the RHS only
Rustavi intersection		Water pipes under ramps	-
2+330		Water pipes	-
2+490		Powerline	6 m
2+660		Powerline	one pylon of HV line to be relocated
3+560	4+850	Water line	HV, 24 m high
6+640	7+520	Water line	
8+700		Water line	
10+440		Powerline	HV, 24 m high
10+680	11+700	Water line	
11+250		Powerline	8m
11+380		Powerline	8m
12+150		Powerline	HV, 20m high
12+650		Irrigation channel	Culvert to be added
13+400		Irrigation channel	Culvert to be added
15+050		Powerline	double line 9m
15+120		Powerline	8m

15+770		Water canal	Culvert to be added
16+120		Powerline	9 m, double line
16+500		Gas pipe line	
16+680		Water canal	Culvert to be added
16+700		Gas pipe line	
19+000	-	Water canal	Culvert to be added
20+870	-	Powerline	HV, 24 m
Section 2 (Sadakhlo interchange-Red bridge)			
3+150	3+440	Power transmission line	3 high-voltage transmission towers, 8m high
4+050	-	Power transmission line	20 m
6+320	6+380	Power transmission line	3 high-voltage transmission towers, 8 m, are to be relocated
8+400	-	Power transmission line	1 high-voltage transmission towers, 8 m, is to be relocated
8+940	-	Power transmission line	2 high-voltage transmission towers, 8 m, are to be relocated
9+040	9+160	Power transmission line	3 high-voltage transmission towers, 8 m, are to be relocated
9+940	10+480	Power transmission line	12 high-voltage transmission towers, 8 m, are to be relocated
10+400	-	Power transmission line	HV 20 m
10+500	-	High-voltage power transmission line	Triple, 20 m
10+540	10+680		5 high-voltage transmission towers, 8 m, are to be relocated
10+700	Ramp	Power transmission line	8 m

10+860	-	High-voltage power transmission line	Crosses LHS unit as well

4.10.7 Traffic Management during Construction

Normal practice is for the Contractor to propose a Work Schedule and Methodology to the Engineer's Representative, which may include traffic diversions and traffic management as required.The Engineer's Representative must approve the Contractor'sproposalsbeforethework plan cancommence.
As the project envisages the development of a new corridor for the project road and at the same time, secondary (ground) roads are quite well developed in the region, the existing traffic control will not be associated with great difficulties. During the traffic control , the relevant measures will be necessary along the final section of the project corridor (from village Meore Kesalo to the Red Bridge), where the project envisages the development of the new highway in parallel to the old road.

The works on the given site will be first of all, accomplished within the corridor to widen, during which the traffic will move along the old road. After the given stage is over, the traffic flow will move to the new road and the works will start in the old road corridor. Temporary embankments are envisaged to provide the adequate space for construction.

The priority in specifying the organizational procedures necessary for the road traffic will be given to the improved safety of the road and local infrastructure. All locations where the construction works are planned near the traffic flows, will be clearly marked in the technical draft of traffic organization, and physical barriers will be installed between the construction sites and the traffic flows.

Similarly, the temporary objects and/or diversion routes for each local road, along which the traffic may be hampered during the construction will be shown in the complete technical design. For such sites, small-scale measures for traffic covering the construction period will be developed.

4.10.8 Temporary access roads

The local roads are quite well developed in Rustavi-Red Bridge highway corridor. There is a network of ground roads running between the agricultural plots. Presently, heavy techniques can also move through the corridor planned on Iagluja Plateau. However, the construction works of this section will be mainly accomplished from the starting and last points, in an on-coming direction. The main (key) highway in the construction phase is the existing E60 road from Rustavi to Red Bridge. Thus, the project virtually does not envisage cutting the temporary ground roads for the consequently purposes.

4.10.9 Recultivation of the temporarily used areas and hard shoulders

After the construction of the project road main is complete, the recultivation works will be accomplished. These works imply the restoration of the temporarily used areas and putting them to their original state to the extent possible. One of the principal guiding documents of the recultivation works will be Decree №424 of the Government of Georgia, Technical Regulation – on "Topsoil Removal, Storage, Use and Cultivation". The recultivation works will be accomplished mainly along the road shoulders (slopes of the embankments formed for the roadbed) and on the camp areas. The recultivation and landscape harmonization works will use topsoil, which will be stripped in the project corridor and stored separately until the onset of the earthworks.

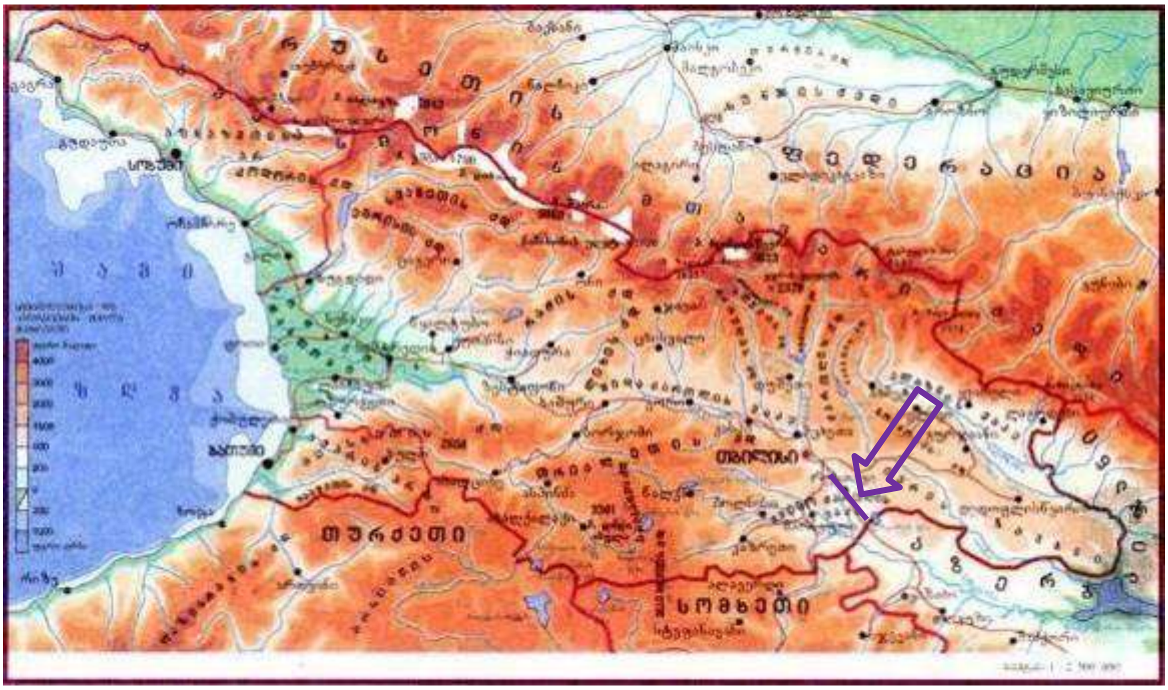
5 NATURAL AND SOCIAL-ECONOMIC STATE OF THE PROJECT CORRIDOR – BACKGROUND PROPERTIES, FIELD STUDY RESULTS

5.1 Physical-geographical and administrative location

As mentioned above, in a physical-geographical respect, the study corridor is located on Kvemo Kartli Plain. In a physical-geographical respect, this territory covers Kvemo Kartli Plain, which is an extreme north-western part of Kura-Araxes vast Plain. The alluvial plain is located on both banks of the river Mtkvari and bordered by the slopes of Trialeti and Lokhi Ridges, Shua Khrami mountain group and Iori Plateau. The corridor will partly run over Iagluja syncline plateau erected in the north-eastern part of Marneuli Plain (Marneuli Plain is a part of Kvemo Kartli Plain).

Below, the location of the project implementation site is shown on the physical map of Georgia.

Drawing 5.1.1. Location of the study corridor on the physical map of Georgia

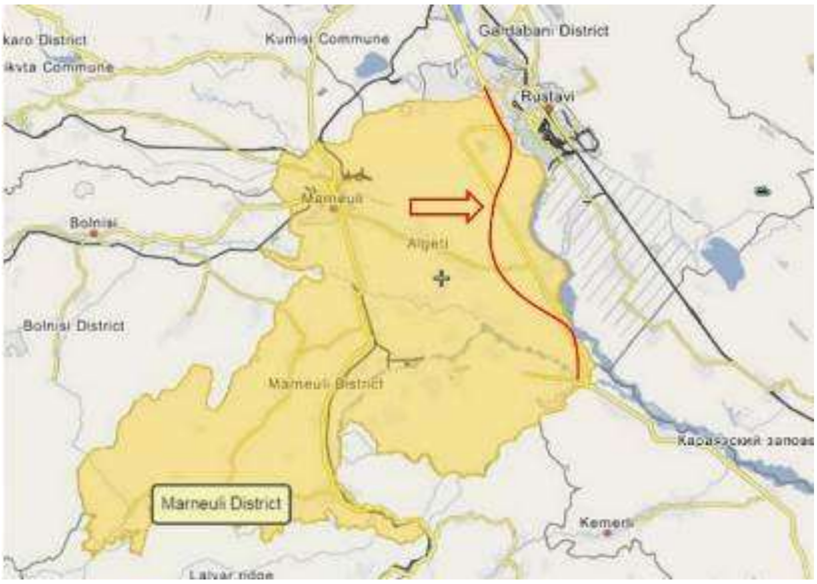


According to the administrative-territorial division of Georgia, the main part of the project corridor belongs to Marneuli Municipality. Marneuli Municipality is located within the administrative borders of Kvemo Kartli. It is located in south-eastern part of Georgia. From north, it is bordered by Tetritskaro Municipality; by Gardabani Municipality from the north-east and by Bolnisi Municipality from the west. Southern border of Marneuli Municipality coincides with Georgian-Armenian border and its eastern border coincides with state Georgian-Azerbaijan border.

A small section (initial section) of the highway is located within the borders of self-governing unit – Rustavi. The city is located on Kvemo Kartli Plain, on both banks of Mtkvari River, at 370 m asl.

The drawing below shows the location of the project corridor within the borders of Rustavi and Marneuli Municipality.

Drawing 5.1.2. Location of the project corridor in relation to the administrative units



The following paragraphs give the description of the social-economic conditions by considering the location of the project corridor described above.

5.2 Description of natural environmental objects

According to monograph "Spatial and time analysis of the landscapes of Georgia" (Dali Nikolaishvili; Iv. Javakhishvili Tbilisi State university - [Tb.], 2009), three types of landscape can be identified in the project corridor:

1. Plain-hilly accumulative landscaoe with semi-desert and steppe vegetation, rarely with shybliak (Landscape 22);
2. Accumulation and valley landscape with tugai and meadow herbs, rarely with swamps and salty areas (Landscape 51);
3. Low mountain arid-denudational landscapes with "shibliak", partially botriochloa and stipa steppes and "phrygana" (Landscape 58).

Below we give the general description of the given type of landscape, while the following paragraphs describe its individual components within the limits of the project corridor and adjacent areas.

1. **Plain-hilly accumulative landscaoe with semi-desert and steppe vegetation, rarely with shybliak (Landscape 22):**

Name of landscape: Gardabani-Marneuli.

Location: Is spread over Kvemo Kartli Plain. It is also spread on the territory of Azerbaijan.

Administrative regions: Gardabani, Marneuli, Tetrtskaro.

Area:0,37 thous. km^2 (0,53% of the total area of Georgia).

Bordering landscapes: Plain-lowland (65 %), low mountain (19 %), lower mountain(16 %).

Relief: Accumulative and erosive-accumulative. It is presented by the plain inclined south-east, rarely terraced. Hilly surfaces occur at some locations as well.

Migration regime: Accumulative, Elluvial-accumulative, super-aqual.

Geology: Molassa formations. Alluvial-Prolluvial and Alluvial- Delluvial deposits.

Climate: Subtropical, semiarid, slightly Continental.

Soils: Dark, grey-brown, carbonic calcium, salinated. Mechanical composition: common clay-containing; Heavy loam at greater depths. The density also increases as the depth increases. Clay content and heavy loam is also characteristic to the salinated soil. However, the mechanical composition is lighter at greater depths. Consolidated horizon is fixed in the middle layers. Depressed horizons have particularly poor filtration properties.

Vegetation cover: The floristic composition is poor. Xerophilous prick herbs are typical.

Vertical structure of the natural-territorial complex: dominating type is Ш occupying almost all the territory of the landscape.

Amount and supply of geomasses:

Geomasses	A	P2	Pi2	M2	Mv2	Ml2	Sab	S_{100}	L_{100}	Huab	Hu_{100}
Mean valaue	15	20	1,5	1,1	1,1	0	4300	6000	13000	65	87
Supply, mln t	0,6	0,38	0,06	0,04	0,04	0	288	402	871	2,2	2,9

Type of anthropogenic transformation: The landscape is changed almost all over the territory. It is covered with dense irrigation channels and is presented by agricultural plots (vegetable, fruit, winter pastures). The ecological situation near the roadsides and settled areas is severe. The use of pastures, irrigation systems and agricultural plots has changed the ecosystems significantly.

Degree of anthropogenic transformation: Almost totally transformed.

Number of experimental plots- 3.

The given landscape is most common in the project corridor.

2. Accumulation and valley landscape with tugai and meadow herbs, rarely with swamps and salty areas (Landscape 51):

Name of landscape: Floodplain

Location: Is spread along the gorges of big rivers in Eastern Georgia, in the floodplains and adjoining terraces, as well as along the irrigation systems (of a secondary origin) as a narrow strip. Their propagation on the background of dry climate – steppes and semi-desert ecosystems is the result of additional humidification of ground and soil what is associated with relatively high levels of ground waters.

Administrative districts: Khashuri, Kareli, Gori, Kaspi, Mtskheta, Akhalgori, Dusheti, Tetritskaro, Dmanisi, Bolnisi, Marneuli, Gadrabani, Akhmeta, Telavi, Sagarejo, Gurjaani, Signagi, Dedoplistskaro

Area: 1,655 thous. km^2 (of the total area of Georgia 2,4 %).

Bordering landscapes: Plain-valley (50%), low-mountain (20%), lower-mountain (10%), middle-mountain forest (9%), upper-mountain forest (1%), high-mountain plateaus (10%).

Relief: This is presented by accumulative plains and basins, with hydromorphic and sub-hydromorphic regime. It is a slightly inclined plain.

Modern geomorphological processes: Alluvial processes.

Migration regime: Super-aqual.

Geology: Quaternary sediments: loamy clay and carbonate. The soils are high-productive with rich harvest.

Climate: Average annual air temperature 12^{0}C. January -0,3^{0}C, July 25^{0}C. Total annual atmospheric precipitations 360 (Red Bridge) - 510 (Bolnisi) mm. the maximum falls in May-June having a positive affect on the productivity of the agricultural crops.

Soils: Alluvial.

Vegetation cover: Tugai forests, meadows, rarely swamps and salty areas are spread here, what is mostly due to incorrect irrigation. It represents a 25-30-meter-high tugai forest, with a sub-forest, with curly herbs and thick grass cover forming a single grass cover at some locations. Shrubs are spread along the forest edges and in the woodcut areas.

Types of geomasses: A, Pt, Pf, Pi, Pg, Ps, Z, Ml, Mm, Ssa, Ls, Hg, Hs.

Occurence ratio of geomasses: -0,75.The conditions are particularly favorable for mortmass accumulation due to less intense degradation of organic substances. Its average amount is 50-60 t/ha (Mo). The occurrence of stexes favorable for mortmass accumulation is 45-50%.

index of intensity of the biological circulation - 20-50.

Type of anthropogenic transformation: The floodplain forests were spread along almost all big rivers in Eastern Caucasus in large areas in the past. However, today, these forests are almost completely destroyed and are preserved only as small plots of plantations. They are replaced by the secondary grasses and shrubs and agricultural plots – cereals, fruit gardens and vineyards giving quite rich harvest.

Degree of anthropogenic transformation: Almost completely changed

Some sections of the project corridor can be attributed to the given type of landscape.

3. Low mountain arid-denudational landscapes with "shibliak", partially botriochloa and stipa steppes and "phrygana" (Landscape 58)

The given type of landscape common in Eastern Georgia – in the eastern part of Iori Plateau and in Azerbaijan beyond the borders of Georgia. Hypsomerically, it occupies the altitudinal range of 300 (400) – 900 (1000) m asl. Its original appearance is well preserved.

Name of landscape-Gareji.

Location: Is spread in within the limits of Iori Plateau, from Tbilisi to Iori gorge and border of Azerbaijan. As a small massif, it is also presented on Iagluja Plateau as well and spreads over large areas on the territory of Azerbaijan.

Administrative districts: Gardabani, Marneuli, Sagarejo, Signagi, Dedoplistskaro.

Area: 1,54 thous. km^2 (2,2 % of the total area of Georgia).

Absolute height: (400) 500 m to 1000 (1100) m.

Bordering landscapes: Plain-lowland (32 %), low mountain (68 %).

Relief: Arid-denudation and erosive-denudation, with sloped mountain feet hillocks and depressions, and plateau surfaces in some places. The surface washing is limited. The badlands occupy large areas. Development of erosion processes is due to heavy rains and atmogenic processes.

Migration regime: Elluvial-accumulative, transelluvial

Geology: Molassa, volcanogenic and volcanogenic-carbonate formations.

Mineral wealth: a number of pseudo-volcanic mud, Grdzeli Tba and Sakhare Tba Glauber's salts.

Climate: Subtropical, transient from moderately warm to continental air, with warm winter and hot summer.

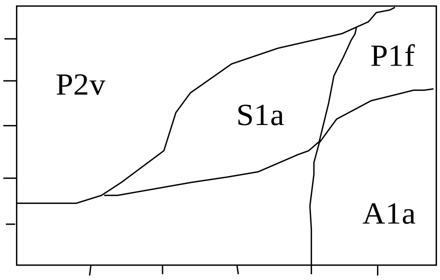
Hydrographic network: With episodic currents. Average annual flow comprises 1-2 l/sec for 1 km^2.

Soils: Grey-brownish soils of loamy and clay loamy mechanical content is spread. Mudding is mostly expressed in the middle horizons of soils. Lower layers are dense. It contains a thin humus layer. The more the depth, the less the density, and therefore, in the lower layers the filtration is better.

Vegetation cover: Steppe herbs are common (botriochloa and stipa steppes) alternating with shibilak. There are also typical representatives of the Meditterrenian flora here, the macchia-type shrubs - low trees and bushes adapted to the dry climate, with coarse and reduced and usually spiny leaves.

Principal geohorizons:

Pv,fx^{50} $\square^{1,5}_{0,7}$
Pv,fx^{30}A $\square^{0,7}_{0,3}$
Pv,fx40,x^{10}A $|^{0,3}_{0,15}$
Pv,ix^{50}MmA $\square^{0,15}_{0}$
L^{10}SaHs''Ps $\square^{0}_{0,30}$
Ls^{10}SasHs'Ps $\square^{0,30}$



The part of the project corridor running within the limits of Iagluja Plateau can be attributed to the given type of landscape.

5.2.1 Microclimatic properties

Marneuli Municipality and Rustavi belong to a moderately humid subtropical climatic zone. The climate on the most of the teritory is modetately warm. These areas are characterized by not severe winter and moderate, hot summer. Below are the climatic properties of the study arae based on the meteorological data of Rustavi and Marneuli weather stations (Source: Construction norms and rules “Construction Climatology”).

Table 5.2.1.1. Average monthly and annual air temperatures, t^0C

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year	Abs. Min. annual	Abs. Max. annual
Rustavi														
0,8	2,6	6,6	11,9	17,5	21,6	25,0	25,0	20,3	14,4	7,7	2,6	13,0	-24	41
Marneuli														
0,0	1,9	6,0	11,5	16,8	20,6	23,9	23,5	19,0	13,4	7,0	1,9	12,1	-25	40

Table 5.2.1.2. Extreme air temperatures, t^0C

Average maximm of the hottest month	The coldest five-day-long period	Mean value of the coldest day	Mean value of the coldest period	Period with average monthly temperature <8⁰C		Average temperature at 1:00 pm	
				Duration, days	Average temperature	for the coldest month	for the hottest month
Rustavi							
31,4	-8	-11	0,7	133	3,2	3,9	29,3
Marneuli							
30,3	-9	-12	-0,1	139	2,7	3,8	29,9

Table 5.2.1.3. Air humidity %

I	II	III	IV	V	VI	VII		VIII	IX	X	XI	XII	საშ
	Rustavi												
74	70	68	63	63	58	55		54	62	69	77	77	66
	Marneuli												
75	72	70	66	67	64	60		60	67	74	78	77	69

Average relative humidity at 1:00 pm		Average daily amplitude of relative humidity	
In the coldest month	**In the hottest month**	**In the coldest month**	**In the hottest month**
Rustavi			
62	41	18	30
Marneuli			
61	65	22	25

- Annual amounts of atmospheric precipitations are:
- Rustavi – 382mm;
- Marneuli - 495 mm;
- Daily precipitation maximum:
- Rustavi – 123mm;
- Marneuli - 146mm;
- Weight of snow cover:
- Rustavi – 0.50Kpa;
- Marneuli - 0,50 KPa;
- Number of days with a snow cover:
- Rustavi –12;
- Marneuli - 17;
- The wind properties as per the data of Rustavi weather station are as follows:

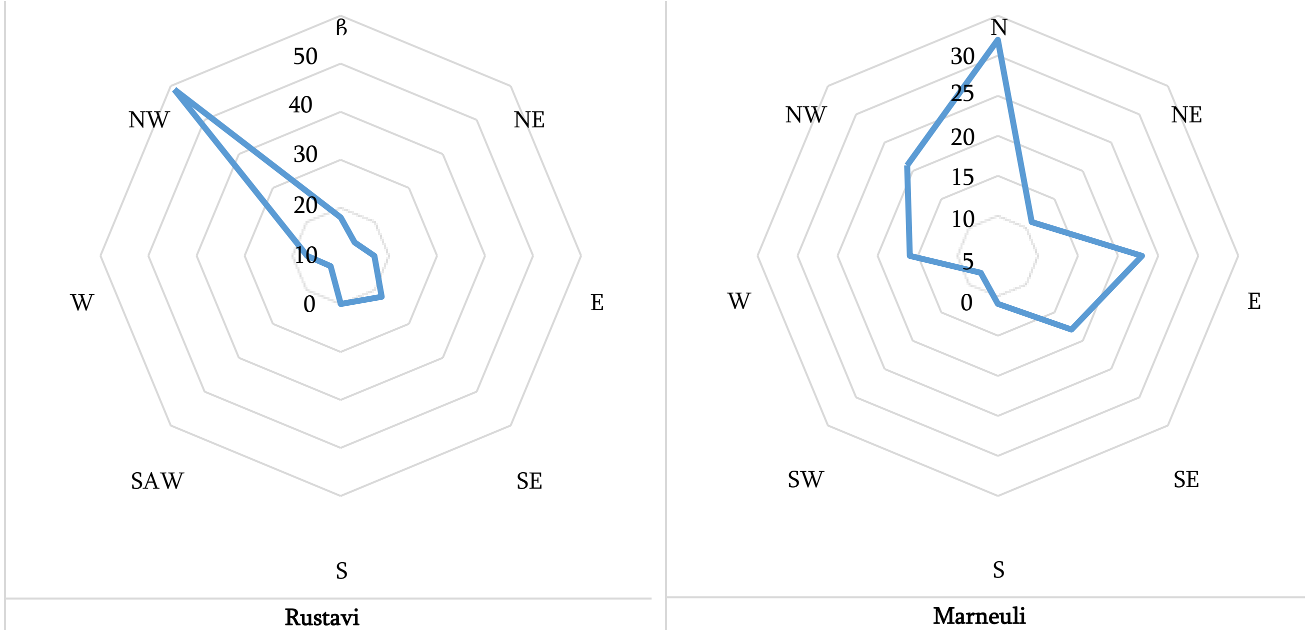
- wind with velocity of 25 m/sec is expected once a year;
- wind with velocity of 29 m/sec is expected once in 5 years;
- wind with velocity of 31 m/sec is expected once in 10 years;
- wind with velocity of 32 m/sec is expected once in 15 years;
- wind with velocity of 33 m/sec is expected once in 20 years;
- maximum and minimum wind velocities:

- January – 5,8/1,7m/sec
- July - 8,2/3,5 m/sec;

➢ <u>The wind properties as per the data of Marneuli weather station are as follows:</u>

- wind with velocity of 17 m/sec is expected once a year;
- wind with velocity of 23 m/sec is expected once in 5 years;
- wind with velocity of 24 m/sec is expected once in 10 years;
- wind with velocity of 25 m/sec is expected once in 15 years;
- wind with velocity of 26 m/sec is expected once in 20 years;
- maximum and minimum wind velocities:
- January – 2,6/0,6m/sec
- July - 4,5/1,3 m/sec;

Wind rose, %:



➢ As the data of Rustavi and Marneuli weather stations suggest, the rated seasonal freezing depth of grounds is:

- Argillaceous and loamy - 0 cm;
- Fine and dust-like sand clay-sand – 0;
- Large- and average-coarse gravelry sand – 0;
- Large-clastic – 0.

As the data above show, the project area has no particular extreme climatic conditions hampering the construction of the highway.

5.2.2 Climate change

The known likely impacts of climate change on the climate of individual locations are:

a) Changes in Temperature
b) Changes in Precipitation
c) Changes in Humidity

Figure 5.2.2.1: Georgia - Main Hazard Risk areas[1]

The Bank requested the promoter to produce a climate risk and vulnerability note assessing the risks to the project resulting from climate change.

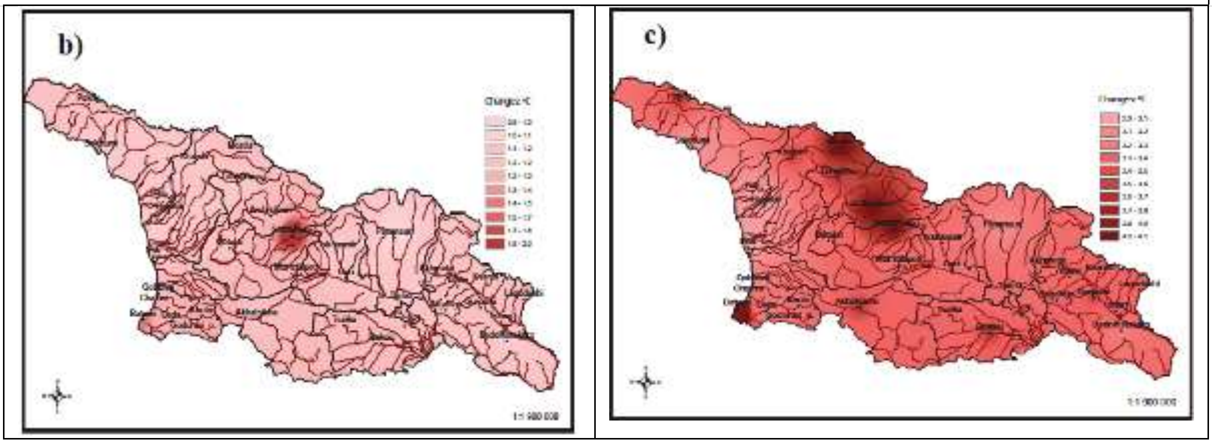
The Aware climate risk screening identified the final project climate risk rating as “Low risk”, with the risks of flooding, snow loading and landslide identified as “low risk from climate change”.

a) Changes in Temperature

Current climate change was assessed based on observations of 33 stations of hydro meteorological network of Georgia, in the period of 1961-2010, while the forecast scenarios for 2021-2050 and 2071-2100 were developed using regional climate model RegCM454. Basically, the following climate parameters were examined: mean annual temperature, total annual precipitation, average wind speed and relative humidity, as well as extreme climate indexes (SU25, TR20, ID0, FD0,Rx1day, Rx5day, R50mm, R90mm, CCD and CWD55). Average values calculated in each period for different climate parameters were compared, and the trend (increase, decrease) and the nature of territorial distribution were identified. Seasonal and annual trends were determined and their statistical reliability was assessed.

Figure 5.2.2.2: Change of average annual temperature:; b) 1986-2010 and 2021-2050; c) 1986-2010 and 2071-2050

[1] CLIMATE RISK IN GEORGIA: COUNTRY PROFILE – USAID, 2017.

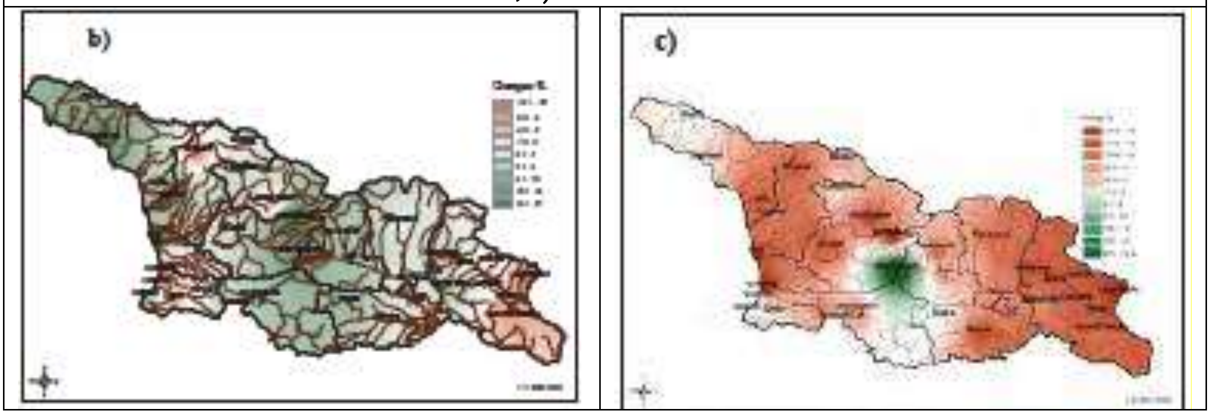


For a road project, the main aspects of climate change that are likely to impact on the project are:

b) Changes in Precipitation

Sustainable trends of the increase of precipitation are basically observed in West Georgia, especially in its mountain areas. This trend will be increased until 2050, and after that the decrease will be started, except for some areas (Batumi, Pskhu and Mta – Sabueti). In East Georgia decreasing trend is changed to increase and by 2050 the growth of precipitation on the average by 3, 4% is expected; However Lagodekhi is still an exception and the precipitation decrease by 6.3% is predicted (Figure 3. b). Significant decrease of precipitation is expected by 2100 on whole territory of Georgia, mostly in Samegrelo, Kvemo Kartli and Kakheti (22%). Central part of Likhi Range, where total annual precipitation is being increased by 93% is an exception in this period (Figure 3. c).

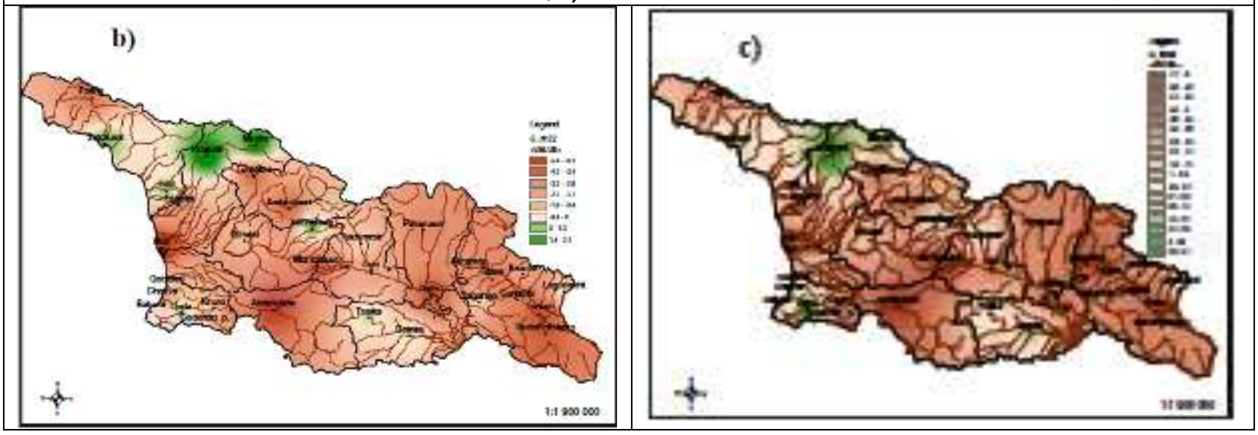
Figure 5.2.2.3: Maps of total annual precipitation change between the periods of b) 1986-2010 and 2021-2050; c) 1986-2010 and 2071-2100



c) Relative humidity

Relative humidity has basically increased by 2% on the whole territory of the country, between first and second periods. The biggest increase (5.4%) with sustainable trend is recorded on Goderdzi Pass. This increasing trend will be changed by decreasing on the majority of stations by 2050 and 2100. There are some exceptions, where this parameter will continue to rise significantly: Khaishi (4.7%), Keda (4.6%) and Mestia (2.2 %) (see Figire 4. b, c).

Figure 5.2.2.4: Change of average annual values of relative humidity between the periods of: b) 1986- 2010 and 2021-2050; c) 1986-2010 and 2071-2100



Summary of Climate Action Calculation

The estimates of the climate adaptation measures under the project have been provided by the promoter and calculated by the Services over the project investment cost as defined by EIB.

The promoter's climate adaptation cost to adapt the project to the risks of (i) flooding and runoff; (ii) mass movement and erosion, have been calculated as follows (For Rustavi-red Brdige Road Section):

A	B	C	D	E	F
Project component with Climate Action	Total Component Investment Cost (M.GEL)	% of component cost to total for CA	Cost GEL	Cost EURO	Budget Line
Section 1: Rustavi – Algeti Junction					
Earthworks (0.3 % Total Component Investment Cost)	129	0.3%	387 223	127 796	Construction Contractor
Culvert, Drainage and Underpasses (0.1% Total Component Investment Cost)	0.8	0.1%	811	268	Construction Contractor
Bridges (1.8% Total Component Investment Cost	43	1.8%	790 765	260 980	Construction Contractor
Section 2: Algeti Junction – Red Bridge					
Earthworks (0.3 % Total Component Investment Cost)	24	0.3%	72 900	24 060	Construction Contractor
Culvert, Drainage and Underpasses (0.1% Total Component Investment Cost)	0.3	0.1%	306	101	Construction Contractor
Bridges (1.8% Total Component Investment Cost	14	1.8%	261 494	86 301	Construction Contractor

5.2.3 Geology

5.2.3.1 General geology

As per the geotechnical zoning map of Georgia, the study area is a part of the eastern subsidence zone of the Georgian Block.

A part of the geological map related to the project area is given in Drawing 5.2.2.2.1. The geological map shows that two principal formations present in the project area:

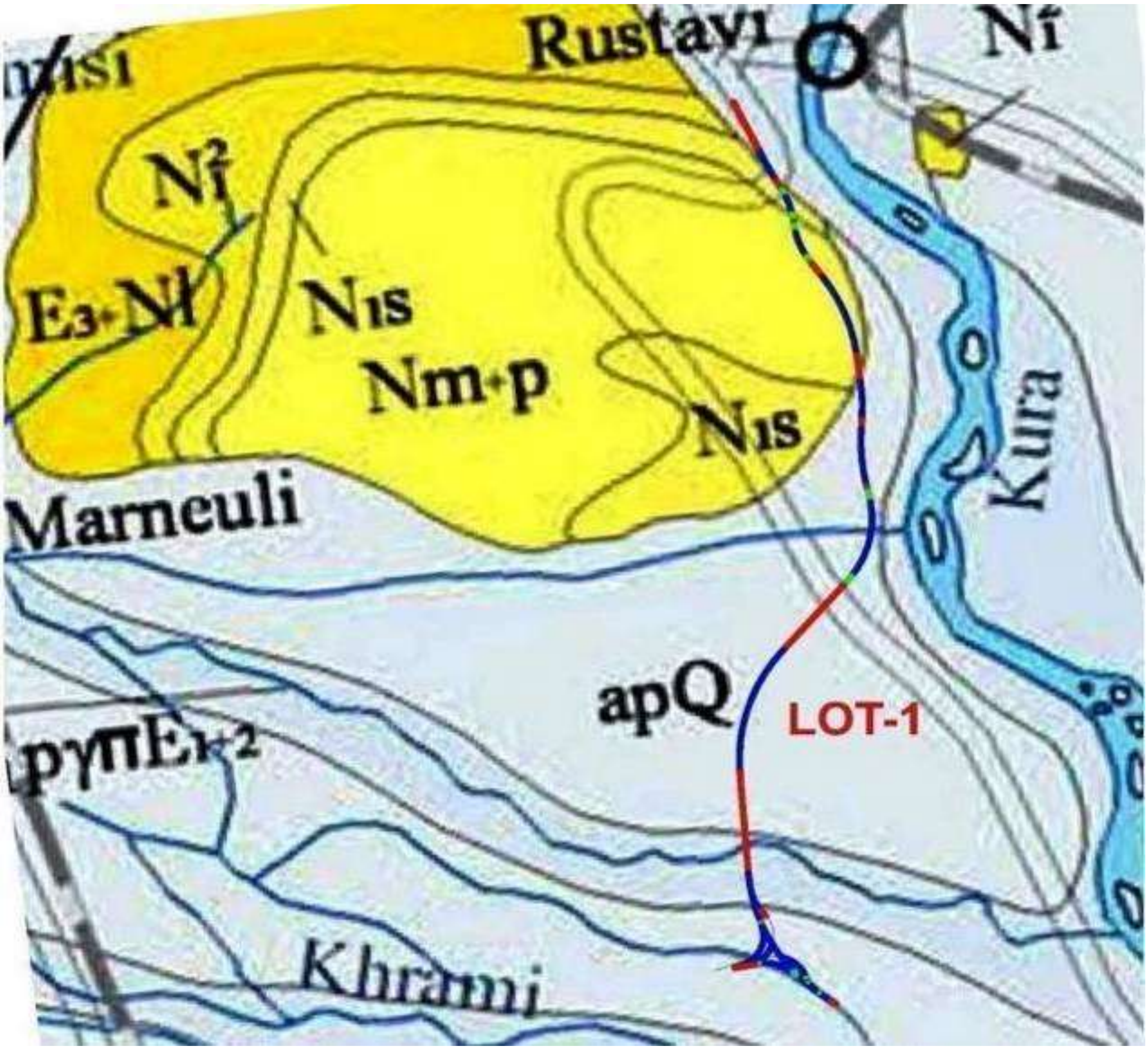
- Iagluja Plateau, mostly with "N" Tertiary formations: sandstones, clays and conglomerates and marls and limestones at some places, and
- Sadakhlo-Red Bridge alluvial lowland with Quaternary and modern alluvial formations.

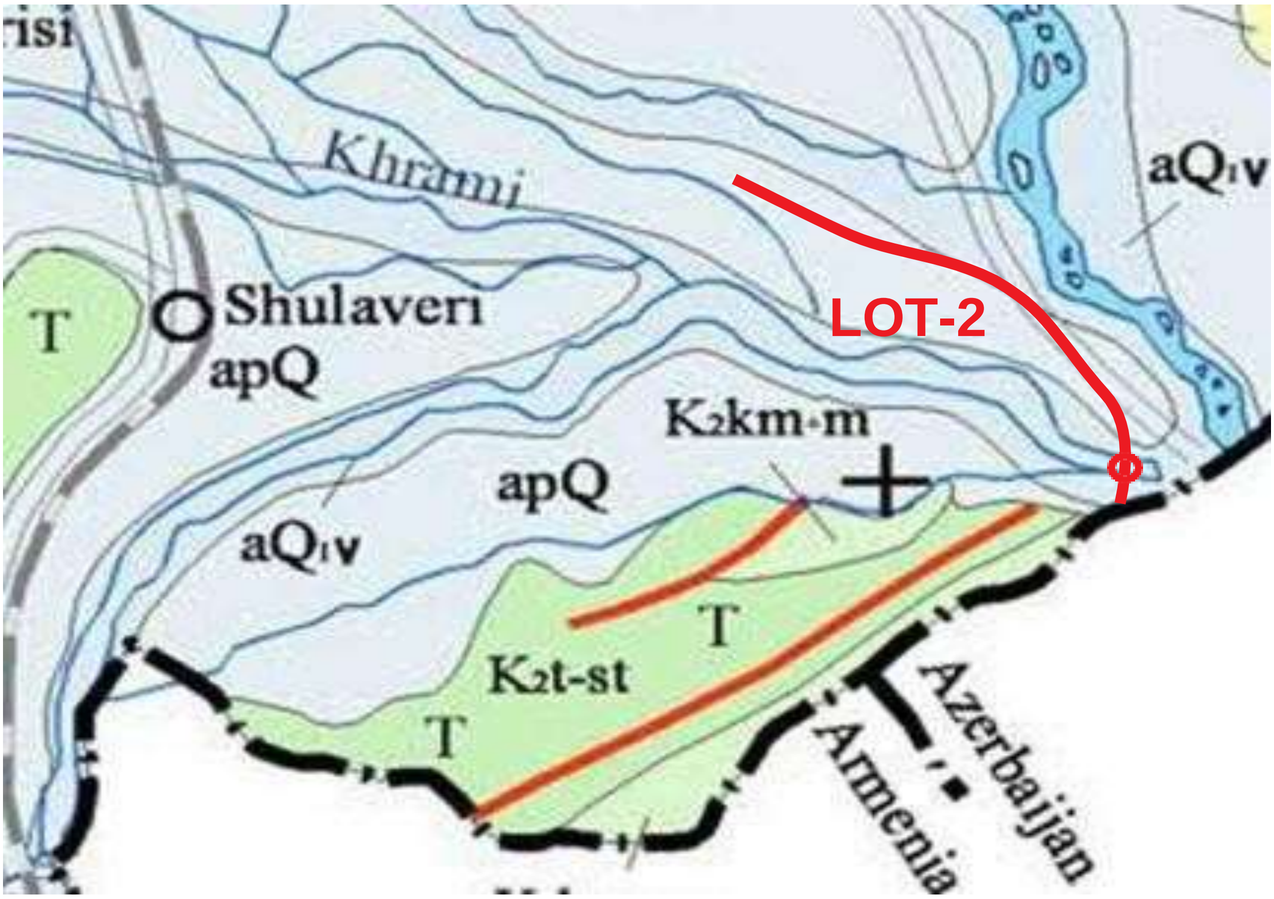
The oldest deposits – the Upper Eocene stratum – is presented by fine-grain, thick-layer sandstones. The degree of lithification of Oligocene rocks is low here and they are presented by stratified clays, though of hard consistence. As for the Lower Miocene stratum, it is presented by dark grey argillites, with think interlayers of argillites and siltstones.

Paleogenic-Neogenic rocks in the study region are covered with a layer of varying thickness of the Quaternary grounds of various genesis. The thickness of the layer of the Quaternary clay grounds is relatively more on the plains of Mtkvari terraces, where their accumulation is associated with the movement of temporary surface waters. The Tertiary formations are mainly made up of: sandstones, clays, conglomerates, sometimes, marls and limestones. In particular, the objects itself is located in the region, where the upper layer is mainly presented by a thin alluvion layer (gravel and shingle), which lies on hard rocks (sandstones of different degrees of cracks, etc.).

As the studies accomplished on the site make it clear, all kinds of Miocene deposits are spread n the piedmont. Most common types of ground are: clay, sandstones and conglomerates.
All kinds of alluvion formations are spread along the section of alluvion plain, which may occur both, in the riverbeds and beyond the former and existing riverbeds. Under the alluvion deposits, there are Pleistocene deposits, which, as a rule, are grain grounds.

Figure 5.2.3.1.1. Geological map of the project area





Q $\alpha\zeta Q$	Q-Quaternary system (undismembered). Genetic types of deposits: a-alluvial, m-marine, am-alluvial-marine, I-Iacustrine, Ia-Lacustrine-aaluvial, Im – Lacustrine-marine, ap-alluvial-proluvial, pd- proluvial-talus deposits: coarse gravels, blocks, gravels, sands, conglomerats, clays, loams, g-glacial: apg-alluvial-proluvial-glacial (fluvioglacial) deposits: boulder-coarse gravel accumulation, loams, sands, aC-subbaerial cale-alkalic andesites, decites, andesite-decites
Q_{IV}	Q*v*-contemporaneous deposits; a-alluvial, am-alluvial-marine, m-marine, Im-Iacustrine-marine, p-proluvial, ap-alluvial-proluvial, Ip-Iacustrine-proluvial deposits: coarse gravel, sands, clays, sometimes pear bogs.
Nm-p	Meotian and Pontian stages. Marine and continental molasse: conglomerates, sandstones, clays.
N_1s	Sarmatian stage. Marine and continental mplasse: sandstones, clays, conglomerates, sometimes marls.

5.2.3.2 Geomorphology

Kvemo Kratli Plainis bordered by the slopes of Trialeti and Lokhi Ridges; its western border is the northern part of Samsari Ridge and Javakheti Ridge; its eastern border is Samgori and Davit Gareji mountain ridges, in northern border is Trialeti Ridge, while in the south, Loki Ridge isolates Kvemo Kartli from Armenia.

The greatest (central) part of Marneuli Municipality is occupied by Marneuli accumulative plain (Borchalo Plain) with its height of 270-400 m, length of 40 km, the greatest width of 20 km. The Plain is bordered by Iagluja Plateau from the north, by Loki Ridge and Babakara Hillock from the south, by Mtkvari River from the east and Mashavera Gorge follows along its western edge to the city of Bolnisi. The general inclination of Plain is directed south-east – almost in parallel to Mtkvari River. The surface of the Plain is flat and has a dense net of gorges of rivers Algeti, Khrami and Debeda. The gypsum clays constituting the river terraces show pseudo-karst events, what is seen in the relief as piping holes, wells and caves, as well as natural bridges.

An important geomorphlgical elements in the study area is Iagluja Plateau, where the initial section of the project corridor will run (See Figures 5.2.2.1.1.). The Plateau is located in the northern part of Marneuli Municipality. It is elevated in the northern part and forms Ighluja Hillock (sizes: 17X11 km). Its absolute height 788 m. Ighluja Hillock is built with a stratum of Neogene conglomerates and sandstones, which is a Molassa formation of the Lesser Caucasioni. The eastern end of the Hillock is crossed by dry gorges.

Figure 5.2.3.2.1. Iagluja Plateau

Immediately in the project corridor, the relief is dissected in its initial part, along the section running across Iagluja Plateau. Here, the absolute heights vary between 370-460 m asl. The corridor is crossed by some dry gorges. Thereafter, the alignment continues across a flat relief. In the direction of the Red Bridge, the absolute levels gradually decrease and reach 275 m at the final point.

5.2.3.3 Geological sections made within the project area

First of all, foothills part of this section there are several deep (more than 6,0 m) cuts and several high embankments (more than 6,0 m).

Deep cut section in the first part are located at:

- between km 2+440– 2+880 max depth is 28,3 m
- between km 3+320– 4+420 max depth is 27,7 m
- between km 5+200– 5+900 max depth is 20,7 m
- between km 6+180– 6+340 max depth is 17,3 m
- between km 7+380– 7+000 max depth is 20,1 m
- between km 7+380– 8+760 max depth is 19,6 m
- between km 9+200– 9+560 max depth is 18,8 m

High embankment in the first part are located at:

- between km 4+680 – 4+920 max. height is 7,7 m
- in the vicinity of Bridge No. 1 (km 6+083 - 6+150) max. height is 17,1 m
- between km 7+080 – 7+300 max. height is 22,9 m
- between km 8+900 – 9+080 max. height is 11,3 m
- between km 10+420 – 10+640 max. height is 8,3 m
- between km 11+240 – 11+400 max. height is 13,7 m

The majority of the second part of the highway (LOT-1) is constructed generally close to the current surface or with 3-6 m high embankment on average. There are only short sections where the road is running in deep (more than 3 m)cut.

Cut sections are located at:

- between km 2+700 – 3+360 max depth is 4,5 m

In the design phase the cross sections were plotted at 20 m intervals along the road profile.. According to the preliminary design embankment slopes are generally to be 1:1,5 (H:V).

5.2.3.4 Tectonics and seismicity

The study area of the object and surrounding area (50 km radius around the research object) includes three major tectonic units and five sub zones of the Caucasus: Greater Caucasus fold-thrust belt, (Southern Slope zone of Greater Caucasus); Transcaucasian intermountain lowlands (Kura foreland); Lesser Caucasus (Achara-Trialeti fold-thrust mountain belt, Artvin- Bolnisi block, Loki-Garabagh zone).

The significant seismicity of the investigation territory is manly linked to the block structure of earth crust and the seismic activities of the eastern ending of the Adjara-Trialeti mountain belt and Artvin-Bolnisi block (especially of Khrami-river basin).

According to the acting normative document in Georgia PN 01.01-09 - "Earthquake Engineering" (Georgian building code, 2009) the design object is located in the MSK intensity VIII seismic zone with the maximum horizontal acceleration value 0.18 g. However, modern investigation of probabilistic seismic hazard based on international standards (for example, the EMME project of the Global GEM Program) have shown that the acting normative seismic hazard map of Georgia (PN 01.01-09 "Earthquake Engineering") (especially by PGA) is not correct and significantly decreases the real expected seismic hazard in terms of PGA. Thus, before establishing new norms like Eurocodes it is important to evaluate PGA and SA values individually for each significant object.

According to the above said the investigation area is considered as the territory, the boundaries of which are 50 km far from the location of the design object and covers every main seismically active zone of the above mentioned morphological elements

To establish regularities of seismicity in the investigated aAccording to the above said the investigation area is considered as the territory, the boundaries of which are 50 km far from the location of the design object and covers every main seismically active zone of the above mentioned morphological elementsrea, primarily on the basis of seismic database of the M. Nodia Institute of Geophysics, TSU the following catalogues and sets were compiled: 1) catalog of all fixed earthquakes; 2) catalog of moderate and strong earthquakes *M*S>3.5 in the same period; 3) catalog of macroseismic data of strong earthquakes and set maps of isoseismals; 4) catalog of parameters of active faults, and 5) set models of the equation of predicting strong motions (GMPE models).

On basis of these data, the maps of epicenters were constructed for investigated area in whole and around object with the average radius 20 km. They show the density of distribution of earthquakes of various magnitudes. There are presented all earthquakes from the pre-instrumental period to 2018 that are indicated in catalogs. For moderate and strong earthquakes (MS>4.5) the date of occurrence is also indicated.

Figure 5.2.3.4.1. Map of moderate and strong earthquakes epicenters (*M*S>3.5).

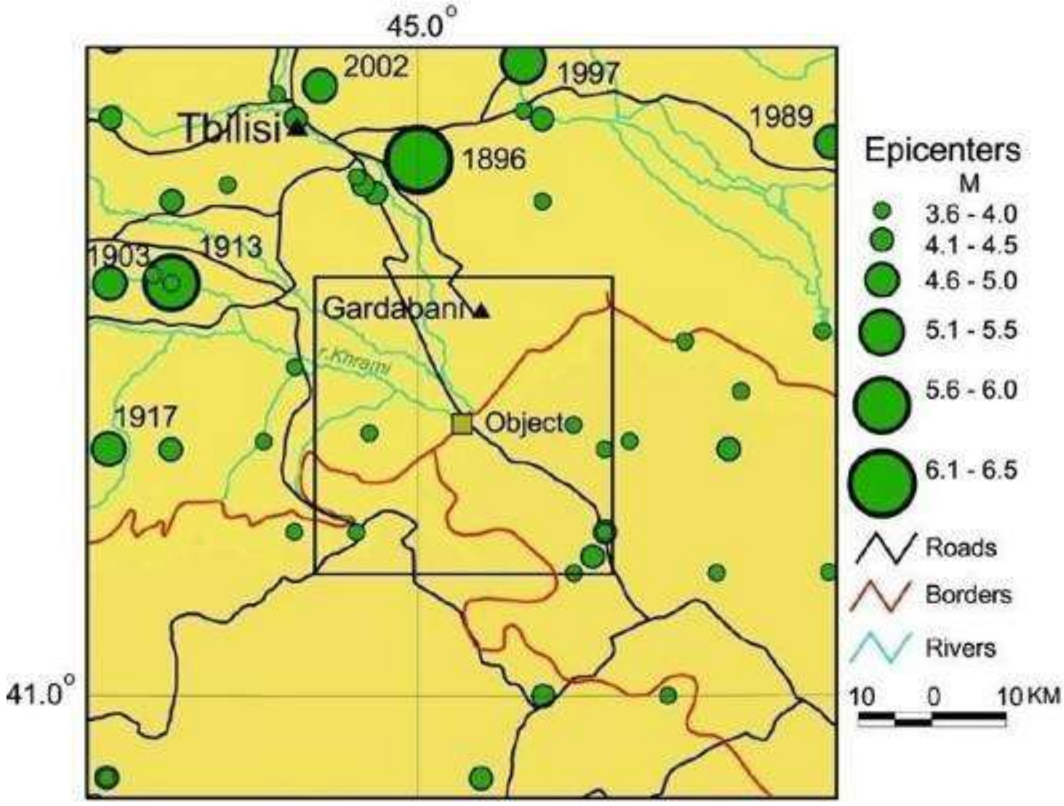
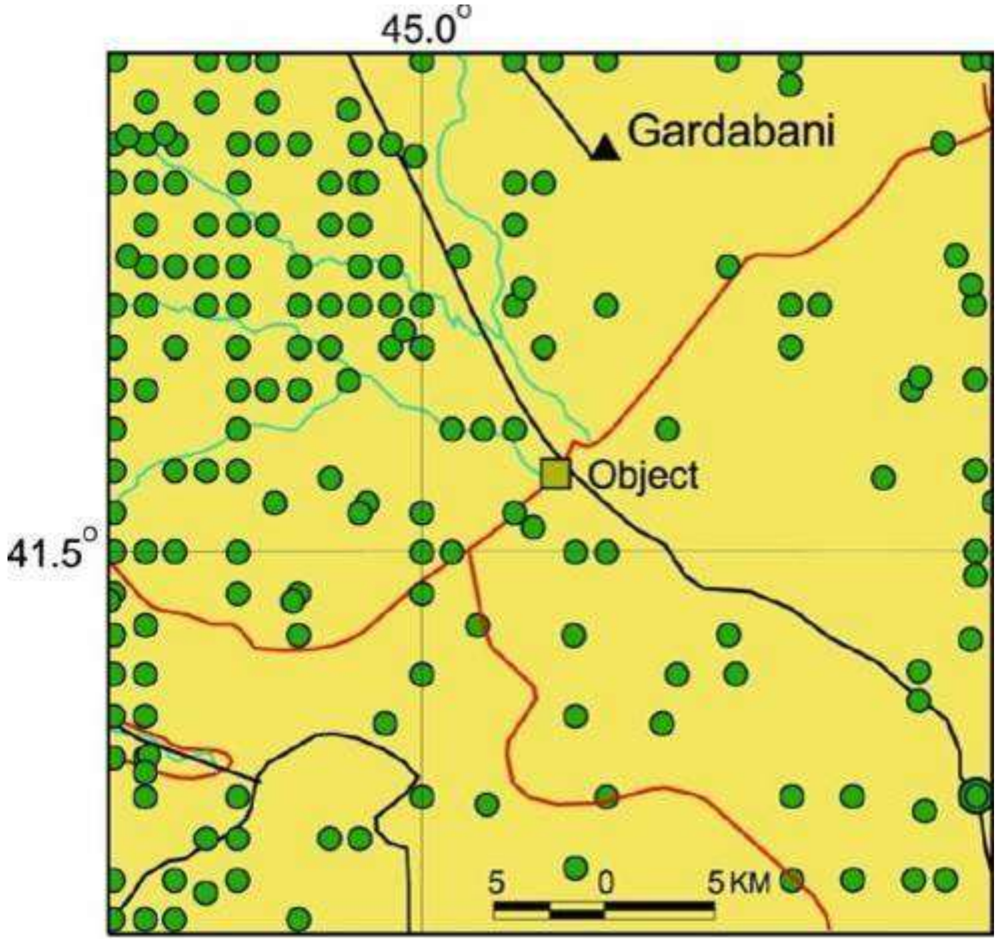


Figure 5.2.3.4.2. Map of all fixed earthquakes epicenters near the investigated object



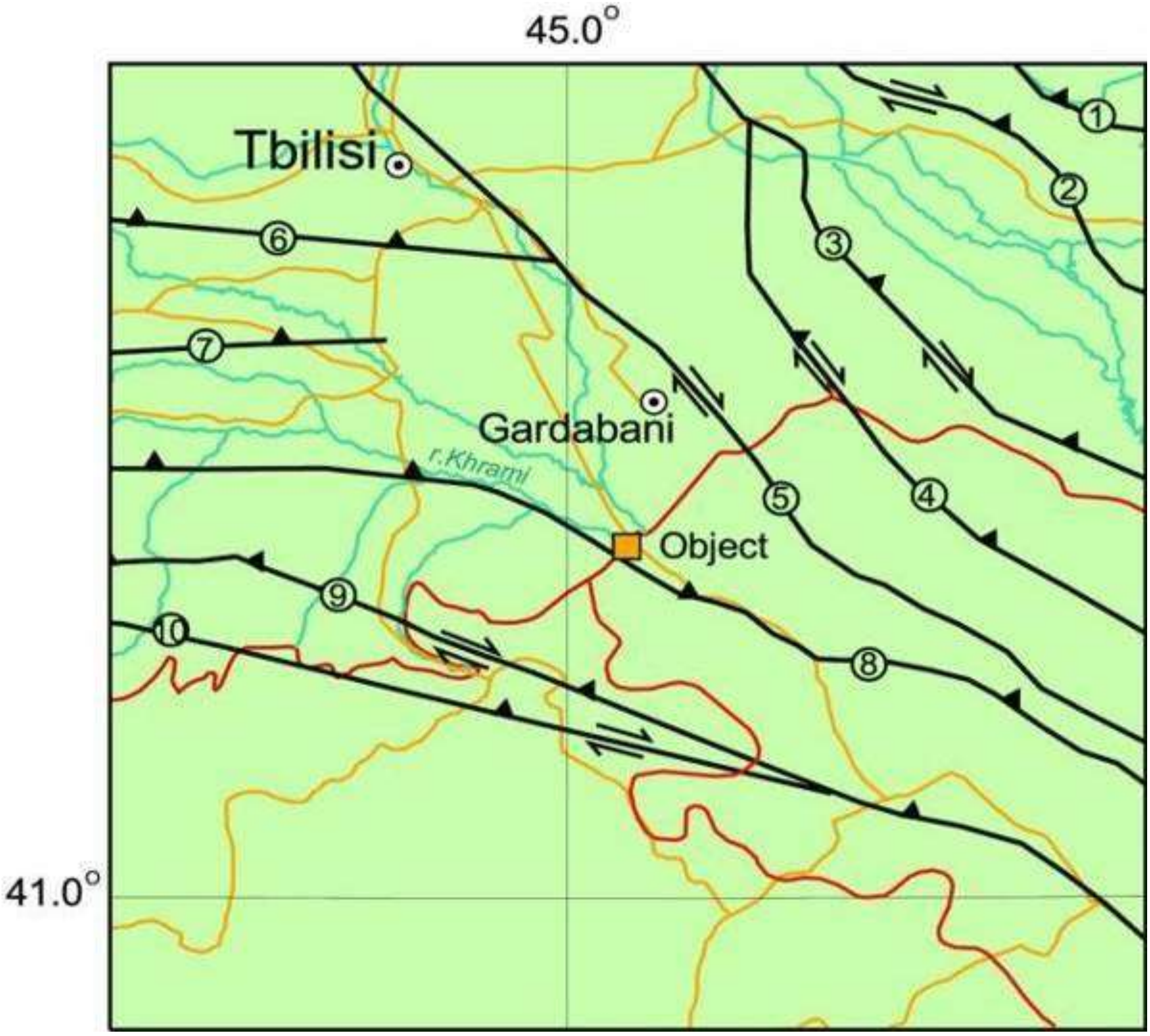
Analysis of obtained maps show seismological condition of the investigated area. In particular, according to a map of moderate and large earthquakes epicenters, the whole area is covered with earthquake epicenters with various densities. The most concentration areas of epicenters are observed in the north-western segments of the area, which is connected to the eastern edge of Adjara-Trialeti Mountain Belt and Artvin-Bolnisi block. It is noteworthy that the strongest historical earthquakes have great influence on the seismicity of the region, especially when considering the seismicity of the building territory of the object.

5.2.3.4.1 Seismically active faults and seismic source zones (SSZ) of the area

Detail seismic investigation of the given area requires the study of seismotectonic conditions regularities. The result of such investigation is separation of seismic source zones (SSZ). The methods of SSZ division, used in this work (Varazanashvili, 1989, 1998), based on the wide range of geological-geophysical and seismological data. Its conceptual base is complex block structures of the earth crust of Georgia territory. Continuous deformation caused by endogenous process takes place in the earth crust. In this condition the inhibition of block relative motion take place on some transition zones of blocks. This causes the creation of the areas, where the elastic potential energy is accumulated. This energy can be released by the sudden rapture or by the earthquake. Very important is specify the spatial location of intrablock transmission zones to establish the SSZ or potential places caused strong earthquakes. To solve this problem it is essential to have data of active faults for investigatedarea.

The area considered in this report 10 relatively large seismically active faults (fault zone, FZ) revealed on the basis of geological, geophysical, morphological and seismological data (Fig. 5.2.2.2.1.2.). Here is a list of fault zones (FZ) passing through the territory of Georgia (G), Azerbaijan and Armenia and numbered from 1 to 10: Orkhevi (G1), Eldari (G2), Taurtepe (G3), Udabno (G4), Tbilisi (G5), Teleti (G6), Khrami North (G7), Khrami South (G8), Loki North (G9), Dmanisi (G10). Brief description of the mentioned faults is set out below by Adamia et al. (2008) and Sesetyan et al. (2017).

Figure. 5.2.3.4.1.1. Seismically active faults zones (FZ) of the investigation area



Conclusion and recommendations

During past historical period the highest seismicity (intensity 6-8 MSK) on the territory of the object were formed by the strongest earthquakes of regional type. While weak instrumental earthquakes near the object confirm the modern seismic activity of this area.

10 seismically active faults have been studied for determining regularities of the seismotechtonic conditions or for allocation of seismic source zones (SSZ). They were identified using geological, geophysical, geomorphological and seismologicaldata.

Using active faults, identified by complex data, map of seismic sources zones has been created, which describes potential seismic capabilities of the area. 10 SSZ were allocated in the region, which were differentiated with six magnitude ranges and 0.5 steps (5.0≤Mmax≤7.5). SSZ parameterization was done.

Seismic hazard analysis for the study area was done using probabilistic methods for peak ground acceleration (PGA) and spectral acceleration (SA) with a period of 0.2, 1 sec, at rock (VS30=905 m/sec), to 1000 year recurrence period and 75 year waiting time. For calculations well known European and USA software (OPENQUAKE and EZ-FRISKTM) were used.

Probabilistic values of ground motion PGA for horizontal and vertical components, which correspond to 1000 year recurrence period, in 75 year waiting time, were (see table 2): at rock: PGAH=0.37 g, PGAV=0.28 g.

For study area magnitude-distance deaggregation results for 1000 year recurrence period (75 year waiting time) is given in table 3. The deaggregated results (see Table 3) of probabilistic hazard assessment have shown that main contribution in seismic hazard is (for PGAH) from earthquakes with magnitude MW=5.7 (MS=5.4) from the mean distance around 27 km (this distance includes the nearest zone and SSZ #3, 7 and 8), and for PGAV is from earthquakes with magnitude MW=5.1 (MS=4.5) from the mean distance around 14 km (in the main SSZ #7 and 8), forrock.

The deterministic assessment of seismic hazard are estimated for fractile 0.5, for the largest magnitude in each SSZ at its closest distance to the object. The high seismic hazard (0.444 g PGAH and 0.336 g PGAV) on the object is possible from the #8 SSZ, where the object is located and south-west of the object, at a distance of about 2 km, there is Khrami South seismically active fault. #3, 7 and 10 SSZ, also can cause the significant seismic hazard (0.077-0.143 g PGAH and 0.058-0.108 g PGAV).

According to EUROCODE 8, obtaining of the specific response spectrum should be based on the paragraph 3.2.2.5 of EC8 EN 1998-1.2004, using q behavior coefficient, which in its turn, depends on the construction design of road buildings (bridge)and should be considered while working on the construction part of theproject.

5.2.3.5 Hydro-geology

According to the hydro-geological zoning of Georgia (I. Buachidze, 1970), the project highway corridor belongs to the Marneuli-GARDABANI artesian basin ($III1^2$).

Considering the geological characteristics, groundwater flow generally occurs within the quaternary alluvial-proluvial deposits - shingle, conglomerates, sands, sandstones, loamy clays, as well as from the water-bearing horizons containing modern alluvion formations. The springs associated with these deposits are mainly of a low yield. The underground water currents circulate in the packs of Old Quaternary formations mainly to the depth of 20 m, which are mainly formed at the expense of the irrigation systems.

With their chemical composition, the waters of the Old Quaternary deposits are sulfate-hydrocarbonate calcium-sodium-manganese, with their general mineralization varying within the limits of 1.0-10.0 g/l and wihtin the limits of 0.5-1.5 g/l in modern deposits.

The ground water within the scope of the project corridor flows through the alluvial-prolluvial deposits of the Quaternary Age as per the geological plan. There are more than one water surfaces fixed along the study section. Due to the content of silt and clay in the layer, the ground waters outcrop and established levels differ from one another.

Generally, as per the common practice, maximum ground water level may be said is 2 m higher than the ground water level measured during the low-water period.

Particularly noteworthy is the situation in the vicinity of the water flowing near Mtkvari River. As a rule, the level of Mtkvari River influenced the ground water level. Generally, during the river low-water, the ground water is absorbed by the river and during the abundant-water periods, the ground water is accumulated. The studies on the site were accomplished during the low-water period of the river and during the season of a low ground water level. Ground water flows along the river current. In the abundant-water period of the river, the ground water level may much exceed the fixed level.

Ground water outcropped in all boreholes provided along the study section.

Table 5.2.3.5.1. Topographical data of ground waters

Borehole No.	Ch.	From Center aligment, m		From Center aligment, m		Height, m	Ground water level (established), m	Height, m
		Left side (LHS) m	Left side (LHS) m	x	y	z		
31	0+920		49.6	497184,0	4600946,0	368,0	8,0	360,0
1	1+555		8.00	497504,0	4600392,0	381,0	11,5	369,5
3	1+715		5.00	497583,0	4600260,0	383,0	6,2	376,8
25	2+640	56.00		498037,0	4599434,0	437,0	-	
6F	3+680		11.70	498305,0	4598449,0	443,0	-	
5F	3+700	15.00		498336,0	4598449,0	445,0	-	
12F	3+700	15.00		498336,0	4598449,0	445,0	16,8	428,2
7F	3+700	98.00		498403,0	4598497,0	449,0	-	
9F	5+123	37.00		499085,0	4597235,0	442,0	-	
4F	5+123		173.00	498888,0	4597164,0	441,0	12,6	428,4
1F	5+134		43.00	499014,0	4597197,0	433,0	-	
30	5+911		47.00	499190,0	4596451,0	450,0	11,0	439,0
11F	6+518		40.00	499276,0	4595852,0	494,0	14,9	479,1
10F	6+523		90.00	499227,0	4595843,0	500,0	-	
2F	6+526		35.00	499282,0	4595847,0	494,0	12,6	481,4
2	7+89.00		10.00	499334,0	4595287,0	462,0	8,5	453,5
24	7+150		2.00	499340,0	4595240,0	456,0	15,2	440,8
4	7+194		1.80	499334,0	4595192,0	447,0	2,5	444,5
5	7+253		3.00	499333,0	4595122,0	451,0	8,0	443,0

7	7+312	1.00		499337,0	4595062,0	468,0	20,8	447,2
3F	7+515	224.0		499548,0	4594852,0	483,0	20,8	462,2
32	8+656		4.5	499420,0	4593728,0	456,0	-	
8F	9+280	215.00		499778,0	4593119,0	404,0	2,8	401,2
33	10+568		20.00	499176,0	4591907,0	381,0	4,6	376,4
8	11+404		2.00	498660,0	4591263,0	371,0	2,8	368,2
6	11+925		1.30	498343,0	4590879,0	372,0	-	
34	12+886		13.00	497683,0	4590139,0	358,0	5,7	352,3
35	14+413		16.00	497017,0	4588772,0	334,0	7,7	326,3
10	15+795		13.00	496965,0	4587393,0	316,0	2,2	313,8
36	16+200		7.00	496996,0	4586990,0	322,0	8,5	313,5
9	17+467		10.00	497092,0	4585725,0	322,0	4,4	317,6
11	17+785		14.50	497115,0	4585408,0	311,0	0,5	310,5
16	17+840		20.00	497118,0	4585352,0	311,0	3,0	308,0
19	18+565		117.00	497198,0	4584610,0	320,0	-	
37	19+43		117.00	497496,0	4584214,0	320,0	4,0	316,0
22	19+580		206.00	497588,0	4583715,0	319,0	11,4	307,6
38	20+660		3.50	498537,0	4582996,0	315,0	3,8	311,2
26	0+573	8.00		499311	4582508	311.0	15.0	296.0
39	2+105	CL	CL	500596	4581684	307.0	6.2	300.8
40	3+424		1.00	501791	4581127	306.0	3.4	302.6
41	4+587		6.00	502884	4580727	306.0	3.6	302.4
27	5+574	108.00		503779	4580358	304.0	8.2	295.8
42	6+545	34.00		504428	4579565	306.0	no	
43	7+580	33.00		504971	4578691	312.0	no	
44	8+615	12.50		505519	4577804	319.0	no	
45	9+520	24.00		505820	4576943	320.0	no	
28	10+725		28.00	505730	4575737	268.0	2.8	265.2
29	10+895	3.50		505762	4575564	272.0	11.0	261.0

5.2.3.6 Engineering Geological Survey

Geotechnical and geological investigations were implemented to obtain actual geological conditions to be applied at the detailed engineering design phase of the project...

The study area at the time of field investigation included different elevations to analyze the soil formation, type and sustainability.

In the first part according to the site investigation some fragmentary layer covered the clay and silt soil layers situated close to the surface. Below the cohesive soils Miocene conglomerate and sandstone occurred down to the bottom of the boreholes.

In the second part, at the plain area the formation within the depths of the drilled boreholes in the upper part consists mostly of Clay and Silt blended with stone forming the hard strata to the full depth of exploration. The lower layers are rather sedimentary sandy gravel and gravelly sand, containing some silt and clay.

During the design phase, detailed soil investigation, geo-physical survey, Bore Holes and Trial pits were executed.

The Geotechnical investigations were done in three stages:

a. *Engineering Geological Survey*

A review of the project area was completed at detailed design to support the feasibility stage in assessment of the main geological hazards of the project

- Faults and discontinuities, shear zones
- Landslides and indication of slope instability
- Erosion, water ingress, water flows, permanent water table
- Evidence of seismic hazards

b. *Geotechnical investigation at the detailed design study stage*

- Cored boreholes, report nr. 5334, by M/s Sak& Co, dated July 2017 Geophysical survey in the LAGHUJA ridge

c. *Geotechnical investigation at Detailed Design stage*

A second investigation campaign was launched in November 2017 and February 2018 and Boreholes were drilled at critical embankment and bridge locations.

The next part is dealing with the third (c) stage of site exploration. The previous stages (a and c) were detailed in the Feasibility Study issued on November 13. 2017.

In order to investigate soil conditions, 12 pc boreholes were drilled to a depth of 10.0and 25.0 m. Drilling works were carried out by drilling rig “UGB-1-vs”, mechanical core drilling, diameter 160 mm, without washing, reduced runs and continuous extraction of core, using pipe casing. The total linear measurement of the boreholes was140m, the average length was 11,7m. The location data for the boreholes were as follows:

Table 5.2.3.6.1. Topographical data of boreholes within the foothills area

Borehole No.	Ch.	From Center aligment, m		Coordinates m		Elev. m	Depth	Elev. m bottom
		Left side (LHS) m	Right Side (RHS) m	x	y	z		
31	0+920		49.6	497184.0	4600946.0	368.0	10.0	358.0
1	1+555		8.00	497504.0	4600392.0	381.0	14.6	366.4
3	1+715		5.00	497583.0	4600260.0	383.0	15.0	368.0
25	2+640	56.00		498037.0	4599434.0	437.0	30.0	407.0
6F	3+680		11.70	498305.0	4598449.0	443.0	30.0	413.0
5F	3+700	15.00		498336.0	4598449.0	445.0	29.0	416.0
12F	3+700	15.00		498336.0	4598449.0	445.0	26.0	419.0
7F	3+700	98.00		498403.0	4598497.0	449.0	28.0	421.0
9F	5+123	37.00		499085.0	4597235.0	442.0	28.0	414.0
4F	5+123		173.00	498888.0	4597164.0	441.0	30.0	411.0
1F	5+134		43.00	499014.0	4597197.0	433.0	16.4	416.6
30	5+911		47.00	499190.0	4596451.0	450.0	20.0	430.0
11F	6+518		40.00	499276.0	4595852.0	494.0	25.0	469.0
10F	6+523		90.00	499227.0	4595843.0	500.0	25.0	475.0
2F	6+526		35.00	499282.0	4595847.0	494.0	30.0	464.0
2	7+89.00		10.00	499334.0	4595287.0	462.0	30.0	432.0
24	7+150		2.00	499340.0	4595240.0	456.0	29.0	427.0

4	7+194		1.80	499334.0	4595192.0	447.0	24.0	423.0
5	7+253		3.00	499333.0	4595122.0	451.0	24.0	427.0
7	7+312	1.00		499337.0	4595062.0	468.0	30.0	438.0
3F	7+515	224.0		499548.0	4594852.0	483.0	30.0	453.0
32	8+656		4.5	499420.0	4593728.0	456.0	8.0	448.0
8F	9+280	215.00		499778.0	4593119.0	404.0	15.0	389.0

Table 5.2.3.6.2. Topographical data of boreholes within the plain area

Borehole No.	Ch.	From Center alignment, m		Coordinates m		Elev. m	Depth	Elev. m bottom
		LHS m	(RHS) m	x	y	z		
33	10+568		20.00	499176.0	4591907.0	381.0	10.0	371.0
8	11+404		2.00	498660.0	4591263.0	371.0	15.0	356.0
6	11+925		1.30	498343.0	4590879.0	372.0	15.0	357.0
34	12+886		13.00	497683.0	4590139.0	358.0	10.0	348.0
35	14+413		16.00	497017.0	4588772.0	334.0	10.0	324.0
10	15+795		13.00	496965.0	4587393.0	316.0	14.0	302.0
36	16+200		7.00	496996.0	4586990.0	322.0	10.0	312.0
9	17+467		10.00	497092.0	4585725.0	322.0	15.0	307.0
11	17+785		14.50	497115.0	4585408.0	311.0	20.0	291.0
16	17+840		20.00	497118.0	4585352.0	311.0	20.0	291.0
19	18+565		117.00	497198.0	4584610.0	320.0	19.0	301.0
37	19+43		117.00	497496.0	4584214.0	320.0	10.0	310.0
22	19+580		206.00	497588.0	4583715.0	319.0	17.0	302.0
38	20+660		3.50	498537.0	4582996.0	315.0	10.0	305.0

5.2.3.6.1 Engineering Geological Survey by CPTu Sounding

CPT sounding is a cost-effective, reliable and environmentally friendly in-situ method of determining the physical characteristics of subsurface soils. The sounding operations were carried out in December, 2018.

Static (CPT) soundings were performed in accordance with DIN Standard 4094-1:2001-6 conforming to EN ISO Standard 22476-1:2013.

During the CPT measurement, a cone on the end of a series of rods was pushed into the ground with constant intrusion velocity and continuous measurements were made of the resistance to penetration of the cone against the surface of the sleeve. A piezo-cone, was used at every exploration in this project, and this measured pore pressure. The total force acting on the cone divided by the projected area of the cone produced the cone resistance. The total force acting on the sleeve, divided by the surface area of the sleeve produced the sleeve friction.

Many factors influence CPT profiles, including physical cone properties, vertical effective stress, pore pressure, soil compressibility and fabric, and depositional characteristics.

The CPT used at the project site was mounted on a 24 ton weight truck and consisted of a 36 mm diameter rod with surface area of 15 cm2and a 60-degree-apex-angle cone at the base.

The cone is equipped with electronic load cells that measure both point resistance and frictional resistance between the soils and the cylinder side of the cone. The truck consists of the following elements:

- Thrust Machine: Apparatus providing thrust to the coiled push rod system so that the required constant rate of penetration is controlled;
- Reaction Equipment: Reaction for the thrust machine (24 ton weight CPT truck);
- Push Rod System: Thick-walled cylindrical tube used for advancing the penetrometer to the required test depth added in 1-meter increments until the physical limitations of the system are exceeded due to site conditions;
- Piezocone Penetrometer: Cylindrical terminal body mounted on the lower end of the push rods, including a cone, a sleeve, a filter, and internal sensing devices for the measurement of cone resistance, sleeve friction, pore pressure, and inclination; and
- Measuring System: Apparatus and software, including sensors, data transmission apparatus, recording apparatus, and data processing apparatus.

The major application of the CPT is soil profiling and classification. Typically, the cone resistance, (qc) is high in sands and low in clays, and the friction ratio Rf is low in sands and high in clays. CPT classification charts cannot be expected to provide accurate predictions of soil type based on grain size distribution but provide a guide to the mechanical characteristics of the soil, or the soil behavior type (SBT). CPT data provides a repeatable index of the aggregate behavior of the in-situ soil in the immediate area of the probe. Hence, prediction of soil type based on CPT is referred to as soil behavior type (SBT).

Usually, correlations use the basic CPT parameters of cone resistance (qc) and friction ratio (Rf). The friction ratio is expressed in percent and calculated by using the following equation:

$$Rf = f_s/q_c*100$$

Where:

Rf = Friction ratio

fs = Sleeve friction resistance

qc = Tip resistance

The collected data is presented in a graphical format as shown in Appendix4. The logs present soil parameters versus depth below ground surface in meters, and include:

- cone tip resistance plot in MN/m^2,
- friction sleeve resistance plot in MN/m^2,
- friction ratio plot in percent (%), and
- pore pressure in MPa (where applicable).

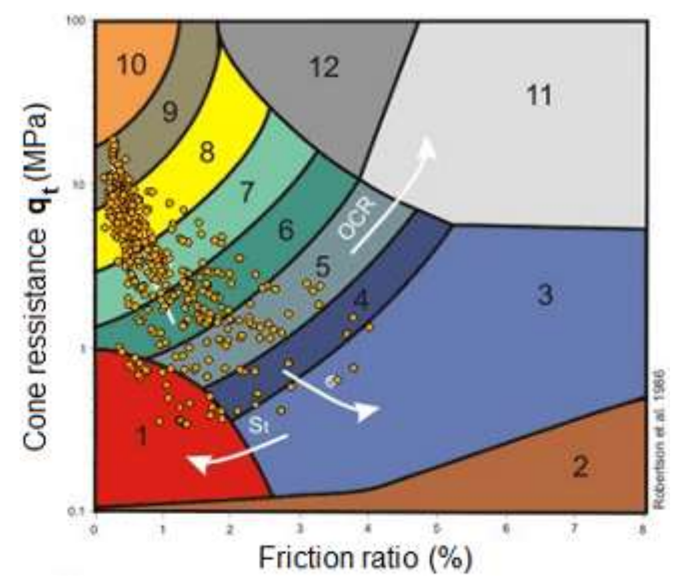
Measuring these parameters, the ratio of sleeve friction resistance and tip resistance can be calculated. This friction ratio (fs/qc×100) is also drawn. Empirically, the type of the soil can be determined:

- sand: $f_s/q_c \approx 1$ %,
- silt $f_s/q_c \approx 2{,}5$ %,
- clays $f_s/q_c > 4$ %

The Standard of Eurocode 7 was used for evaluating the CPT sound diagrams as well as the international literatures and experience2.

The soil classification according to CPT results are presented in the figure below.

Figure 5.2.3.6.1.1 The soil classification according to CPT results



Zone	Soil Behavior Type
1	Sensitive fine grained
2	Organic material
3	Clay
4	Silty Clay to clay
5	Clayey silt to silty clay
6	Sandy silt to clayey silt
7	Silty sand to sandy silt
8	Sand to silty sand
9	Sand
10	Gravelly sand to sand
11	Very stiff fine grained*
12	Sand to clayey sand *
* Overconsolidated or cemented soil	

Table 5.2.3.6.1.2 Topographical data of CPTu tests

CPTu No.	Ch.	From Center aligment, m		Coordinates m		Elev. m	Depth	Elev. bottom [m]
		Left side (LHS) [m]	Right Side (RHS) [m]	x [m]	y [m]	z [m]	[m]	
1	1+730	35.00		497627	4600262	381.0	20.20	360.8
2	1+730		18.00	497579	4600239	386.0	20.10	365.9
3	2+636		52.00	497925	4599415	440.0	30.16	409.8
54	4+956		4.00	498985	4597375	438.0	16.48	421.5
55	6+00		2.00	499246	4596370	444.5	9.48	435.0
4	7+54	CL	CL	499347	4595322	472.0	16.00	456.0
8	7+120		63.00	499280	4595257	451.0	5.35	445.7
5	7+140	CL	CL	499343	4595238	456.0	2.52	453.5
9	7+160	56.00		499398	4595210	453.0	4.77	448.2
10	7+249	66.00		499405	4595126	447.0	8.61	438.4
6	7+258		4.00	499332	4595118	451.0	8.65	442.4
7	7+310		14.50	499320	4595067	465.0	14.30	450.7
11	357		8.00	498684	4591295	366.0	6.51	359.5
12	11+870		13.00	498345	4590910	373.0	13.65	359.4
13	15+540	CL	CL	496952	4587649	318.0	15.21	302.8

[1] with special regards to: Swedish Geotechnical Institute (1995)- The CPT test (Information 15E); T. Lunne, P.K. Robertson, J.J.M. Powell: Cone Penetration Testing in Geotechnical practice (Blackie Academic); P.R. Robertson: Soil classification by the cone penetration test (Can. Geotechn. J. 27: 151-158)

14	15+637	CL	CL	496961	4587552	316.0	15.29	300.7
15	15+740	CL	CL	496969	4587450	316.0	10.12	305.9
16	15+800	CL	CL	496974	4587391	316.0	15.26	300.7
17	15+900	CL	CL	496982	4587289	316.0	15.26	300.7
18	15+960	CL	CL	496985	4587230	318.0	15.16	302.8
19	16+120	CL	CL	497000	4587073	322.0	15.18	306.8
20	17+520			497108	4585674	322.0	15.10	306.9
21	17+786		14.00	497116	4585410	311.0	20.11	290.9
22	17+786	19.50		497150	4585412	311.0	20.05	291.0
23	17+840		15.00	497122	4585357	311.0	20.09	290.9
24	17+840	21.00		497158	4585360	311.0	20.04	291.0
25	18+976		2.00	497465	4584273	320.0	17.49	302.5
26	19+490		16.00	497716	4583820	319.0	16.28	302.7
27	19+550	13.50		497773	4583790	319.0	16.75	302.3
56	19+610		650.00	497154	4583621	320.0	15.05	305.0

5.2.3.6.1.1 Values derived from CPT

Due to the relatively high sand content of the soil layers some informative soil parameters may obtain from the cone resistance (q_c) of the CPT tests according to the EN 1997-2:2008

Table 5.2.3.6.1.1.1. Derivation of the effective friction angle (ϕ) and drained Young modulus of quartz & feldspar sands from the tip resistance (qc) of pressure sounding (example)

Density index	q_c (MPa)	Effective friction angle[a] ° (degree)	Drained Young modulus[b] E, (MPa)
Very loose	0.0 – 2.5	29 – 32	< 10
Loose	2.5 – 5.0	32 – 35	10 – 20
Medium dense	5.0 – 10.0	35 – 37	20 – 30
Dense	10.0 – 20.0	34 – 40	30 – 60
Very dense	> 20.0	40 – 42	60 – 90

[a] - Values given are valid for sands. For silty soil a reduction of 3° should be made. For gravels 2° should be added.

[b] - E, is an approximation to stress and time dependent secant modulus. Values are obtained for drained modulus corresponding to settlements for 10 years. They obtained assuming that the vertical stress distributions follow the 2:1 approximation.
Furthermore, some investigations indicate that these values can be 50% lower in silty soil and 50% higher in gravelly soil. In over-consolidated coarse soils, the modulus can be considerably higher. When calculating settlements for ground pressures greater than 2/3 of the design bearing pressure in ultimate limit state, the modulus should be set to half of the values given in this table.

5.2.3.6.1.2 Empirical soil parameters

Shear strength and compression tests were performed on undisturbed core samples of the cohesive soils. For the determination of internal friction angle, cohesion and bulk modulus can be used the following relationships based on the results of other laboratory tests (Atterberg limits):

- **Internal friction angle and cohesion in case of cohesive soils**
  The shear parameters of the cohesive soil were calculated from the index of plasticity (PI) and from the relative consistency (CI). The following empirical equation can be used for the calculation of the internal friction angle:

ϕ = (30 - 0,4* PI) [°]

- **Compression modulus in case of cohesivesoils**

The modulus of compressibility of the clays can be calculated from the PI and the CI values, using the empirical equation of Kopácsy: Es = CI*(16-0,2*PI) [MPa]

Table 5.2.3.6.1.2.1. Approximate friction angle of cohesive soils

	PI	e	□		
	%		CI ≈ 1,2	CI ≈ 1,0	CI ≈ 0
silty sand, sandy silt	1-10	0.5	28°	28°	24°
		0.7	26°	26°	20°
Silt, sandy clay	10-15	0.5	26°	26°	20°
		0.7	24°	24°	18°
Clay	15-20	0.6	22°	20°	15°
		0.8	20°	18°	12°
	20-	0.7	18°	16°	10°
		0.9	15°	12°	8°

5.2.3.6.2 Engineering-geological Explorations by Trial Pit

Trial pits are carried out in order to recover large bulk samples of soil or if detailed visual examination of the strata is required. The main advantage of this method compared with other site investigation techniques is the relative speed with which the work can be carried out. The disadvantage is the level of surface disturbance and the difficulty in carrying out effective reinstatement of the excavations.

Trial pits are usually carried out when the ground is able to stand temporarily unsupported. Where there is water present in the excavation, problems may be encountered due to instability of the side walls.

The subsurface conditions were assessed in a total of twenty-eight (28) trial pits excavated across the study area, by means of a back actor to depths between 1.60 and 4.10 m. Trial pits were labelled TP1 through TP33.

Alluvial and residual material was intersected across the investigation site. The alluvial material is dominated by clayey soils, gravelly sandy silt, silty sand and gravel, and gravel and stone fragment. The residual material encountered was comprised of gravelly silt and clay.

The positions of the trial pits are indicated on the locality plan presented in attached Layout of LOT-1.

The list of the trial pit coordinates is provided in Table 4-4. The trial pits were profiled according to the method and terminology of Jennings et al (1973). The trial pit profiles and photographic plates are presented in the attachment.

Table 5.2.3.6.2.1. Topographical data of trial pits

Trial pitNo.	C h.	From Center alignment, m		Coordinates m		Elev. m
		Left side (LHS) [m]	Right Side (RHS) [m]	z [m]	**y [∂]**	**z [∂]**
14	0+420	27.00		497038.0	4601425.0	362.0
15	1+430	17.00		497487.0	4600494.0	376.0
17	2+770	9.00		498023.0	4599289.0	420.0
16	2+770	70.00		498023.0	4599289.0	420.0

18	2+770		16.00	497999.0	4599271.0	425.0
8	3+690	53.00		498382.0	4598470.0	
9	3+690	104.00		498408.0	4598507.0	
10	3+720	18.00		498353.0	4598448.0	
11	3+720	CL	CL	498324.0	4598432.0	
19	4+260	6.00		498678.0	4597981.0	443.0
20	4+260	CL	CL	498655.0	4597970.0	442.0
21	4+260		27.00	498628.0	4597952.0	440.0
12	5+150	8.00		499078.0	4597218.0	
23	5+680	CL	CL	499185.0	4596703.0	473.0
22	5+680		20.00	499154.0	4596679.0	467.0
24	5+680		76.00	499123.0	4596667.0	464.0
7	6+440		70.00	499226.0	4595854.0	
4	6+500	CL	CL	499227.0	4595856.0	492.0
31	7+500	30.00		499334.0	4594871.0	492.0
32	7+550	38.00		499378.0	4594852.0	491.0
33	7+520	95.00		499431.0	4594833.0	488.0
1	9+330	135.00		499693.0	4593075.0	
26	10+180	78.00		499461.0	4592203.0	388.0
25	10+180	135.00		499479.0	4592204.0	379.0
27	11+180	35.00		499447.0	4592202.0	388.0
28	11+180	75.00		498839.0	4591390.0	375.0
29	11+180	115.00		498902.0	4591370.0	369.0
30	11+180	150.00		498952.0	4591363.0	367.0

5.2.3.7 Conclusions and Recommendations

The explored soil structure is matched to the formerly described geological conditions. There is no significant geotechnical objection to the building or construction of the road and its engineering structures based upon the preliminary design.

The first part of the studied section (km 0-11) the boreholes encountered middle and upper miocene formations. These formations occurred close to the terrain surface as firm to very stiff medium and high plasticity clay mixed with some gravel and sand, generally till, extending to the full depth of penetration. In the vicinity of the ground water level the condition of the soil becomes into moderately stiff and soft. At some boreholes below the clayey layers sandstone and conglomerate occur. Due to the applied boring technology the degree of the weathering could not be determined accurately.

The bearing capacity of the miocene formation layers generally are excellent however the slope fragmented deposits in the bottom of the valley are weaker, especially if the ground water is occurring as well. Due to the foothills terrain deep cuts and high embankments located within this part requesting special attention during the construction.

Generally the high plasticity clay of the middle miocene formation due to its expansive characteristic is not suitable to use in embankment construction. The upper miocene middle plasticity clay and the weathered conglomerate and sandstone are suitable to embankment construction. The condition of explored soil layers was generally firm and stiff. In some cases, where the weathered layers contained large quantities of cobbles and/or boulders, compaction difficulties may be expected.

The second part of the LOT-1 section (km 11-20) the boreholes encountered alluvial and proluvial deposits. Below the top soil layer medium and high plasticity clay and silty sand was present in stiff and firm consistency. The vertical position of the different type of soils have no specific rules however the sand and gravel content is increasing in the vicinity of rivers, natural cavities, old ravines and gorges.

The bearing capacities of the quaternary deposit layers are adequate to support embankment and engineering structures. Swallow foundation method can be applied at engineering structures (e.g. box culverts, underpasses, etc.) however most of the foundation levels of the structures are beneath embankments.

Generally, the ground water table is not expected to occur within 2 m below the existing surface. However, in the vicinity of the River Algeti and Polit-Arkhi a special case exists and the (ground) water level may exceed the terrain surface.

There is also a locally low section within this part (km 15+440 - 15+960) where the ground water occurred close to the surface. Based on the site exploration soft silty clay layers and some gravel and sand pockets were encountered to bottom depths of site investigations. In the specific notes is discussed in details.

There are no organic soils within this section. The topsoil should be removed within the border of the construction area. The removed topsoil should be deposited in stockpiles for later use according to the soil treatment plan preparing by the Contractor.

The fill of the embankment should be properly compacted. The maximum thickness of a layer of the fill must not exceed 30 cm. The compaction should be carried out by single layer. The requested rate of the density is $T r\gamma$=90%. The density of each layer should be checked according to the approved qualification and sampling plan submitted by Contractor.

It should be noted that effectively, for the cohesive soils, compaction is highly depend on the moisture content of the soil. The best results can be achieved if the moisture content is close to the optimum. Due to the majority of the earthworks being in embankment construction, with the occurrence of only a short section of cutting, acquisition of some material from soil borrow pits will be necessary.

If the earthworks are performed under unfavorable weather conditions, the local installation of different kind of geosynthetics may be necessary in some areas where the ability is important to separate, filter, reinforce, protect, or drain soil layers.

Generally there are two important aspects of implementing geosynthetics in this project:

a.) separate two different layers e.g. subsoil and embankment fill
b.) strengthening the earthworks to be constructed

The required bearing capacity values of the subsoil, of the improved layer and of the subgrade shall be included in the implementation plan. The purpose of the geosynthetics implementation is to resist the shear stresses from the embankment (lateral sliding of embankment) and possibly also shear stresses from the subsoil (extrusion/squeezing).

If an embankment is built on weak subgrade, pore waters in the subgrade are forced to leave by the load, consolidation takes place and the bearing capacity of the subgrade increases. In case of quick construction of the embankment, this pore water pressure is suddenly greatly increased and causes a hydraulic soil break under the embankment and the constructed embankment slips apart.

Embankment foundation is necessary to prevent this type of failure to occur on weak subgrades. To prevent the slipping apart of the embankment body some kind of reinforcement needs to be installed at the bottom of the embankment that will hold it together along the embankment toe.

A structure designed using subgrade parameters, the weight of embankment and its working together with the geogrids and the tensile strength of the geogrid. By default biaxial or triaxial geogrids are used, but for higher loads it may become necessary to use uniaxial geogrids placed perpendicular to the axis of the embankment. Geogrids may be placed at a spacing of max. 40 cm, because in layers exceeding this thickness the arching of aggregate filling material occurs. The solution is acceptable if consolidation in the various phases is not excessive, because the elasticity of the embankment foundation with multilayer reinforcement fully copies the settlements pertaining to the embankment height. This embankment foundation does not reduce settlement.

Road subbase is very sensitive to impacts during construction. Precipitation, drenching and construction traffic, and their combined effects, can cause severe damage. As we know, the subbase is subjected to the greatest load during construction and these loads are not distributed but linear loads, as the construction equipment move on the surface. Therefore the subbase must be designed to consider these impacts and must be reinforced to ensure the underlying subgrade does not suffer any rutting, for slack waters in the rut may cause the quick failure of the substructure of the whole road structure.

- Most suited for subbase reinforcing are biaxial or triaxial geogrids with integral junctions. Obviously the type of fill on the grid is important too. These types of geogrids do not function properly with well graded 0/60 crushed stone. It is important that the so called interlocking effect between the grid and the fill particles is created, i.e. the particles protrude into the openings of the grid and are locked in place.
- Based on the bearing capacity of the subgrade, using design charts, the thickness of subbase course can be determined that will provide the required load bearing capacity on the top of the subgrade.
- In the construction of roads and railroads an important objective is to ensure access to the construction site in all weather conditions. This objective is also met by subbase reinforcement.
- Embankment foundations act on relatively better quality subgrades as subbase reinforcement, because the objective is to increase the bearing capacity of the structure from poor to the generally required value of 40 MPa.
- Subbase reinforcement cannot be discussed without the drainage of the soil structure. New geosynthetic products are gaining ground that can replace drainage blankets and can be connected into vertical drains made of the same or similar materials. With their joint use the drainage of earthworks in cuts or embankments can be properly solved. They ensure both during construction and service that the earthwork will not get drenched through, ensuring that the bearing capacity realized at the construction will be kept up in the long run.
- Subbase reinforcement has a special case when railway ballast is reinforced. Tensar developed a grid type for use in railway ballast reinforcement that doubles the service life of the structure. It is a good idea to use it for new structures because with low extra cost longer service life can be achieved.

Other important are where the geosynthetics are wildly use the slope protection either in cut or embankment. All slope surfaces must be protected against erosion by rainwater. Slope protection basically means sodding, the roots of the grass prevent the washout of soil particles. Artificial protection protects the slope until the roots of the grass are developed. Materials most frequently used are natural, biologically degradable textiles. The geocell described earlier is also capable of erosion control on slope surfaces.

- The type of protection is normally determined by the angle of the slope, but the soil and geometrical location of the slope and rain intensity must also be considered.
- For slight slops jute or coconut shuck protection is sufficient onto which grass seed is sown or grass will grow through it. For steeper slopes some form of spatial geogrid is required that can be filled with humus or even rubble. For even steeper slopes geocell protection is recommended that can be filled with soil, but they are typically filled with stone.

5.2.4 Soil

The soil cover in the project implementation zone is presented by quite diversified types of soil. In the intense land cultivation area, where the longest section of the design corridor must run, there are Cinnamonic grey-brown soils spread. The given soils are fertile and are widely used to grow cereal crops and vegetables.

Along the section running across Iagluja Plateau, dominant are poorly developed, skeletal, often intensely washed away soils of a little thickness with limestones outcropping on the surface. They are characterized by small strength of humus and their density decreases as the soil depth increases.

Along the sections of the highway running near the surface waters, alluvial soils also present.

The main problem with soils is weathering and pollution with different substances.

The reason for this is improper use of inorganic fertilizers, destruction of field protection and wind break belts and faulty operation of irrigation systems on the one hand and wind and water erosion on the other hand.

5.2.5 Hydrology

Rustavi-Red Bridge modernization road runs across Kvemo Kartli Plain, with Iagluja Ridge (Iagluja Plateau) penetrating to it from the west, in the area adjacent to the city of Rustavi. 27 nameless dry gorges crossing the modernization road head on the eastern slope of Iagluja Ridge, which, after crossing the road, run onto the right terrace of the Mtkvari River. The basins and gullies of these gorges, which are clearly shaped on the eastern slope of Iagluja Ridge, after crossing the road merge with the terrace of the Mtkvari River and disappear.

The areas of the water catch basins of the nameless dry gorges running from Iagluja Ridge up to the intersection with the modernization road vary from 0,07 to 8,64 km2, their lengths vary from 0,25 to 6,15 km and the gradients of their beds vary from 29,0 to 20,7‰.

The geology of the nameless dry gorges is presented by the Quaternary deposits, which are covered with loamy soils. The basins of the gorges lack the forest cover and only sparse bushes and grass of the vegetation cover grow in the area.

The gorges are dry for most of the year. Water in the gorge beds appears only during the intense rains and when the low snow cover melts. In addition, the discharges and levels of the freshets caused by intense rains much exceed the discharges and levels caused by snow melting.

The modernization road is also crossed by two large gorges (Saridire and Kovu) and two rivers – the Algeti and the Khrami.

Saridire Gorge heads at 760 m altitude on the southern slope of Iagluja Ridge and crosses the modernization road at 364 m. The area of the water catch basin of Saridire Gorge up to the intersection with the modernization road is 41,2 km^2 and its length is 14,2 km. The gradient of the gorge bed is 27,9‰. The water regime of the gorge is identical to that of the gorges running down Iagluja Ridge. Its bed is dry for most of the year. Water in the gorge bed appears only during the intense rains and when the low snow cover melts. In addition, the discharges and levels of the freshets caused by intense rains much exceed the discharges and levels caused by snow melting.

Kovu Gorge, which runs across the depression plain of Kvemo Kartli Lowland, is the natural water intake of the water drained from the irrigation channels and irrigated areas and as a result its bed is bogged. The area of the water catch basin of Kovu Gorge up to the intersection with the modernization road is 15,0 km^2 and its length is 6,80 km. The gradient of the gorge bed is 9,3‰. Unlike the dry gorges described above, the bogged bed of Kovu Gorge always contains water and as a result, passages of water peak discharges through the Gorge are not excluded during the intense rains.

After crossing the Algeti River, the modernization road forks into Rustavi-Red Bridge and Algeti-Sadakhlo sections.

The Algeti River heads on the eastern slopes of Trialeti Ridge, from the springs at 1900 m altitude and flows into the Mtkvari River from its right side, near village Kesalo. The length of the river is 118 km, its total fall is 1625 m, its average gradient is 13,8‰; the area of the river water catch basin is 763 km^2; the average height of the river basin is 1000 m. The river is flown by 188 tributaries with the total length of 508 km.

The Algeti River is alimented with snow, rain and ground waters. In addition, the role of the ground waters in the river alimentation is very little. The water regime of the River Algeti is characterized by spring flood, summer and autumn freshets and winter instable low-water period. In natural conditions, 44-50% of the annual runoff flows in spring, 20-23% flows in summer, 5-7% flows in autumn and 4-10% flows in winter. The given percentage distribution of the annual runoff is not stable and varies within great ranges. The Algeti River is characterized by catastrophic freshets in its lower course. On May 17, 1966, the stream-risen River Algeti due to the downpour rains flooded the city of Marneuli. More than one hundred people could survive only when helped with helicopters.

In 1983, near village Tbisi, 70 km from the River confluence, a 470-meter-long and 87-meter-high Algeti water reservoir of an irrigation purpose, with total volume of 65,0 mln. m3 and with useful capacity of 60,0 mln. m3 formed with a stone-fill dam was put to operation. The area of the water catch basin of the River in the section of Algeti water reservoir fill is 422 km2. The water reservoir totally regulated the River runoff and changed its water regime in its lower course. In terms of total filing of the water reservoir, the water is expected to be discharged from the dam flood-control outlet with its value equaling 240 m3/sec under the project. The Algeti River is widely used for irrigation.

The River Khrami (Ktsia-Khrami) heads on the southern slopes of Trialeti Ridge, in Javakheti mountains, 2,4 km east of mountain Karakaia (2850,8 m), at the altitude of 2422 m above sea level and flows into the Mtkvari River from its right side, near village Shakhli. The total length of the river is 201 km, its total fall is 2167 m, its average gradient is 10,7‰; the area of the river water catch basin is 8340 km^2. The river is flown by 2234 tributaries with the total length of 6471 km.

The River basin covers the areas in south-east of Georgia and north-western part of Armenia. The relief of the River basin is mountainous and intensely dissected with the gorges of the river tributaries.

In 1947, near settlement Tsalka, in 117 km from the river mouth, a 33,2-meter-high and 113-meter-long Khrami (Tsalka) water reservoir of the power generation and complex purposes formed with a stone-fill dam was put to operation. The total volume of the water reservoir is 313 mln. m^3 and its useful capacity is 293 mln. m^3. The area of the water catch basin of the Ktsia-Khrami River in the section of Tsalka water reservoir is 1045 km^2. Khrami (Tsalka) water reservoir totally regulated the Ktsia-Khrami River runoff in its lower course.

The River is alimented with snow, rain and ground waters. However, the role of the ground waters in the river alimentation is significant only past Tsalka water reservoir, at the expense of Dashbashi springs flowing out of the volcanic slopes of the gorge. In natural conditions, the water regime of the river depends on the alimentation sources and is characterized by one spring flood and low-water periods in other seasons of the year, which in some years may be disturbed by the freshets caused by summer or autumn rains. In natural conditions, 38% of the annual runoff flows in spring, 26% flows in summer, 24% flows in autumn and 12% flows in winter. Past Tsalka water reservoir, the internal-annual distribution of the River runoff totally depends on the amount of water discharged from the water reservoir for power generation purposes. In terms of total filing of Tsalka water reservoir, the water is expected to be discharged from the dam flood-control outlet with its value equaling 500 m^3/sec under the project.

Past Tsalka water reservoir, the River is widely used for power generation and irrigation purposes. The water reservoir supplies regulated water of the River Ktsia-Khrami to Khhramhesi-I (Khrami HPP I) and Khhramhesi-II (Khrami HPP II), as well as Tetritskaro, Bolnisi and Marneuli agricultural plots of field.

In addition to the rivers and gorges described above, Rustavi-Red Bridge modernization road is crossed by the main irrigation channels and their distribution valves. It should be noted that Kvemo Lartli Plain, following its climatic conditions, needs intense irrigation and consequently, there is a very dense network of the irrigation channels developed over Kvemo Lartli plain. The conductivity of the irrigation channels was calculated at the stage of developing the relevant projects, and any passage of water peak discharges capable of threatening the safe operation of the modernization road, is virtually, excluded.

5.2.5.1 Water peak discharges

Dry nameless gullies crossing Rustavi-Red Bridge modernization road and heading on the eastern slope of Iagluja Ridge, are not studied hydrologically. Therefore, the values of their water peak discharges at the crossing points with the rehabilitation road are identified by the method given in “The technical reference to calculate the peak discharges of the rivers in the Caucasus”.

It should be noted that this method yields the water peak discharge values 12-15% higher than the boundary intensity formula given in SNiP 2.01.14-83 (Determination of Design Hydrological Properties), which was deduced for the rivers of the former USSR in the 1960s. The boundary intensity formula does not consider the global climate changes of the recent decades and the resultant increase in the precipitation intensity. This is why it gives lower values of the water peak discharge. By considering the increased intensity of precipitations on the background of global climate changes and increased values of water peak discharge as a result, it was decided to calculate the design values of water peak discharges by using the method referred to in the Technical Reference. This method is well approved in Georgia and as the practical experience suggests, it meets the modern conditions resulting from the climate change.

As per this method, the water peak discharges of the rivers and gorges with the areas of their water catch basins not exceeding 300 km2, are calculated by the following formula:

$$Q = R \cdot \left[\frac{F^{2/3} \cdot K^{1,35} \cdot \tau^{0,38} \cdot \bar{i}^{0,125}}{(L+10)^{0,44}} \right] \cdot \Pi \cdot \lambda \cdot \delta \ \text{m}^3/\text{sec}$$

where R - is a regional parameter. Its value for West Georgia is taken as 1,15.

F - is the area of the water catch basin in the design section, km^2 .

K - is the climate coefficient of the region, whose value is taken from a specially designed map.

τ - is the reoccurrence in years.

$\bar{i}$ - is the balanced gradient of the river or gorge in units from the mouth to the design section.

L - is the length of the river or gorge from the mouth to the design section, km.

Π - is the coefficient characterizing the soil cover in the river basin. Its value is taken from a special map and relevant table.

λ - is the basin forestation coefficient, whose value is calculated with the following expression:

$$\lambda = \frac{1}{1 + 0,2 \cdot \frac{F_t}{F}}$$

where Ft is the area of the basin covered with forest, %.

δ is the basin form coefficient, with its value gained from the expression:

$$\delta = 0,25 \cdot \frac{B_{\max}}{B_{sas}} + 0,75$$

Where $B_{\max}$ is the maximum basin width (km).

B_{Ave} is the average basin width (km), and its value is taken from expression: $B_{Ave} = \frac{F}{L}$.

When calculating the water peak discharges of small gorges with the area of their catch basins less than 5 sq.km, the formula above additionally includes specially designed coefficients relevant to the areas of the catch basin referred below.

F km^2	<1	1	2	3	4	5
K^{I}	0.70	0.80	0.83	0.87	0.93	1.00

The values of the morphometric elements to calculate the water peak discharges of the gorges crossing the modernization road fixed via topographic map scaled 1:25000 and values of water peak discharges (for 200-, 100-, 50-, 20- and 10-year reoccurrences) calculated by the formula above, are referred to in Table 5.2.4.1.1. below.

The runoff of the Algeti River was studied from 1940 through 1986, in the section of Hydrological Station Partkhisi. Hydrological Station Partkhisi was located 78 km from the River estuary. In 1983, as mentioned above, 70 km from the River estuary, Algeti water reservoir was put to operation, which flooded the territory of Hydrological Station Partkhisi and virtually, made the 46-year-long data useless.

Therefore, the water peak discharges of the Algeti River in the section of the modernization road are calculated by using a regional-empirical formula, which was developed for the Algeti River basin at Transcaucasian Scientific-Research Institute of the Hydrometeorology Institute and is published in "The technical reference to calculate the peak discharges of the rivers in the Caucasus".

This regional-empirical formula, which can be used for the rivers with their water catch basins of more than 300 km2, is as follows:

$$Q_{5\%} = \left[\frac{8{,}15}{(F+1)^{0{,}50}} \right] \cdot F \quad \text{m}^3\text{/sec}$$

where F is the area of the water catch basin of the river (km2). In our case, the water catch basin of the River Algeti is taken from Algeti water reservoir dam to the crossing point with the modernization road, i.e. less the water catch basin of the River in the dam section what equals F_{sapr} =763-422=341 km2.

By inserting the area of the river water catch basin in the given formula, we gain the value of the water peak discharge of 5% provision in the area from Algeti water reservoir dam to the intersection with the modernization road. Transition from a 5% provision to other provisions is made with specially designed transition coefficients given in the same Technical Reference.

In addition, it must be considered that in case of total fill of Algeti water reservoir and a freshet formed in its whole basin, the amount of water envisaged by the project will be discharged from the flood-control outlet of Algeti water reservoir, what will be added to the water peak discharge formed from the water catch basin past the water reservoir.

Water peak discharges of the Algeti River in the section of the modernization road, added by the maximum water amount discharged from the water reservoir, are also given in Table 5.2.4.1.1.

The runoff of the Khrami River past Khrami (Tsalka)water reservoir was studied at different times and with different durations, near village Dashbashi, at Khramhesi building (diversion channel), Khramhesi settlement (conductive channel), near village Trialeti, village Kakliani, portal of conductive tunnel, village Tsknari, village Dagetkhachini, village Imiri and near Red Bridge. The observations at the said hydrological stations stopped in the 1990s.

Rustavi-Red Bridge modernization road ends at Red Bridge, with the observations over the peak discharges in its section carried out in a discontinued series for 60 years (1928-35, 1940-91), but the data are officially published only thorough 1986.

In 1947, as it was mentioned above, Khrami (Tsalka) water reservoir was put to operation, which regulated the River runoff in its lower course. Therefore, it was decided to fix the peak discharges of the River Khrami in Red Bridge section from the moment of putting the water reservoir through 1986.

The 40-year-long variation series (1947-86) of the observation data over the officially published water peak discharges of the River Khrami in Hydrological Station Red Bridge section was statistically treated in line with the effective normative documents of Georgia by using the moments, maximum likelihood and graphical-analytical methods.

The parameters obtained by using the moments and maximum likelihood methods were virtually the same. The gained results are given below:

1. By using the moments method: the many-year value of the water peak discharges: $Q_0 = \frac{\Sigma Q_i}{n} =$ 358 m3/sec;

Variation coefficient $C_v = \sqrt{\frac{\Sigma(K-1)^2}{n-1}} =$ 0,66;

The value of the asymmetry coefficient $C_s = 4 \cdot C_v =$ 2,64 was obtained by the nearest conjunction of the theoretical and empirical points on the probability cell.

2. By using the maximum likelihood method: when the variation and asymmetry coefficients are determined by using special nomograms, as the statistical function of λ_2 and λ_3, when $\lambda_2 = \frac{\Sigma \lg K}{n-1}$ and $\lambda_3 = \frac{\Sigma K \lg K}{n-1}$, the following parameters of the distribution curve are obtained:

- Average many-year value of water peak discharges $Q_0 = \frac{\Sigma Q_i}{n} =$ 358 m3/sec;
- Variation coefficient $C_v =$ 0,66;
- Asymmetry coefficient $Cs = 4 C_v =$ 2,64.

The parameters to evaluate the representativeness of the variation series are established: the relative square error of average many-year peak discharge equaling $\varepsilon_{Q_0} =$ 10,4 % and and the relative square error of the variation coefficient $\varepsilon_{C_v} =$ 13,4 % obtained by using the two methods are satisfactory, as under the requirements of the Building Norms and Rules, $\varepsilon_{Q_0} \approx 10\%$ and $\varepsilon_{C_v} \leq 15\%$.

The mean square deviation was also established and it is 236.

The gained parameters of the distribution curve and three-parameter gamma-distribution ordinates were used to fix the values of water peak discharges of the River Khrami of different provisions in the section of H/S Red Bridge.

As the value of the variation coefficient is more than 0,50, the parameters of the distribution curve are also determined by the graphical-analytical method, when the value of the asymmetry coefficient is determined as a function of sloping coefficient S. Its value is calculated as follows:

$$S = \frac{Q_{5\%} + Q_{95\%} - 2 \cdot Q_{50\%}}{Q_{5\%} - Q_{95\%}}$$

As for the average many-year value of the water peak discharges, it is calculated by formula:

$$Q_0^{\ I} = Q_{50\%} - \Phi_{50\%} \cdot \delta$$

Mean square deviation is calculated as follows:

$$\delta = C_v \cdot Q_0{}^I = \frac{Q_{5\%} - Q_{95\%}}{\Phi_{5\%} - \Phi_{95\%}}$$

where $Q_{5\%}$, $Q_{50\%}$ and $Q_{95\%}$ are the values of water peak discharges of 5, 50 and 95% provisions established by means of the empirical curve of provision;

$\Phi_{5\%}$, $\Phi_{50\%}$ and $\Phi_{95\%}$ are the rated ordinates of a binomial curve of 5, 50 and 95% provision.

The calculations with the graphical-analytical method yielded the following parameters of the distribution curve:

Average many-year value of peak discharges $Q_0{}^I =$ 365 m3/sec.

Variation coefficient is $C_v =$ 0,69;

Asymmetry coefficient $C_s =$ 1,90;

Mean square deviation $\delta =$ 251.

The parameters gained by the graphical-analytical method and rated ordinates of the binomial distribution curve were used to fix the peak discharge values of different provisions of the river Khrami in the section of hydrological station Red Bridge. As the theoretical points obtained by using the graphical-analytical method coincide best with the empirical points plotted on the probability cell, the design value of the water peak discharge of the Khrami River in the section H/S Red Bridge is accepted to be the peak discharges obtained with the graphical-analytical method. At the same time, it should be noted that for 70-year-long operation of Khrami water reservoir, water from the dam flood-control outlet has never been discharged and therefore, the amount of water to discharge from the dam flood-control outlet was not considered in the calculations of the water peak discharges.

The values of the water peak discharges of different reoccurrences of the river Khrami in the section of the Red Bridge Hydrological Station are given in Table 5.2.4.1.1.

Table 5.2.5.1.1. Water peak discharges of the rivers and gorges crossing Rustavi-Red Bridge modernization road

Name and number of the river/ gorge	F **km²**	L **km**	i **Bed**	λ	δ	K	Π	K^I	**Peak discharges m³/sec**				
									$\tau = 200$ years	100 years	50 years	20 years	10 years
D-gorge #1	1.03	2.25	0.141	1.00	1.05	4.50	1.00	0.80	13.0	10.8	8.30	5.86	4.51
D-gorge #2	0.69	1.90	0.150	1.00	1.09	4.50	1.00	0.70	9.20	7.67	5.90	4.16	3.20
D-gorge #3	0.90	1.70	0.189	1.00	1.01	4.50	1.00	0.70	10.6	8.81	6.77	4.78	3.68
D-gorge #4	0.24	1.19	0.193	1.00	1.06	4.50	1.00	0.70	4.68	3.90	3.00	2.12	1.63
D-gorge #5	0.27	1.10	0.200	1.00	1.16	4.50	1.00	0.70	5.50	4.56	3.50	2.47	1.90
D-gorge #6	0.16	0.56	0.156	1.00	1.10	4.50	1.00	0.70	3.70	3.08	2.37	1.67	1.28
D-gorge #7	0.56	1.55	0.160	1.00	1.09	4.50	1.00	0.70	8.17	6.81	5.23	3.70	2.84
D-gorge #8	0.28	0.87	0.207	1.00	1.19	4.50	1.00	0.70	5.95	4.96	3.81	2.69	2.07
D-gorge #9	0.15	0.50	0.204	1.00	1.10	4.50	1.00	0.70	3.66	3.05	2.34	1.65	1.27
D-gorge #10	0.34	1.65	0.106	1.00	1.23	4.50	1.00	0.70	6.24	5.20	4.00	2.82	2.17
D-gorge #11	0.081	0.45	0.127	1.00	1.23	4.50	1.00	0.70	2.57	2.14	1.64	1.16	0.89
D-gorge #12	8.64	6.15	0.046	1.00	1.00	4.50	1.00	-	49.4	41.2	31.7	22.4	17.2
Dry gorge #13	0.14	0.65	0.108	1.00	1.04	4.50	1.00	0.70	3.04	2.53	1.94	1.37	1.06
D-gorge #14	0.15	0.40	0.125	1.00	1.02	4.50	1.00	0.70	3.20	2.67	2.05	1.45	1.11
D-gorge #15	3.29	2.70	0.044	1.00	1.13	4.50	1.00	0.88	28.4	23.7	18.2	12.8	9.89
D-gorge #16	0.21	0.70	0.060	1.00	1.02	4.50	1.00	0.70	3.62	3.02	2.32	1.64	1.26

D-gorge #17	0.13	0.45	0.109	1.00	1.03	4.50	1.00	0.70	2.89	2.41	1.85	1.31	1.01
D-gorge #18	0.04	0.20	0.125	1.00	1.00	4.50	1.00	0.70	1.32	1.10	0.85	0.60	0.46
D-gorge #19	0.25	1.20	0.071	1.00	1.11	4.50	1.00	0.70	4.44	3.70	2.84	2.01	1.54
D-gorge #20	0.31	1.65	0.067	1.00	1.08	4.50	1.00	0.70	4.87	4.06	3.12	2.20	1.69
D-gorge #21	0.64	1.90	0.068	1.00	1.12	4.50	1.00	0.70	8.15	6.79	5.22	3.68	2.83
D-gorge #22	0.06	0.38	0.079	1.00	1.07	4.50	1.00	0.70	1.73	1.44	1.11	0.78	0.60
D-gorge #23	0.40	1.40	0.075	1.00	1.18	4.50	1.00	0.70	6.46	5.38	4.14	2.92	2.24
D-gorge #24	0.041	0.25	0.100	1.00	1.00	4.50	1.00	0.70	1.30	1.08	0.83	0.59	0.45
D-gorge #25	0.54	2.05	0.068	1.00	1.08	4.50	1.00	0.70	6.97	5.81	4.47	3.15	2.42
D-gorge #26	0.36	1.05	0.074	1.00	1.11	4.50	1.00	0.70	5.74	4.78	3.67	2.59	2.00
D-gorge #27	0.07	0.45	0.029	1.00	1.07	4.50	1.00	0.70	1.68	1.40	1.08	0.76	0.58
Saridere #28	41.2	14.2	0.028	1.00	1.12	4.50	1.00	-	124	103	79.2	55.9	43.0
R. Kovu#29	15.0	6.80	0.009	1.00	1.00	4.50	1.00	-	57.5	47.9	36.8	26.0	20.0
R. Algeti #30	341	-	-	-	-	-	-	-	565	470	380	285	225
R.Khrami#31	8260	-	-	-	-	-	-	-	1440	1245	1095	860	700

The design water conducting capacity of the structures crossing the water objects envisaged within the limits of Rustavi-Red Bridge Highway is in compliance with the data given in the Table.

5.3 Biological environment

The biological study accomplished in the project corridor of Rustavi-Red Bridge Highway incorporated three components:

1. Study of floristic environment;
2. Study of fauna and assessment of their habitats;
3. Study and assessment of the territories protected by the national legislation and international conventions.

The biodiversity studies were accomplished in several stages, including the preliminary study, which was done at the Scoping stage and detailed study, which was accomplished at the EIA stage. The main accent during the study was made on sensitive species and habitats. Based on the information given in the present paragraph, the impact caused by the construction and operation of the road on the existing habitats/species was assessed.

5.3.1 Flora and vegetation cover

5.3.1.1 General decsription of the vegetation cover

The study area belongs to the geobotanical region of Kvemo Kartli Plain, which covers the territory past the city of Tbilisi (Soganlugi) and is situated on the both banks of the river Mtkvari. It is located between Trialeti Ridge, Somkheti Ridge and Iori Plateau.

A small part of the territory of the region (one of the least regions of East Georgia) is covered with vegetation. In addition, the natural vegetation is intensely transformed under the impact of human activities. This is particularly true with the lowlands, where the natural vegetation was changed by the cultural crops long ago. The vegetation cover spread on the territory of the region, despite its limited area, in respect of its typological structure and history of development, as well as modern successive exchange, is extremely diversified and presents a complex picture.

In a phytocenologic respect, the forest vegetation is diversified. Mountain forests with the dominant monodominant forests of Georgian oak (*Quercus iberica*) and Persian oak (*Quecus macranthera*) are common at the highest elevation.). It is noteworthy that Persian oak descends quite low in the region (like in Eastern Trialeti in general). Hornbeam-oak forests (*Quercus iberica + Carpinus caucasica*) and polydominnat hardwood plantations (*Georgian and Persian oaks, box elder - Fraxinus excelsior, hornbeam - Carpinus caucasica, lime- Tilia begoniifolia, field maple - Acer campestre*) are also common in this area.

Remnants of sparse arid forests have survived on the territory of the region (*mostly in the basins of the rivers Khrami and Algeti*): small plantations of Mt. Atlas mastic tree (*Pistacia mutica*) and hackberries (*Celtis caucasica*) forests. Many species typical to the sparse arid (light) forest are their part: Georgian maple (*Acer ibericum*), Balkan maple (*Acer hyrcanum*), buckthorn (*Rhamnus pallasii*), Christ's Thorn (*Paliurus spina christi*), funtic (*Cotinus coggygria*), sumach (*Rhus coriaria*), Georgian Honeysuckle (*Lonicera iberica*), jasmin (*Jasminum fruticans*), etc..

In the floodplains of the rivers Mtkvari and Khrami, there are remnants of vast floodplain forests (which have survived the destruction): willow forest (Salix excelsa, S. alba, S. pseudomedemii) and poplar-willow forest (*Salix excelsa + Populus canescens + P. nigra*), species common to their phytocenosis (elm - Ulmus minor, common oak - Quercus pedunculiflora, mulberry - Morus alba, gaiter-tree - Svida australis, tamarisk - Tamarix ramosissima, blackthorn - Prunus spinosa, silkvine – Periploca graeca, blackberry - Rubus anatolicus, sea-buckthorn - Hippophaë rhamnoides, traveller's joy - Clematis orientalis, etc.).

Hemicryptophyte and xerophilous bushes grow on the slopes of the hillocks and plateaus. They are presented by many different formations: Bushes of Christ's thorn (*Paliurus spina christi*), bushes of spiraea (*Spiraea hypericifolia*), bushes of buckthorn (*Rhamnus pallasii),* bushes of oriental hornbeam (*Carpinus orientalis*), Mixtofruticeta, etc.

Over the dry eroded slopes, there are bushes of astragalus (*Astragalus microcephalus*) and prickly-thrift (*Acantholimon lepturoides*) spread.

Stepe vegetation is common all over the territory of the region (*plains, plateaus, slopes of the hillocks*), mostly on the Chernozem-like soils. Beard-grass (*Botriochloa ischaemum*) and Artemisia formations-beard-grass (*Botriochloa ischaemum + Artemisia lerchiana*) are widely spread.

Common species in the elevated parts of the area are Bushes of Christ's thorn-beard-grass (*Paliurus spina christi – Botriochloa ischaemum*), feather-grass (*Stipa lessingiana, St. pulcherrima*) and gramineous herb steppe groupings (*Festuca valesiaca, Bromus japonicus, Phleum phleoides, Ph. paniculatum, Cynodon dactylon, Achillea biebersteinii, Filago arvensis, Salvia sclarea, Xeranthemum squarrosum and others*).

Semi-desert plants are mostly developed in lowland areas, on dark and salt soils. This vegetation is mainly presented by Artemisia formations (*Artemisia lerchiana*). Atriplex cana formations (*Salsola nodulosa*) and other formations of semi-desert plants are relatively rare. Edifier (*wormwood*) is often an absolute dominant of Artemisia formations. Other common species are Caragana grandiflora, Sterigmostemum torulosum, Torularia torulosa, etc.

Ephemers and ephemeroids: Alissum tortuosum, Gagea dubia, Medicago minima, Pterotheca sancta, Trachynia distachya, etc. develop in great numbers in the cenoses in spring. Semi-desert with Artemisia formations are the best winter pastures (mostly for sheep).

Marsh vegetation is developed along the banks of the water reservoirs and rivers, mostly as small sections. They are dominated by cattail formations (*Typhalatifolia, T. laxmannii*).

One of the most interesting sections within the limits of the geobotanical region of Kvemo Kartli is Iagluja Hillock. It is stretched for 17 km from west to east. The hillock is built with the neogenic conglomerates drifted from Trialeti and sandstones. The average height of the hillock is not great (max. 766 m asl). The Hillock is almost deprived of a hydrographic network (it is waterless with only temporal salt springs in it).

The vegetation cover of Iagluja Hillock is very interesting with its genesis and structure. Today, there are remnants of sparse arid forest survived in the area. In the past, here grew Mt. Atlas mastic tree. hackberries and juniper plantation phytocenoses. Artemisia formations (*Artemisia lerchiana*) and beard-grass-Artemisia formations (*Artemisia lerchiana + Botriochloa ischaemum*) are widely spread. Steppe vegetation: beard-grass (*Botriochloa ischaemum*), Festuca supina-beard-grass (*Botriochloa ischaemum + Festuca valesiaca*), feather-grass (*Stipa lessingiana, St. pulcherrima*), feather-grass-Festuca supina-beard-grass and xerophilous bushes: Bushes of Christ's thorn (*Paliurus spina christi*) and astragalus formations (*Astragalus microcephalus*) cover large areas. Ephemers and annual vegetations: Bromus japonicus, Echinaria capitata, Medicago minima, Poa bulbosa, Salvia viridis, Trachynia distachya, Trifolium arvense and many others grow in great numbers in hytocenoses (mostly, in grass formations). In early spring, very beautiful geophytes – lilac (*Iris iberica, I. pumila*) and Giant Gagea (*Gagea commutata*), etc. grow in the phytocenoses.

5.3.1.2 Detailed botanical study of the study area and study methods

A field study was undertaken within the limits of the study area. The goal of the field study was to explore the baseline condition of the plant species in the study area and provide a detailed botanical study of the territory.

The major goal of the floristic study was to identify the plant species, sensitive habitats and communities, which will be under the impact in the construction corridor. The distribution of the plant communities registered in the area was fixed with GPS coordinates.

The Latin names of the plants referred to in the text will be obtained according to the Second edition of "Flora of Georgia" (I-XIV volumes, 1987-1996, N. Ketskhoveli, A. Kharadze, R. Gagnidze); Plant Nomenclature List (2005, R. Gagnidze) and Botanical Dictionary 1991, A. Makashvili).

Total 14 project sites were decsribed in the course of the botanical study on the example of the reference plots. their decsription is given below.

GPS coordinates: X- 0499085 / Y-4599000**:** Dominant species along this section are: xerophilous bushes – Bushes of Christ's thorn (*Paliurus spina christi*), and its structure is presented by buckthorn (*Rhamnus pallasii*), sea-buckthorn (*Hippophaë rhamnoides)*, juniper *(Juniperus spp).* There is a remnant of sparse arid forest fixed here: one individual of Mt. Atlas mastic tree (*Pistacia mutica*). Artemisia formations (*Artemisia lerchiana*) and beard-grass-Artemisia formations (*Artemisia lerchiana + Botriochloa ischaemum*) are widely spread. Ephemers and annual plants: *Bromus japonicus, Echinaria capitata, Medicago minima, Poa bulbosa, Salvia viridis, Trachynia distachya, Trifolium arvense* and many others develop in the phytocenoses. The natural vegetation is intensely transformed due to the human's activity. The area is used as pastures. Contamination of the area with household waste is observed. Sensitivity: average.

Paliurus spina christi

Pistacia mutica Pistacia mutica

GPS coordinates X-0499040/Y-4597029 - Dominant species along this section are: Christ's thorn (Paliurus spina christi), with mixed buckthorn (Rhamnus pallasii), sea-buckthorn (Hippophaë rhamnoides), juniper (Juniperus spp), tamarisk (Tamarix ramosissima). The natural vegetation is intensely transformed due to the human's activity. The area is used as pastures. Contamination of the area with household waste is observed. Sensitivity: low.

Tamarix ramosissima

Shrubs

Juniperus spp

Waste

GPS coordinates: **X-0499177/Y-4596449;** 0499130/4595728; 0499306/4591922: Dominant species along this section are: Christ's thorn (*Paliurus spina christi*), with mixed buckthorn (*Rhamnus pallasii*), sea-buckthorn (*Hippophaë rhamnoides)*, juniper*(Juniperus spp)*. Artemisia formations (*Artemisia lerchiana*) and beard-grass-Artemisia formations (*Artemisia lerchiana + Botriochloa ischaemum*) are widely spread. Ephemers and annual plants: *Bromus japonicus, Echinaria capitata, Medicago minima, Poa bulbosa, Salvia viridis, Trachynia distachya, Trifolium arvense* and many others develop in the phytocenoses. The natural vegetation is intensely transformed due to the human's activity. The area is used as pastures. Sensitivity-law.

Secondry Shrubs

Beginning of the wind-break belt

GPS coordinates: X-0498336/ Y-4590849– Along this section, on the roadside, there is a wind-break belt; dominant is Black Locust (Robinia pseudoacacia), and blackberry (Rubus caesius) and dog-rose (Rosa canina) are worthwhile from the bushes. Sensitivity: low.


Wind-break belt

GPS coordinates: X-0498337/Y-4590850 - Along these sections, on the roadside, there is a wind-break belt; dominant is cypress (Cupressus spp) (average diameter: 35-40 cm), mixed with Black Locust (Robinia pseudoacacia), (average diameter: 30-35 cm), nut tree (Juglans regia)(average diameter: 30-35 cm). The corridor also crosses the wind-breaking belt on the road crossing with Black Locust (Robinia pseudoacacia), poplar (Populus piramidalis), black poplar (Populus nigra) and Canadian aspen (Populus deltoides) fixed in them. Sensitivity: average.

Cupressus spp

Nut trees

GPS coordinates: X-0498196/Y-4590770 : Along this section, there is grows vineyard on a privately owned plot. There are nut trees (Juglans regia), Pleaster (Elaeagnus angustifolia), Willow (Salix alba), wild plum (Prunus divaricata), Black Locust (Robinia pseudoacacia) fixed in the adjacent area. Sensitivity: average.

Walnut tree in the vineyard

Walnut trees

GPS coordinates: X-0498071/Y-4590620: Along this section the following species are fixed: nut tree (Juglans regia), Pleaster(Elaeagnus angustifolia), Willow (Salix alba), wild plum (Prunus divaricata), mulberry (Morus alba), plum tree (Prunus domestica), Black Locust (Robinia pseudoacacia), blackberry (Rubus caesius), dog-rose (Rosa canina), blackthorn (Prunus spinosa), poplar (Populus piramidalis). Sensitivity: average.

Walnuts on the background of bushes

Prunussp inosa

Nut trees

GPS coordinates: X-0497419/Y-4589814; Along these sections, there are Pleaster(Elaeagnus angustifolia), Willow (Salix alba), tamarisk (Tamarix ramosissima), poplar (Populus piramidalis), mulberry (Morus alba), blackberry (Rubus caesius), dog-rose (Rosa canina) fixed. Sensitivity: low.

Pleaster

Tamarisk on the background of Pleaster

Willow

Oleaster

GPS coordinates: X-0498489/Y-4582985 - Along these sections, there is 1 mulberry tree (Morus alba) growing in the cultivated plot. Sensitivity: low.

Mulberry tree

GPS coordinates: X-0501196/Y-4581371: The following species are fixed along this section: Black Locust *(Robinia pseudoacacia),* hawthorn (Crataegus spp), mulberry *(Morus alba),* blackberry *(Rubus caesius)*, wild plum *(Prunus divaricata),* plum tree *(Prunus domestica)*,dog-rose *(Rosa canina).* Sensitivity: low.

Hawthorn

GPS coordinates: X- 0503500/Y-4580457 –There is a private plot along this section, with corn sown on it. Sensitivity: low.

Corn field

GPS coordinates: X-0503750/Y-4580234; X- 0503893/Y-4580104 – Along this section, the following species are fixed: mulberry (Morus alba), blackberry (Rubus caesius), wild plum (Prunus divaricata), plum tree (Prunus domestica), dog-rose (Rosa canina), Siberian apricot (*Prunus armeniaca*) and , etc. Sensitivity: low.

GPS coordinates: X- 0505667/Y-4577339 - Dominant species on the right side of the road are: *Biota (Biota orientalis)*, with the admixtures of Pine (*Pinus nigra, P. sosnovskyi*), Pleaster*(Elaeagnus angustifolia)*, Willow *(Salix alba),* sea-buckthorn (*Hippophaë rhamnoides),* Almond-tree *(Amygdalus communis)*. Pines infected with various pests and diseases are identified in the area. Sensitivity: average

Coniferous plants

Almond-tree

Damaged beech Damaged biota

GPS coordinates: X- 0505766/Y-4575904 Along the whole length of this section, there is a landscaping zone fixed with the participation of Coniferous plants. Of the Coniferous plants, dominant are: Pine (Pinus nigra, P. sosnovskyi), Biota (Biota orientalis). mixed with: Cedar (Cedrus deodara), cypress (Cupressus spp), hornbeam (Carpinus caucasica), Almond-tree (Amygdalus communis). BlackLocust (Robinia pseudoacacia), tamarisk (Tamarix ramosissima), nut tree (Juglans regia). Of bushes, noteworthy are: Pleaster(Elaeagnus angustifolia), sea-buckthorn (Hippophaë rhamnoides), blackberry (Rubus caesius), dog-rose (Rosa canina) and, etc. Pines infected with various pests and diseases are identified in the area. Sensitivity: average.

Pine forest with biota Biota

Coniferous plants

Nut Tree

Pine

5.3.2 Taxation results of timber resources in the project area

The field works were accomplished in line with Decree #179 of the government of Georgia of July 17, 2013 "On Approving the Rule of forest taxation and monitoring".

The trees were registered in different quarters. See Annex 5.

During the taxation of individual trees, all timber species with 8-cm or more diameterswere taxed in the taxation area, depending on the thickness grades. We identified the altitudinal degree and calculated the volumes for timber wood species. Besides, all bushes and sprouts with the diameter of less than 8 cm were taxed.

Table 5.3.2.1. gives the list of imber wood and non-timber wood species spread in the study area.

Table 5.3.2.1

#	*Timber wood species*		*Note*	*Qty*
	English	*Latin*		
1	*White poplar*	*Populus alba*		*18*
2	*Silver poplar*	*Populus pyramidalis*		*76*

3	*Willow*	*Salix magnifica*		*13*
4	*Caspian locust*	*Gleditsia caspia*		*923*
5	*Silver wattle*	*Acacia dealbata*		*32*
6	*Mulberry*	*Morus alba*		*169*
7	*Wallnut*	*Juglans regia*	***Red List***	***24***
8	*Hackberries SiSv.*	*Celtis dlabrata*	***Red List***	*1*
9	*Mediterranean cypress*	*Cupressus sempervirens*		*460*
10	*Cherry plum*	*Prunus insititia*		*4*
11	*Pine*	*Pinus nigra*		*131*
12	*Deodar cedar*	*Cedrus deodara*		*3*
13	*Box elder*	*Fraxinus excelsior*		*11*
14	*muxa qaT.*	*Quercus iberica*		*2*
15	*Field maple*	*Acer campestre*		*1*
16	*Lime*	*Tilia caucasica*		*41*
17	*Shamrock*	*Malus sylvestris*		*1*
18	*Wild apricots*	*Prunus armeniaca*		*11*
19	*Elm tree*	*Ulmus foliacea*		*12*
20	*Plane trees*	*Platanus*		*12*
		Total		*1978*
		Bushes with the < 8 cm diameter		
1	*Blackberry Cv.*	*Rubus caesius*		2140
2	*Dog-rose*	*Rosachinensis*		237
3	*Christ's thorn*	*Paliurus spina-christi*		273
4	*Hawthorn*	*Crataegus microphylla*		140
5	*Lilac*	*Syringa*		300
6	*Pomegranate*	*Punica granatum*		40
8	*Cherry plum*	*Prunus insititia*		351
9	*Nettle trees*	*Celtis dlabrata*	***Red List***	82
10	*Lime*	*Tilia caucasica*		30
11	*European ash*	*Fraxinus excelsior*		17
12	*Caspian locust*	*Gleditsia caspia*		1125
13	*Silver poplar*	*Populus pyramidalis*		11
14	*Mulberry*	*Morus alba*		121
		Total		6855

5.3.3 Fauna and their habitats

5.3.3.1 General description of the project corridor

The major animal species common in the corridor envisaged by the project and in its adjacent area are those typical to the steppes. The number of forest species is quite reduced as a result of the small forested areas and strong anthropogenic impact.

Mostly grassy and very sparse bushy plants grow on the site spread along the initial section of the corridor and over Iagluja Plateau. Trees mainly grow at some locations, sometimes as isolated individuals.

Shibliak (Christ's thorn, Astragalus), grasses – with dominant yellow bluestem and wormwood

Common reed grass

There is a landfill located along one section of the study area, which is a feeding ground for the representatives of the living world. However, on the other hand, it is a large reservoir of plastic and other inorganic waste, which do not decompose when get in an animal body and cause animal death.

Landfill

The following bird species were identified on the given territory: carrion crown (Corvus corone), Eurasian tree sparrow (Passer montanus), Eurasian skylark (Alauda arvensis), Eurasian magpie (Pica pica), Common starling (Stumus vulgaris).
The last section of the study corridor is presented by artificially grown pine and cedar plantation. The plantation is intensely degraded and is sparse. Consequently, its conservation value is very low.

The following species were identified in the given area: chaffinch (Fringilla coelebs), cuckoo (Cuculus canorus), Eurasian tree sparrow (Passer montanus), Great tit (Parus major) and Black-billed Magpie (Pica pica).

5.3.3.2 Animal species common in the project corridor and adjacent to it

Mammals:

As the literary sources suggest, the following animal species are common in the project area: Red fox (Vulpesvulpes), jackal (Canisaureus), European hare (Lepuseuropaeus) and populations of some other small mammals, such as field mouse (Apodemusagrarius), European water vole (Arvicolaterrestris), Caucasian Mole (Talpacaucasica), vesper bats (Vespertilionidae), European hedgehog (Erinaceuseuropaeus). As the local residents inform, a wolf (Canislupus) is present in the floodplains adjacent to the rivers and steppes in the environs of the study area.

The project area is not an important habitat for mammals, as it is mainly presented as fields and arable and sowing lands and there is already a motor road across it. During the accomplished studies, 3 of the literary known species were identified in the field, including:

Jackal *(Canis aureus)*— The jackal killed as a result of car accident wasx seen on the last section of the project corridor (on the site where the project road approximates the existing road). See Figure 5.3.2.2.1. is a member of the dog family. Its body is 71-85 cm long. It lives in the floodplain and piedmont forests, bushes and near water reservoirs. It feeds on animal and vegetable food, mostly on mouse-like rodents, rabbits, birds, reptiles, amphibians, fish, insects, etc. This predator is found in almost all regions of Georgia, up to 1000 m above sea level.

Figure 5.3.3.2.1. Jackal (Canis aureus) on the existing road

Forest dormouse (*Dryomys nitedula)*— In the floodplain fragments of the project area, there was a nest (wintering capsule) of forest dormouse found, in which Forest dormouse winters (See Figure 5.3.2.2.2.). it is a representative of Rodentia order, Gliridae family.Its habitat is forests, bushes, gardens and vineyards, and often gardens near the houses. The rodent lives all over the territory of Georgia and poses big problems to farmers (it mainly feeds on cornel crops).

Figure 5.3.3.2.2. Forest dormouse (wintering capsule)

Along many sections of the project corridor, particularly on the sites crossing the agricultural plots, of Muridae, the holes of the Striped field mouse (*Apodemus agrarius*) were found. (See Figure 5.3.2.2.3.), This species is widely spread all over the territory of Georgia and mostly lives in the agricultural plots of field. During the periods of massive propagation, they cause mass destruction of harvest (wheat, barley, corn, etc.).

Figure 5.3.3.2.3. Holes of Striped field mouse (Apodemus agrarius)

During the survey, attention was paid to the study of the coastline of the objects crossing the corridor and identification of the signs of water-loving mammals (including Otter (Lutra lutra), which is the Georgian Red-Listed species). However, the survey did not reveal any tracks of this species or habitats attractive for Otter. Besides, no sensitive sites attractive for numerous bat colonies for living were identified.

Based on the results of the literary data and field visits, the following mammals were identified within the project area:

Table 5.3.3.2.1. Mammals common in the project area

№	Latin name	English name	Red List	IUCN	Bern Convention	Literary data	Identified during the survey
1	*Erinaceus concolor Martin.*	Hedgehog		LC		+	-
2	*Suncus etruscus Savi.*	Etruscan shrew		LC		+	-
3	*Vulpes vulpes*	Red fox		LC		+	-
4	*Canis aureus*	Jackal		LC		+	+
5	*Lepus europaeus*	European hare		LC		+	-
6	*Apodemus agrarius*	Striped field mouse		LC		+	+
7	*Talpa caucasica*	Caucasian mole		LC		+	
8	*Arvicola terrestris*	European water vole				+	-
10	*Canis lupus*	Wolf		LC	II	+	-
11	*Dryomys nitedula Pallas.*	Forest dormouse		LC		+	+

IUCN Red List categories:
CR = Critically Endangered
EN = Threatened.
VU = Vulnerable

NT = Near Threatened.
LC = Least Concern.

Birds:

Georgia is an important area for west palearctic birds, as one of their major immigration routes runs across the country (Black Sea basin, Javakheti and Dedioplistskaro). However, the study area itself is not an important migration route, so called “narrow neck”, stopping, resting or wintering place.

The majority of the bird species found in the area are widely spread all over Georgia. Besides, their populations are numerous.

The majority of the bird species identified in the study area are bush-loving species. There are also species associated with cliffy places and water locations.

During the immigration period, the rivers banks and floodplain environs can be used by the water and marsh-loving birds as temporary shelters.

During the field surveys in the project zone, 27 of 33 bird species known from the literature were fixed in the field.

Common heron (*Ardea cinerea*) and Great egret (Ardea alba) should be noted (See Figures 5.3.2.2.4 and 5.3.2.2.5.). They were identified during the field visit, live in the wet places. The seen individuals were moving towards Gardabani managed reserve (along the existing road). Consequently, the road cannot be considered as a hampering factor for them.

Common heron (Ardea cinerea) lives in humid and wet places, in the reeds along the banks of water bodies and in the cliffs. They live in colonies or in pairs. They feed on animal food. The project area is not a suitable habitat for the common heron. Consequently, no impact is expected on it.

The great egret (*Ardea alba*) is common in south-eastern Europe, Asia, south Africa, Madagascar, Australia, new Zealand, South America and southern part of North America. It lives in the lakes and riverside floodplains, wet meadows and marshes, mostly in deergrass or high-herb locations. It nests on the ground, broken deergrass and sometimes, in bushes and trees. In Georgia, it is more common in Javakheti, near the river confluences and lakes. As already mentioned, great egret was fixed in the project area when it was moving towards the habitat suitable for it (including Gardabani Managed Reserve). Neither operation, not exploitation phase of the project is expected to have an impact on the given species.


Figure 5.3.3.2.4 Common heron (Ardea cinerea)


Figure 5.3.3.2.5. Great egret (Ardea alba)

Fringillidae – Chaffinch, the same as common chaffinch (*Fringilla coelebs*) was fixed in the area. This bird is common in all Georgia and lives both, in the sparse and riverside floodplain forests See Figure 5.3.2.2.5.


Figure 5.3.3.2.6. Chaffinch (common chaffinch) - (*Fringilla coelebs*)

Paridae - Great tit (*Parus major*) was fixed in the area. This species is known to be common for almost all types of habitats; however, it prefers forest habitat for breeding.

Laniidae - Red-backed Shrike (*Lanius collurio*) was seen in the field. It lives in the open spaces covered with bushes and trees (field, recreational forests).

Turdidae - Mistle Thrush (*Turdus viscivorus*) and thrush (*Turdus merula*) was seen in the field. These species are common in different types of forests, gardens, bushes and recreational parks.

Passer - Eurasian tree sparrow (*Passer montanus*) was fixed in the area. This species lives almost all over Georgia, in the forests (mostly sparse forests) and fields. See Figure 5.3.2.2.6.

Figure 5.3.3.2.7. A flock of Eurasian tree sparrows (*Passer montanus*)

Corvidae - Black-billed Magpie (*Pica pica)*(*Pica pica)* See Figure 5.3.2.2.7, rook (*Corvus frugilegus) See*Figure 5.3.2.2.8. and Carrion (*Corvus corone*) See Figure 5.3.2.2.9 were seen in the study area. These species have wide areas of distribution and diversified habitats (forest edges, gardens, recreational forests, valleys, wind-break belts and people's habitats.

Figure 5.3.3.2.8 Black-billed Magpie - (Pica pica)

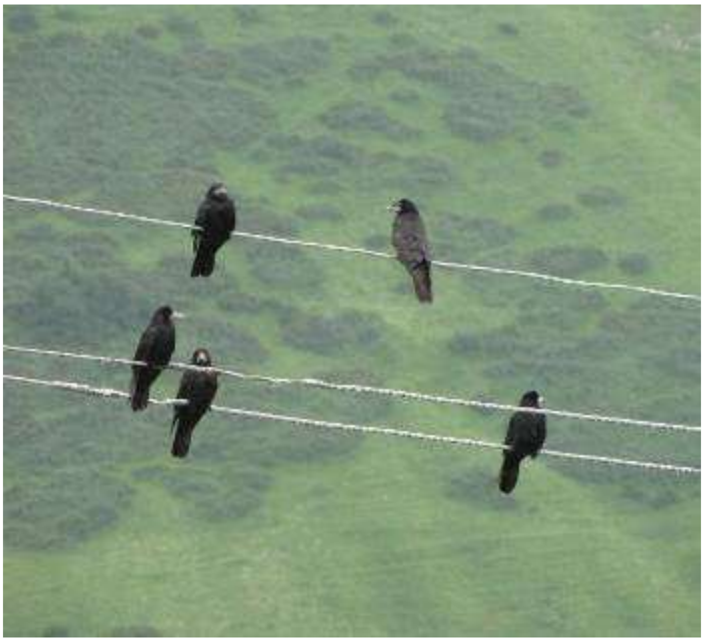


Figure 5.3.3.2.9. A flock of rooks - (Corvus frugilegus)

Figure 5.3.3.2.10. Carrion - (Corvus corone)

Motacillidae - white wagtail (*Motacilla alba*) was fixed in the study area. This species is widely spread all over Georgia and lives (and breeds) on the banks of the rivers and water bodies.

Apodiformes - Common Swift (*Apus apus*) was found in the area. This species prefers open areas, mountain and plain steppes, semi-deserves, etc. as its habitats.

Sturnidae - Flocks of starling (*Sturnus vulgaris*) were seen during the field studies. This species commonly nests as colonies in sparse forests, bushes, agricultural plots and people's dwelling areas.

Cuckoos - Cuckoo (*Cuculus canorus*) was seen in the area. The habitat of this species covers hardwood and mixed forests.

Falconidae – a male Common Kestrel (*Falco tinnunculus*) was seen in the area. This species feeds on small rodents and its habitat is semi-deserts, fields and meadows as well as cities and villages. See Figure 5.3.2.2.10.

Figure 5.3.3.2.11. Common Kestrel - (Falco tinnunculus)

<u>Accipitridae</u> – Common Buzzard (*Buteo buteo*) was seen in the area. This species feeds on rodents and other small animals and chooses both, forests and open fields as its habitat.

<u>Coraciidae</u> - European Roller (*Coracias garrulus*) was seen in the study area. This species mainly lives in the steppe forest habitats and rarely in sparse forests. See Figure 5.3.2.2.11.

Figure 5.3.3.2.12. European Roller - (Coracias garrulus)

<u>Phasianidae</u> – of the Phasianidae, quail (*Coturnix coturnix*) was seen in the area. This species is common all over Georgia and lives in the valleys and fields and alpine meadows.

Based on the literary data and surveys, we can conclude that the following bird species are common in the project area:

Table 5.3.3.2.2. Bird species common in the project area

№	Latin name	Georgian name	Red List	IUCN	Bern Convention	Season	Literary data	Identified during the survey
1	*Motacilla alba*	White wagtail		LC	II	YR-R, M	+	+
2	*Apus apus*	Common Swift		LC		BB, M	+	+
3	*Merops apiaster*	European bee-eater		LC	II	BB, M	+	-
4	*Corvus cornix*	Carrion		LC		YR-R	+	+
5	*Garrulus glandarius*	Eurasian jay		LC		YR-R	+	+
6	*Turdus merula*	Thrush		LC		YR-R	+	+
7	*Delichon urbicum*	common house martin		LC	II	BB, M	+	+
8	*Sturnus vulgaris*	Starling		LC		YR-R,M	+	+
9	*Columba livia*	Rock dove		LC		YR-R	+	-
10	*Columba oenas*	Stork dove		LC		YR-R	+	-
11	*Columba palumbus*	Common wood pigeon		LC		YR-R	+	-
12	*Hirundo rustica*	Barn swallow		LC	II	BB, M	+	+
13	*Oriolus oriolus*	Eurasian golden oriole		LC	II	BB, M	+	-
14	*Turdus viscivorus*	Mistle thrush		LC		YR-R	+	+
15	*Erithacus rubecula*	European robin		LC	II	YR-R	+	-
16	*Fringilla*	Chaffinch		LC		YR-R,	+	+

	coelebs					M		
17	*Cuculus canorus*	Cuckoo		LC		BB, M	+	+
18	*Phoenicurus phoenicurus*	common redstart		LC	II	BB, M	+	-
19	*Passer montanus*	Eurasian tree sparrow		LC		YR-R	+	+
20	*Carduelis carduelis*	European goldfinch		LC	II	YR-R, M	+	-
21	*Carduelis chloris*	European greenfinch		LC	II	YR-R, M	+	-
22	*Parus major*	Great tit		LC	II	YR-R	+	+
23	*Lanius collurio*	Red-backed shrike		LC	II	BB, M	+	+
24	*Turdus philomelos*	Song Thrush		LC		YR-R, M	+	-
25	*Aegithalos caudatus*	Long-tailed bushtit		LC		YR-R, M	+	-
26	*Falco tinnunculus*	Common Kestrel		LC	II	BB, M	+	+
27	*Buteo buteo*	Common Buzzard		LC	II	YR-R, M	+	+
28	*Ardea cinerea*	Common heron	VU	LC	II	BB, M	-	+
29	*Ardea alba*	Great White Egret		LC		YR-V	-	+
30	*Corvus frugilegus*	Rook		LC		YR-R, M	+	+
31	*Pica pica*	Black-billed Magpie		LC		YR-R	+	+
32	*Coracias garrulus*	European Roller		LC	II	BB, M	+	+

33	*Coturnix coturnix*	Quail		LC		YR-R, M	+	+
34	Alauda arvensis	Eurasian skylark		LC		YR-R	+	+

Species seasonal life history at a given site:
YR-R = Year-round resident; breeder, present throughout the year.
YR-V = Year-round visitor; non-breeder, present throughout the year.
BB = Breeding bird; breeder, absent during non-breeding period.
SV = Summer visitor; non-breeder, present in spring and summer.
WV = Winter visitor; non-breeder, present in late fall, winter and early spring
M = Migrant; bird of passage; present primarily in fall and spring.

IUCN Red List categories:
CR = Critically Endangered
EN = Threatened.
VU = Vulnerable
NT = Near Threatened.
LC = Least Concern.

Reptiles:

The study area is not distinguished for diversity or endemism of reptiles. As per the literary sources, at present, there are 26 snake species in Georgia. 2 snake species are common in the study area: dice snake *(Natrix tessellata)* and grass snake (*Natrix natrix).* Both species are associated with water and live near water bodies. They mainly feed on fish and amphibians and rarely, on rodents.

During the field visits, the reptiles were fixed/registeerd by visual observation. 5 of 6 literary known species were seen on site.

Of lizards, Medium lizard (Lacerta media) (See Figure 5.3.2.2.12) nd European legless lizard (Pseudopus apodus) are common in the project area. Mediterranean tortoise (Testudo graeca) was also fixed in the study area (See Figure5.3.2.2.13).

European legless lizard (Pseudopus apodus) – is quite common lizard species in Georgia and its habitats are dry places. Its area in the construction area covers the project area.

Medium lizard (Lacerta media) – this species is common mostly in fields and sparse forests. Medium lizard may use the agricultural plots in the project area as a corridor during migration.

Mediterranean tortoise (Testudo graeca) lives in sparse forests, on meadows and steppes. Presently, its habitats are limited at many locations. It is on the Red List of Georgia.

Figure 5.3.3.2.13. Medium lizard- (Lacerta media)

Figure 5.3.3.2.14. Mediterranean tortoise (Testudo graeca)

Based on the literary data and results of field visits, the following reptile species are common in the project area:

Table 5.3.3.2.3.Reptiles common in the project area

№	**Latin name**	**Georgian name**	**Red List**	IUCN	**Literary data**	**Identified during the survey**
1	Pseudopus apodus	European legless lizard	NE	LC	+	+
2	*Anguis fragilis*	Deaf adder	NE	LC	+	-
3	*Lacerta media*	Medium lizard	LC	DD	+	+
4	*Vipera lebatina*	Levantine viper	NE	NT	+	-
5	*Testudo graeca*	Mediterranean tortoise	VU	VU	+	+
6	*Natrix natrix*	Grass snake	LC	LC	+	+
	Natrix tessellata	Dice snake	LC	LC	+	+

IUCN Red List categories:
CR = Critically Endangered
EN = Threatened.
VU = Vulnerable
NT = Near Threatened.
LC = Least Concern.

Amphibians:

Amphibians are the smallest class of the vertebrates incorporating up to 3400 species. There are 12 amphibians spread in Georgia. 1 of 3 tailless amphibians known from literature were seen in the field, in the river bank zone of the project area. Marsh frog (*Pelophylax ridibundus)* and frog are common all over the territory of Georgia. (See Figure 5.3.2.2.14).

Figure 5.3.3.2.15. Marsh frog - (Pelophylax ridibundus)

Based on the literary data and results of field visits, the following amphibian species are common in the project area:

Table 5.3.3.2.4. Amphibians common in the project area

№	**Latin name**	**Georgian name**	Red List	IUCN	**Literary data**	**Identified during the survey**
1	*Pelophylax ridibundus*	Marsh frog	LC	LC	+	+
2	*Rana macrocnemis*	Long-legged wood frog	LC	LC	+	-
3	*Hyla orientalis*	Eastern tree frog	LC	LC	+	-

IUCN Red List categories:
CR = Critically Endangered
EN = Threatened.
VU = Vulnerable
NT = Near Threatened.
LC = Least Concern

Fish:

Based on the literary data and results of field visits, the following species live in the river: Sevan khramulya *(Capaeta Capaeta),* common chub (*Leuciscuscephalus orientalis),* Kura barbel *(Barbuslacerta cyri),* Kura loach *(Nemachilus Brandti).*

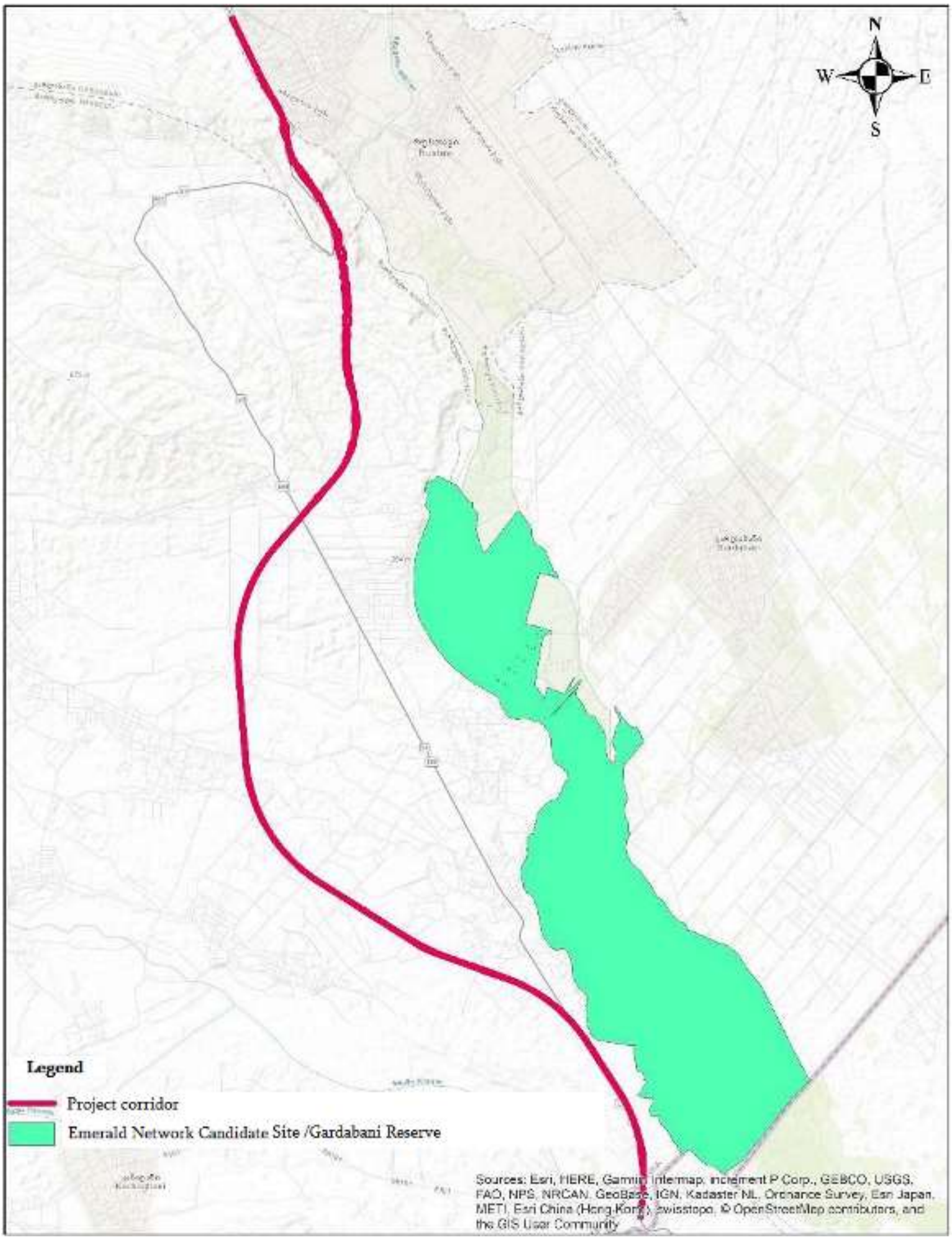
5.3.4 Protected Areas

The following important sites are found near the design corridor:

- National protected area, Gardabani Managed Reserve (MR).
- “Gardabani”, a candidate site of Emerald Network protected by international conventions.

Gardabani MR is found within the borders of an Emerald Network candidate site. The location of the protected areas in respect of the project road is shown in Figures 5.3.3.1. and 5.3.3.1.

Drawing 5.3.4.1. Location of the protected areas in relation to the project road



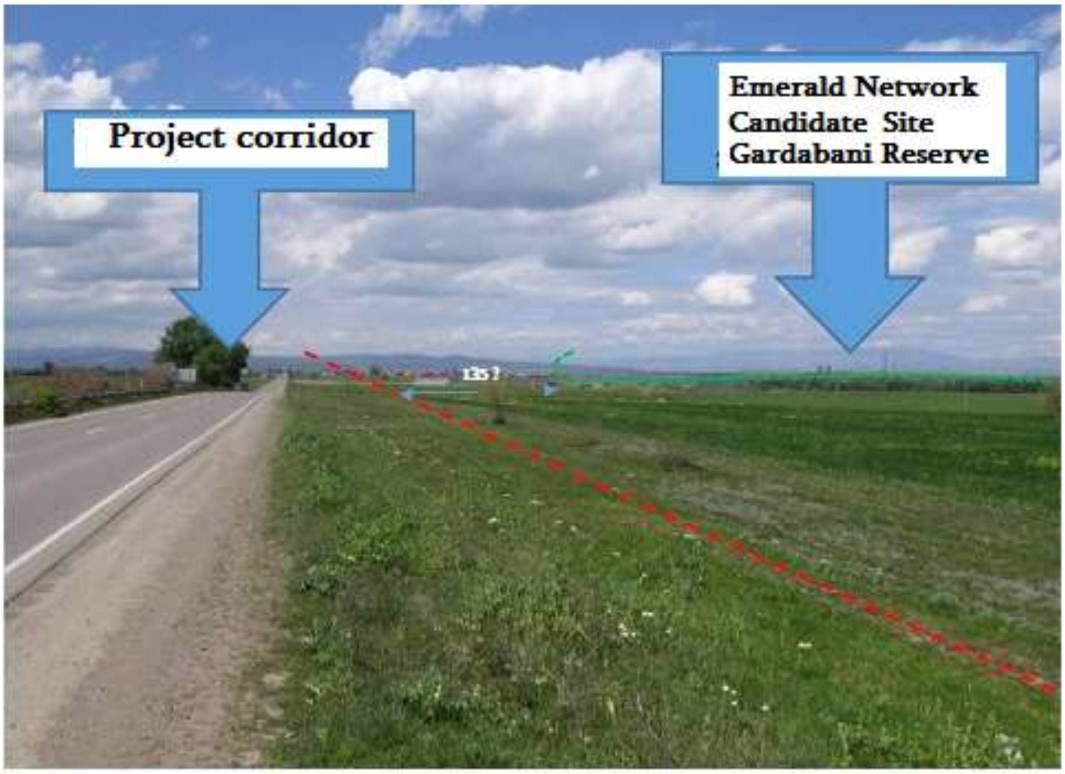


Figure 5.3.4.1. Location of the protected areas in relation to the project road

Gardabani Managed Reserve: was created in 1957 as a state forest-hunting area of Gardabani and in 1996, it was given the status of a managed reserve. The area of Gardabani MR is 3484 ha. It is located on the territories of Gardabani and Marneuli Municipalities, 39 km from Tbilisi. Gardabani Managed Reserve was established to preserve and improve the state of the forest plantations in the area and protect the local fauna species.

The main riches of flora in the Managed Reserve is floodplain forests with abele, black poplar, white willow, high willow, floodplain oak, floodplain elm and Plot's Elm as the principal timber plants. The understory is presented by hawthorn, branched tamarisk and sea-buckthorn. Unfortunately, despite their particular status, today the floodplain forests of Gardabani Managed Reserve cannot boast with great number of animals.

Site Code: *GE0000019*
Area covered (ha): 3734
Bio-geographic region: Steppe (100%)

Types of habitats found on the site: E3.5 – humid or wet oligotrophic meadow: characterized by poor food of boreal, nemoral and steppe zones and frequent peat soils. It covers a meadow with dominant purple moor-grass (Molinia caerulea) and containing rushes (Juncussquarrosus), Matgrass (Nardusstricta) and scirpus (Scirpuscespitosus). Common plant communities are: Molinion caerulaceae, Juncion squarrosi, Junco-molinion, Juncion acutiflori.

Species common in the habitats present on the Emerald Candidate Site (according to “non-standard datasheet”):

Group*	Code	Scientific name	English name
B	A402	Accipiter brevipes	Levant sparrowhawk
I	1930	Agriades glandonaquilo	Arctic blue
B	A229	Alcedo atthis	Common kingfisher
B	A404	Aquila heliaca	Eastern imperial eagle
B	A089	Aquila pomarina	Lesser spotted eagle
B	A029	Ardea purpurea	Purple heron
M	1308	Barbastella barbastellus	Western barbastelle
F	1143	Barbus capito	Bulatmai barbel
B	A021	Botaurus stellaris	Eurasian bittern
M	1352	Canis lupus	Wolf
B	A224	Caprimulgus europaeus	European nightjar
F	1141	Chalcalburnus chalcoides	Danube bleak
B	A030	Ciconia nigra	Black stork
B	A081	Circus aeruginosus	Western marsh harrier
B	A238	Dendrocopos medius	Middle spotted woodpecker
B	A429	Dendrocopos syriacus	Syrian woodpecker
B	A026	Egretta garzetta	Little egret
R	1220	Emys orbicularis	European pond turtle
B	A075	Haliaeetus albicilla	Haliaeetus albicilla
B	A338	Lanius collurio	Red-backed shrike
I	1042	Leucorrhinia pectoralis	Large white-faced darter
I	1043	Lindenia tetraphylla	Bladetail
M	1361	Lynx lynx	Eurasian lynx
R	1222	Mauremys caspica	Caspian turtle
B	A073	Milvus migrans	Black kite
M	1307	Myotis blythii	Lesser mouse-eared bat
B	A072	Pernis apivorus	European honey buzzard
B	A393	Phalacrocorax pygmeus	Phalacrocorax pygmeus
B	A120	Porzana parva	Little crake
B	A119	Porzana porzana	Spotted crake
B	A121	Porzana pusilla	Baillon’s crake
M	1303	Rhinolophus hipposideros	Lesser horseshoe bat
B	A307	Sylvia nisoria	Barred warbler
R	1219	Testudo graeca	Greek tortoise
M	1354	Ursus arctos	Brown bear

The project road corridor does not cross the border of the protected territory, but will run close to it along the last section (the shortest distance is 135 m).

5.3.5 Summary of biological environment survey results

The survey undertaken in several stages made it clear that Rustavi-Red Bridge project corridor is not distinguished for any component of diversity. The vegetation cover is very poor. Trees mainly grow at some locations, sometimes as isolated individuals. Mostly grassy, very sparse bushy and cultural/artificially grown plants grow there. No important animal habitats were identified as a result of high anthropogenic load on the corridor and low density of the vegetation cover. The habitats crossing the project corridor can be grouped in three types:

1. A step-like habitat on Iagluja Plateau with xerophilous vegetation. It covers the initial section of the project corridor, from Rustavi to Algeti;
2. A habitat of an agricultural type, mostly with cultural vegetation, with wind break belts in the roadside zones and artificially grown coniferous plants at the end of the corridor. It covers the greatest part of the corridor, from village Algeti to Red Bridge.
3. Degraded floodplain-type habitats present on the sites crossing the water objects. The anthropogenic load of these habitats is also quite high.

Drawing 5.3.4.1. shows the area of the habitats crossing the project corridor and also shows the location of the plots studied during the botanical survey.

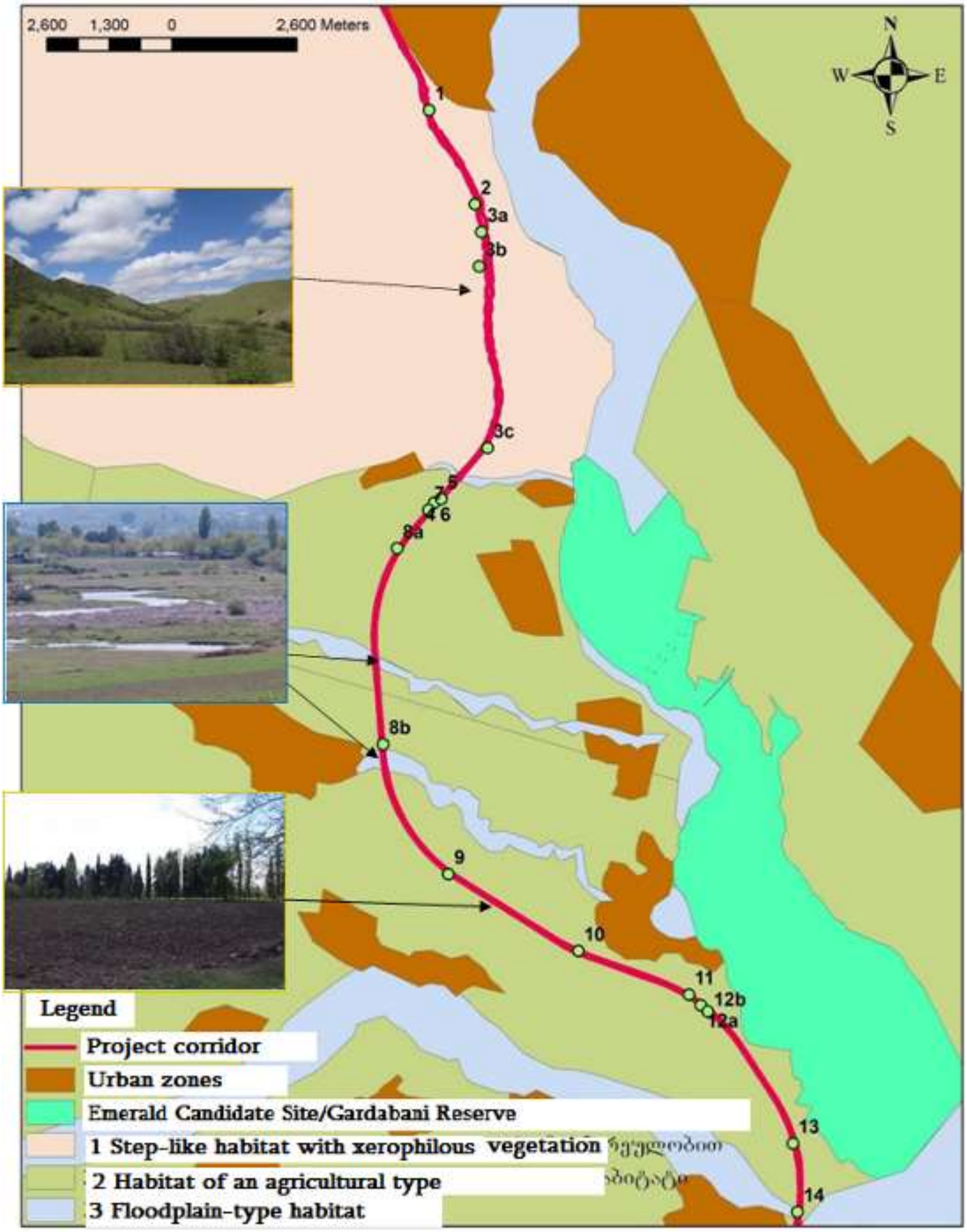
The project corridor does not cross protected areas; however, it will run near the Emerald Candidate Site/Gardabani Reserve. No habitats typical to the said protected areas or similar to them were identified immediately in the project corridor.

During the field survey, we fixed the following Georgian Red-Listed species in the project corridor and near it:

Table 5.3.5.1. Red-Listed Species common in the project area

№	English name	Latin name	Category of protection status
Plants:			
1	Walnut tree	*Juglas regia*	VU
2	Mt. Atlas mastic tree[	*Pistacia mutica Fisch & Mey*	VU
Birds:			
3	Grey heron	*Ardea cinerea*	VU
Reptiles:			
4	Greek tortoise	*Testudo graeca*	VU

Drawing 5.3.5.1. Location of habitats in the project corridor and plots described during the botanical survey



5.4 Social-Economic Environment
5.4.1 General

Rustavi is the administrative center of Kvemo Kartli. It is located in the eastern part of Kvemo Kartli Plain, south-east of Tbilisi. It is built on the both sides of Mtkvari river, on a slightly inclined plain.

Marneuli Municipality is included within the administrative borders of Kvemo Kartli Region. It is located in the south-eastern part of Georgia. The area of the Municipality is 935,2 sq.km and its altitude is 420 m asl. The Municipality has one city and 16 administrative-territorial units including 83 villages.

The administrative-territorial units are: Marneuli, Shulaveri, Kizilajlo, Kulari, Damia-Geurarkhi, Akhkerpi, Tserakvi, Algeti, Kachagani, Kutliari, Tamarisi, Khojorni, Kapanakhchi, Kasumlo and Opreti.

Marneuli, the center of Municipality, is distanced from Tbilisi by 29 km, by 48 m from the regional center Rustavi, by 30 km from Azerbaijan border and by 30 km from Armenian border.

5.4.2 Local population

By 2018, 127,8 thousand people lived in Rustavi. The majority of the population is Georgians. However, there are other nationalities, too (mainly Azerbaijanis, Armenians, Russians and others). The population of Marneuli Municipality is 106,5 thousand. The Azerbaijanis, Georgians, Armenians and others live in the Municipality.

Based on the officials statistics (source: National Statistics Office of Georgia), the population of Rustavi and Marneuli Municipality are given in Table 5.4.2.1.

Table 5.4.2.1. Number of Population, Thousand People

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Georgia	3,847.6	3,829.0	3,799.8	3,773.6	3,739.3	3,718.4	3,716.9	3,721.9	3,728.6	3,726.4	3,729.6
Kvemo Kartli	421.2	424.0	422.8	422.8	421.5	421.0	422.5	425.2	428.0	429.7	432.3
City of Rustavi	118.3	119.9	120.5	121.4	122.0	122.7	124.0	125.0	126.1	126.8	127.8
Marneuli Minicipality	101.5	102.5	102.5	102.8	102.8	103.0	103.6	104.4	105.2	105.8	106.5

As per the age groups, Marneuli Municipality much differs from the average indicators of Georgia. Young and average aged people are most in number. This may be the reason for higher birth rate in the area and less migration of the youth to other cities and towns.

The number of population in the settled areas adjacent to the project corridor is given in Table 5.4.2.2.

Table 5.4.2.2. Population of the villages adjoining the project corridor, thous. people

Village	Population, thous. people		
	As per 2002 census	As per 2024 census	Dynamics
Keshalo	3322	3237	-85
Azizkendi	2170	1536	-634
Didi Mughanlo	1815	1286	-529
Lezhbadini	1538	962	-576
Pirveli Kesalo	1622	1267	-355
Meore Kesalo	1587	1353	-234
Kapanakhchi	1383	1081	-302
Ilmazlo	1033	998	-35

5.4.3 Economics

Kvemo Kartli Region has great potential for industrial development. Industrial center is Rustavi. There are 26 large plants in different branches and fields on the territory of the city, including the following large companies: JSC "Azoti", JSC "Rustavi Metallurgical Plant", JSC "Heidelberg Georgia", JSC "Geosteel", JSC "Jazbegi", etc.

The branch structure of the economy of Maneuli Municipality is as follows: agriculture, industry, construction, transport trade and other branches.

The leading branches of economy in Marneuli Municipality are flour and bread and pastry production, dairy and cheese production, fruit and vegetable tinning, including meat mix, cutting and processing decorative stones, furniture manufacturing and processing sand carriers, etc.

Trade is well developed in the Municipality, with many retail and wholesale trade and service units.

5.4.4 Agriculture

The agricultural land fund of Marneuli Municipality was 57,052,59 ha, including: arable land - 22,271.29 ha; hey-making meadows- 1,724.98 ha; pastures - 30,945.8 ha; area occupied by perennial crops - 2,110.52 ha. The city of Marneuli and communities of Kapanakhchi, Algeti, Kachagani and Kasumlo use 6512 ha of Iagluja and Babakari pastures on the territory of Marneuli Municipality. 33,230 ha of agricultural land is privatized.

Common agricultural crops in the Municipality are: wheat, barley, maize, rye, sunflower; common vegetables are: potato, cabbage, carrot, onion, garlic, beans, cucumber, tomato, etc.

The climatic conditions in the region are extremely beneficial for agricultural production and make it possible to gain harvest two or three times a year.

Cattle-breeding is a well-developed branch in the Municipality, as well as poultry-raising.

The project road will mainly run across the agricultural plots, which are intensely cultivated. The initial section of the corridor runs across Iagluja Plateau. These areas are used as pastures (See Figures 5.4.4.1. and 5.4.4.2.).

Figure 5.4.4.1. Pastures adjacent to the project corridor


Figure 5.4.4.2. Agricultural plots in the project corridor

5.4.5 Tourism, Historical-cultural monuments

Mostly, cultural-recognition tourism is developed in Marneuli Municipality. Agro-tourism is developed on the territories of Tamarisi and Kulari communities. Akhkerpi has a certain potential to become a resort. The Municipality has a perspective to develop horse and hunting tourism.

There are 34 historical-archeological monuments in Marneuli Municipality. An old Georgian architectural monument, Monastic Complex Khujabi (XIII c.) near village Akhkerpi is worth mentioning. A middle-century monastery Khojorni is also important. Tsopa Fortress is also worthwhile. It functioned in the VI-XIII centuries. The fortress is built on a cliffy mountain. There is a site of ancient village near Tsopa Fortress. Opreti Fortress near village Opreti is also worthwhile, which is first mentioned in the literary sources in the X century. The Tserakvi Monastic Complex near village Tserakvi is also notable.

No facts of historical-cultural monuments were identified in the corridor selected for the project road.

5.4.6 Infrastructure

The length of the central and local roads in Marneuli Municipality is 540 km, with 220 km of central roads and 320 km of local roads. 230 km of the roads is asphalted and 310 km is ground roads.

Rustavi and Marneuli Municipality are totally supplied with drinking water. Vilage the people take the drinking water from springs and wells.

The audit of the project corridor and adjoining areas identified the following crossing points of the infrastructural communications with the project road:

- 10, 35 and 110 KW power lines;
- International, regional and local roads;
- Irrigation channels;
- Iagluja landfill without an environmental permit;
- Underground pipelines, etc. (See figures)

The objects immediately crossing the project corridor are listed in paragraph 4.10.6.

Figure 5.4.6.1. PTL I the project corridor

Figure 5.4.6.2. Landfill adjacent to the corridor

Figure 5.4.6.3. Irrigation channel and pipeline

6. METHODS, APPROACHES AND EVALUATION CRITERIA USED TO ASSESS THE ENVIRONMENTAL IMPACT

6.1 Introduction

The principal goal of evaluation of the environmental impact is to identify the kind and value of the impact of the planned activity on physical, biological and social environment. This must become the basis for developing the relevant efficient mitigation measures. In order to achieve this aim it is necessary to identify the criteria so that one should be able to compare the results obtained through calculations and other methods to it. The comparison difference (quantitative change) allows identifying the value of the expected impact (scale, limits of propagation).

Following the requirements of the legislation of Georgia and characteristics of the planned activities, the following types of the environmental impact were considered:

- *Impact on physical environment* – the probability of the atmospheric air quality deterioration, noise and vibration propagation, risks of changing the qualitative state of water and soil environment, violation of the stability of the geological state, visual-landscape impact.
- *Impact on biological environment* – the generic and quantitative decrease of flora and tree-and-vegetation cover, disturbance of the animal world, deterioration of their habitats and probability of immediate impact.
- *Changes in social-economic conditions of the urban zone under the impact, both positive and negative.*
- *Possible negative impact on historical and archeological monuments.*

The evaluation criteria for the each of the above-listed impacts were identified by an individual approach, e.g.:

- The emissions and noise propagation in the atmospheric air were calculated based on the relevant methodic and normative documents. The expected changes in the design points were identified for the most unfavorable conditions. During the calculations, the background state in the pr area was taken into account. The gained results were compared to the normative documents effective in Georgia.
- The value of the impact on the qualitative state of water and soil environment was evaluated by considering the distance from the surface waters and specificity of the technological procedures used during the construction process
- The methods of visual-landscape assessment are based on the landscape value and existing situation of the action site;
- In evaluating the impact on the geological environment, the existing engineering-geological conditions and analysis of the measures necessary for the construction works are important.
- The approach used in evaluating the impact on the biological environment envisages the comparison of the background state and forecasted change resulting from the project implementation.
- In evaluation the impact on the social-economic environment, the attention was paid to various aspects, with the positive impact being most important.
- The method to evaluate the negative impact on the historical and archeological monuments envisages the identification of the probability of their damage or destruction by considering the specifics of their location.

All kinds of impacts were classified with a 3-point system, in particular:

1. *Significant (high) impact* needing high costs to take relevant mitigation measures, the mitigation measures are less efficient and/or the project/technological process need certain corrections. The probability of the population's dissatisfaction is high.
2. *Average impact* implying that in terms of the relevant mitigation measures, the impact can be brought to the admissible level.
3. *Insignificant (low) impact* when in terms of standard mitigation measures, the quantitative or qualitative change of the environment is not significant; no population's dissatisfaction is expected.

It should be noted that some kinds of impact are not expected and there is no need for mitigation measures.

In order to assess the values of some of the impacts, it is also important to assess the duration of impact and evaluate how swiftly a natural object can be restored either to its original state, or state nearly similar to the original one, after the sources of impact are eliminated.

The sub-chapters below give a more detailed description of the criteria used in the environmental impact assessment.

6.2 Assessment criteria of the impact on the atmospheric air quality

Kind of impact	Assessment criteria		
	Significant (high) impact	*Average impact*	*Insignificant (low) impact*
Propagation of combustion products	The MAC portion of the polluting substance concentrations in a 500 m zone and at the border of the populated area exceeds 1 and exceeds or almost equals 0,8 at other sensitive receptors (hospital, recreational zone, etc.). The impact is long or constant.Population's dissatisfaction is inevitable.	The MAC portion of the polluting substance concentrations is less than 0,8 at sensitive receptors (hospital, recreational zone, etc.). Excess MAC in a 500 m zone and at the border of the populated area is fixed only in some cases (technological failure); however, the impact will be temporal and can be easily abolished.	The MAC portion of the polluting substance concentrations is less than 0,8 in the design points. Insignificant deterioration of the background quality of the atmospheric air is expected. the population's dissatisfaction is not expected.
Dust propagation	The MAC portion of inorganic or organic dust in a 500 m zone and at the border of the populated area exceeds 1 and exceeds or almost equals 0,8 at other sensitive receptors (hospital, recreational zone, etc.). The impact is long. The population's dissatisfaction is inevitable.	Dust concentration in excess of MAC in the design points is less likely. Significant dust-formation is expected only in some cases (transportation, windy weather). The impact is controllable and provided the mitigation measures are taken, no population's dissatisfaction is expected.	Insignificant increase in dust propagation is expected only in case of vehicle movement or in a windy weather. The impact is controllable provided standard mitigation measures are taken.
Odor propagation	Objectionable odor spreads towards the settled area and sensitive receptors (hospital, recreational zone, etc.) either constantly, or in the windy weather. Population's dissatisfaction is inevitable.	Provided the technological processes are duly accomplished, the odor propagation towards the settled area and sensitive receptors (hospital, recreational zone, etc.) will be minimal. the population's dissatisfaction is not expected.	There is no risk of objectionable odor propagation towards the settled area and sensitive receptors. Objectionable odor spreads over the area adjacent to the unit.
Condition of the working area (combustion products, dust, odor)	It is impossible to work. Using self-contained breathing apparatus or other protective equipment is inefficient.	Combustion products, dust or odor propagates in the work area, but working is possible provided the relevant protective equipment are used or other measures are taken (e.g. cutting the working hours and the like).	The quality of atmospheric air in the work area is satisfactory. There is no need for PPE to use.

6.3 Noise and vibration propagation – Impact Assessment Criteria

Kind of impact	Assessment criteria		
	Significant (high) impact	*Medium impact*	*Significant (high) impact*
Noise propagation	Noise levels at the border of the settled area exceed 55 DbA during the day and 45 dBA at night, or exceeds50 dBA during the day and 40dBA at night at sensitive receptors. Excess noise levels are intense. Population's dissatisfaction is inevitable.	Noise levels at the border of the settled area little exceed 55 DbA during the day and 45 dBA at night; however, the impact is expected only in some cases or is temporal. The noise levels at the sensitive receptors are admissible; however, additional preventive measures are recommended.	The noise background levels have deteriorated a bit near the settled areas or sensitive receptors. In any case, no levels in excess of the admissible levels are expected. It is sufficient to take standard mitigation measures.
Vibration	Due to the use of heavy technique and other methods, vibration spreads to great distances. There is a probability of damage or destruction of buildings and premises, monuments of cultural heritage or disturbance of geological stability.	Vibration does not spread to far places, or the impact is short-term. The probability of damage of buildings and premises, monuments of cultural heritage or disturbance of geological stabilityis very little. Minor and periodic discomfort is expected.	Vibration propagates only in the working zone. No damage of buildings and premises, monuments of cultural heritage or disturbance of geological stability is expected. No addiitonal mitigation measures are needed.
Condition of the working area (noise and vibration)	It is impossible to work. Using ear-plugs or other protective equipment is less inefficient. It is necessary to change the service staff frequently.	Noise and vibration is a nuisance in the working area; but working is possible provided the relevant protective equipment are used or other measures are taken (e.g. cutting the working hours and the like).	The noise and vibration levels in the working zone are not high. No PPE is needed, or if needed only for short periods. An 8-hour-long working day is permitted.

6.4 Assessment criteria of the expected impact on water

Kind of impact	Assessment criteria		
	Significant (high) impact	*Average impact*	*Significant (high) impact*
Changed flow rate of the surface waters	Under the project impact, the natural river flow rate is strongly changed (either for the year, or temporarily); it is difficult to maintain the present state of the water eco-system. Other water-consuming unit has a limited access to water, or due to the increased water flow, the risk of developing hazardous hydrological events has increased.	Under the project impact, the natural river flow rate reduced to 70% (either for the year, or temporarily); however, the water eco-system is mostly maintained. The access of another water-consuming unit to water has not changed, or Under the project impact, the natural river flow rate increased to 110%. The risks of developing the hazardous - hydrological events are possible to eliminate by using relevant protective measures.	Under the project impact, the natural river flow rate reduced to 70% (either for the year, or temporarily). The access of another water-consuming unit to water has not changed, or the unit is not used for other purposes. The river flow rate will not increase under the impact of the project.
Deterioration of the surface water quality, origination of the sewage	Fishing or drinking-and-industrial water object is under the impact, or Significant amount of sewage is expected. Despite building the treatment plant, there is a probability of discharging the excessively polluted waters, or the probability of emergencies is high. Due to the near location of the water body, there is a possibility for the solid remains and liquid mass to enter the water body.	An industrial-household water unit is under the impact. Sewage is originated; however, at the expense of relevant preventive measures (arranging the duly efficient treatment plant, etc.) it is possible to maintain the qualitative state of the surface water. The existing quality may be changed a bit what will have a minor impact on the water biodiversity, or the probability of emergencies to occur is not high. In such a case, the distances are so great that the risks of the polluting substances flowing into the water are minimal.	There are no surface waters near the water object. Therefore, there is only the possibility of indirect impact, which is not major. No sewage is expected to originate, or the small amounts of liquid remains can be managed by using the methods safe for the water environment (e.g. by an evaporating pond, recycling the liquid remains, etc.).
Ground water pollution	The activity implies using the methods creating the risks of excess pollution of the ground waters (e.g. burying the materials containing polluted substances, etc.); mitigation measures are less efficient, or the probability of emergencies to occur is quite likely with the infiltration of the large amounts of oil products or other polluting substances	The activity implies using the methods creating certain risks of pollution of the ground waters; however, using the mitigation measures is efficient and significantly reduce the risks, or there is probability of emergencies to occur; however, relevant preventive measures are taken.	The risks of the ground water pollution are associated with the unforeseen cases only (minor oil product leakages from technique or equipment and the like.). No large amounts of liquid polluting substances are stored or used in the area threatening the ground waters in case of accidents.

	into the ground layers.		
Impact on the flow rate of the underground waters, changed infiltration properties of the grounds	The activity envisages arranging deep engineering facilities, with which it is possible to cross the underground water-bearing infrastructure. As a result, the outflows of the underground waters may decrease, or The activity envisages using large land areas/cutting down the forests what will deteriorate the ground infiltration properties. This may reduce the intensity of the underground water alimentation with the atmospheric precipitations.	The activity does not envisage arranging deep engineering facilities, and in addition, there are no particularly significant water-bearing horizons spreading on the territory. Despite this, cultivation of land areas or the used building and exploitation methods may have a certain impact on the outflows of less valuable springs.	By considering the small project area, used building and exploitation methods and existing hydro-geological conditions, the impact on the flow rate of the underground waters will be minor. No impact on either drinking, or industrial water is expected.

6.5 *Assessment criteria of the expected impact on the soil*

Kind of impact	Assessment criteria		
	Significant (high) impact	*Average impact*	*Significant (high) impact*
Damage and erosion of the fertile soil layer	The project envisages using over 12,5 ha of agricultural plots or other land areas highly valuable in respect of fertility, or the methods used during the building and exploitation promote the activation of the soil erosion processes over significant areas.	The project envisages using less than 12,5 ha of agricultural plots or other land areas valuable in respect of fertility, or the area to manage is more than 12,5 ha, but this is not an agricultural land or is not otherwise valuable, or The methods used during the building and exploitation promote the activation of the soil erosion processes in some areas, but they can be prevented by using the relevant mitigation measures.	The project envisages using less than 12,5 ha of non-agricultural plots or other land areas less valuable in respect of fertility. Provided the fertile soils layer is duly managed, the impact will be minimal. No erosion beyond the used perimeter is expected.
Soil/ground pollution	Due to the methods used during the building and exploitation, the risks of polluting the fertile layer of the agricultural land of any area (exceeding MAC) are quite high or virtually inevitable or the probability of developing such emergencies leading to the pollution of over 100 m^2 area or over the depth of 0,3 m of soil and ground is quite high.	Due to the methods used during the building and exploitation, there are risks of polluting the less valuable surface layer of lands (exceeding MAC) or there is a probability of developing such emergencies leading to the pollution of less than 100 m^2 area or less than the depth of 0,3 m of soil and ground.	Only minor local pollution of soil/ground is expected, mostly in unforeseen cases. The technology of local cleaning the polluted soil can be used.

6.6 Assessment criteria of the expected impact on the geological environment

Kind of impact	Assessment criteria		
	Significant (high) impact	*Average impact*	*Significant (high) impact*
Violation of the stability of the geological environment under the project impact, activation of hazardous processes	The project is planned to implement in the relief with the III degree of complexity in engineering-geological respect. During the earthworks, the probability of activation of such hazardous geodynamic processes, as landslide, rock fall, mudflow, etc. exists, or the risks of activation of the same processes exist in the operation phase of the object (hydrotehcnical facilities, tunnels, etc. can be considered as such object). It is necessary to build the protective facilities of complex structures or to make corrections to the project.	The project is planned to implement in the relief with the II degree of complexity in engineering-geological respect. During the earthworks or in the operating phase, the probability of activation of hazardous geodynamic processes. However, provided the protective measures in terms of simple-structure facilities these can be prevented.	The project is planned to implement in the favorable relief. No significant resources to build protective structures are needed. Only local, minor erosive processes may develop.
Impact of the existing engineering-geological conditions on the project facilities	The engineering-geological properties of the grounds are not favorable needing building deep foundations to establish the facilities on the cliffy rocks, or hazardous geodynamic processes threaten the stability of the object. It is necessary to build the protective facilities of complex structures or to make certain corrections to the project.	The engineering-geological properties of the grounds allow founding the object, but under certain conditions. The degree of the environment (ground and ground waters) aggressiveness to the reinforced concrete is satisfactory, or hazardous geo-dynamic processes pose a certain threat to the object's stability; however, the risk may be eliminated by taking protective measures of a simple structure.	The object is not a facility of a complex structure. The engineering-geological properties of the territory-constituent grounds are satisfactory. Consequently, there is no need for either deep foundations, or significant measures to protect the engineering facilities.

6.7 Assessment criteria of the expected impact on the biological environment

Kind of impact	Assessment criteria		
	Significant (high) impact	*Average impact*	*Significant (high) impact*
Generic and quantitative changes in the vegetation cover	The project implementation will lead to the destroy of the endemic or Red-Listed species or the project implementation will lead to the use of the forested area over 1 ha or there is a risk for invasive kinds to spread	Following the project implementation, the risks of direct or indirect impacts on the endemic or Red-Listed species are minimal or the project implementation will lead to the use of the forested area less than 1 ha	Following the project implementation, there is no risk of impact on the endemic or Red-Listed species. Only the destruction of the homogenous low-value vegetation cover is expected. There is no risk for invasive species to spread.
Deterioration of the animal habitats, habitat loss or fragmentation	The project implementation will lead to the destroy, reduction or fragmentation of the area of the endemic and Red-Listed animal species or certain species may be reduced or certain population may disappear in the project implementation area or the object is a linear object creating a kind of barrier for migrating animals or there is a risk for invasive kinds to spread.	Following the project implementation, the impact on the endemic or Red-Listed species is less likely. The area of such living organisms with no ability to migrate to long distances may decrease, or quantitative changes of certain species are expected in the project implementation area, but their destroy is not likely.	The project area is under the anthropogenic impact and is not a shelter for animal species. Only the animals adapted to the human activity live in the area with high ecological valency. The object is not a barrier hampering the migrating animals.
Immediate impact on fauna specie s	Due to the project implementation, there are some cases of animal perish (including endemic or Red-Listed species) during the year, or increased probability of poaching.	Due to the project implementation, there are few cases of animal perish (less valuable species) during the year	Perish of the animal species is less likely. The impact is short-term. The probability of increased poaching is minimal.
Direct or indirect impacts on the protected areas	Due to small distance and following the methods used at the building and exploitation stages, there are risks of long-term direct or indirect impacts on the territory.	Following the methods used at the building and exploitation stages, there is a risk of indirect impact on the protected area, but the impact is not long.	Due to a great distance, an impact on the protected area is less likely.

6.8 Assessment criteria of the expected impact on the visual-landscape environment

Kind of impact	Assessment criteria		
	Significant (high) impact	*Average impact*	*Significant (high) impact*
Landscape impact	The project implementation is planned within the limits of the rare and high-value landscapes, or the landscape and its components are in fact intact and have high degree of naturalness.	The project implementation is planned within the limits of a regional or local landscape or the landscape and its components are partially transformed due to the human actions. They have an average degree of naturalness.	The project implementation is planned within the limits of a low-value landscape, which can be substituted, or the landscape and its components are quite devastated due to the man's economic activity.
Visual changes	The project area is easily seen from many locations. Implementation of the activity will have a significant impact on the visual effect for the local people or tourists.	The project area is seen from some observation points having no touristic value.	The project area is almost invisible. The building and exploitation will have a minimal impact on the visual effect for the local people or tourists.

6.9 Social Impact Assessment Criteria

Kind of impact	Assessment criteria		
	Significant (high) impact	*Average impact*	*Significant (high) impact*
Positive impact			
Increased budgetary flows	Increased central budgetary flows	*Increased budgetary flows*	Increased central budgetary flows
Employment and growing income of the population	The possibility to hire 70% of workforce from local population or The possibility to hire 40% of workforce from local rural residents or the possibility to hire 20% of workforce from local population in the high-mountain villages.	A total of 30 to 100 people employment opportunities. or Local villagers from 10 to 30 people employment opportunities. or Highland status of rural residents few employment opportunities.	10 persons employment opportunity.
Improvement of	Improvement of the technical state of the	Improvement of the technical state of the roads in	Simplified rehabilitation of rural roads

transport infrastructure	international, state and regional roads, high probability of distress of transport intensity.	some or high-mountainous village and easy transportation.	and transportation
Other social-economic benefit	At a country, regional or municipal level, or for several high-mountainous villages: • Improved waste management conditions. • Improved water-supply and water-drainage conditions. • Improved power supply and gas supply conditions. • Improved accessibility to other kinds of resources. •	For several or high-mountainous villages: • Improved waste management conditions. • Improved water-supply and water-drainage conditions. • Improved power supply and gas supply conditions. • Improved accessibility to other kinds of resources. •	Only some families (homesteads) receive various social-economic benefits.
Negative impact			
Resettlement, need to use private property	One of several cases of physical resettlement, or over 10 cases of economic resettlement, or one or several cases of economic resettlement in a high-mountainous village	Up to 10 cases of economic resettlement. Provided the compensation measures are taken, no population's dissatisfaction is expected	No physical or economic resettlement is expected. Temporal use of the privately owned land plots and units may be needed, with the relevant compensation measures planned.
Deterioration of transport infrastructure	Deterioration of the technical condition of the international, state and regional roads, significant increase of transport intensity.	Deterioration of the technical condition of the roads in some or high-mountainous villages or significant increase in vehicle movement; however, the impact is temporal.	No deterioration of local roads or significant increase of transport intensity is not expected.
Other negative social-economic effects	At a country, regional or municipal level, or for several high-mountainous villages: • Deteriorated waste management conditions and landfill overload. • Deteriorated water-supply and water-drainage conditions or overloaded	For several or high-mountainous villages: • Deteriorated waste management conditions and landfill overload. • Deteriorated water-supply and water-drainage conditions or overloaded relevant systems • Limited accessibility to other resources.	For several families • Deteriorated waste management conditions and landfill overload. • Deteriorated water-supply and water-drainage conditions or overloaded relevant systems

	relevant systems • Limited accessibility to other resources.	•	• Limited accessibility to other resources. However, the problem can be solved by searching alternative routes.

6.10 Assessment criteria of the expected impact on the historical-cultural monuments

Kind of impact	Assessment criteria		
	Significant (high) impact	*Average impact*	*Significant (high) impact*
Damage to the historical-cultural monuments	Due to the small distance and following the methods used in the building and exploitation phases, there is a probability of damaging the monuments of the international or local historical-cultural heritage.	Due to the small distance and following the methods used in the building and exploitation phases, there is a probability of damaging the monuments of the local historical-cultural heritage.	Due to the great distance, the probability of damaging the monuments of historical-cultural heritage is less likely.
Unforeseen damage to the archeological monuments	Following the historical designation of the project area, there is a probability of the late identification of the archeological monuments.		The area is quite anthropogenic. Therefore, identification of the recent archeological monuments is less likely.

7. DESCRIPTION OF THE PROJECT ENVIRONMENTAL IMPACT AND ASSESSING THE IMPACT VALUE

The environmental impact is assessed for two project phases: construction and operation phases of the highway. The environmental impact assessment is done based on the principal data given above. In particular, the following aspects were taken into account:

- Project specifics, engineering solutions and technological approaches used during the construction and operation processes;
- The existing state of the natural and social environment of the corridor selected for the planned activity;
- Criteria developed in advance to assess the expected impact on each environmental object.

The following types of environmental impacts of the project implementation were considered:

Design phase **Expected impact**	**Construction phase**	**Exploitation phase**
• Emission of harmful substances in the atmosphere	⊕	⊕
• Noise and vibration	⊕	⊕
• Impact on geological environment	⊕	
• Risks of impact on water environment	⊕	⊕
• Risks of impact on soil, pollution risks	⊕	⊕
Impact on the vegetation cover and animal species	⊕	⊕
• Visual-landscape changes	⊕	⊕
• Impact on the social-economic environment	⊕	⊕
• Risks of impact on the historical and archeological monuments	⊕	
• Transboundary impacts	☐	☐
• Cumulative impact	☐	☐

Below, we give a brief description of each kind of impact. The maps in Annex 6 give the general information about spatial nature of each kind of impat. Maps show the areas relatively sensitive to the impact in the construction and exploitation phases.

7.1 Impact on atmospheric air quality – emissions in the construction and operation phases

7.1.1 Construction Phase

The risk of atmospheric air pollution in the construction phase is mainly the stationery air polluting sources provided on the construction camp, such as concrete plant, storage areas of inert materials, fuel reservoirs, etc.

Deterioration of the air quality is also expected during the earthworks in the project area and in the areas adjacent to it, as well as from transport traffic, their exhaust fumes and dusting of the non-faced roads.

Consequently, the number of the sources of emission (emissions of harmful substances) in the atmospheric air was calculated. It should also be noted that the operation of a crushing and storing plant is not planned on the territory of the construction camp. However, the emission calculation given below considers the operation of such a plant, too.

7.1.1.1 Quantitative calculations of the emission (emissions of harmful substances) in the atmospheric air for the construction camp

Concrete plant is an assembly-type stationary structure. The facility includes: batching plant, inert material supply system, pneumatic system, automatic control system and operator's cabin.

Batching plant consists of cranes, transporter and band conveyers, which provides automatic supply of inert material.

Inert material dosing system consists of collecting tank and automatic batcher. The batcher is equipped with precise dosage and delivery system which provides automatic adjustment of the concrete mass.

Water and admixture (in liquid phase) supply system includes balancing chamber which ensures precise dilution. The system is equipped with anticorrosion pump equipment.

The control system is automatic. It has a modern computer controller, which ensures automatic control during the concrete production process as well as automatic water level adjustment.

Concrete loading (equipped with a fabric filter) into the silo, transporting and production of concrete mass will be conducted in the hermetic environment what will reduce air pollution.

Concrete plants (concrete units) do not cause much air pollution, since after mixing naturally wet materials and cement, the technological process is accomplished by using wet method.

The following technological processes and equipment are the source of ambient air pollution:

Cement silos (G-1), road building transport parking area (G-2), diesel reservoir (G-3), crushing and sorting complex (G-4), band conveyors (G-5), supplying, storage and warehousing inert materials (G-6) and warehousing and storing fractioned gravel (G-7).

The actual moisture of gravel varies from 9 to 10 %, and that of sand is >10%.

Plant will be equipped with two cement silos with 100 t total capacity (with relevant filters); open storages for sand and gravel (300 m2 each). The total length of the band conveyors will be 10m; and their width will be 1,0 m.

The emission is calculated for the maximum values of materials. Concrete formula (to produce 1 m3 of concrete) is as follows: sand – 650 kg, gravel – 1100 kg, cement – 420 kg.

Maximum nominal capacity of the batching plant is 60 m3/h. Maximum possible capacity for one-shift work and per annum (150 days of work) is 60 m3/h * 8hr/day * 150 day/year = 54,0 thousand m3/year.

The cement will be supplied immediately from the selected supplier. The inert materials will be supplied from the licensed quarries. The maximum expenditure of the materials is calculated based on the annual output:

Sand - 0,65t * 60 m^3/hr * 900 hr/year = 35,1 thous. t/year.

(Following the tehcnological process, the sand humidity is more than 3%. Thus, emission will not be calculated as per [5]. Gravel: 1,10 t * 60mə^3/hr * 900 hr/year = 59,4 thous. t/year [66 t/hr]

Cement -0,420t * 60 m^3/hr * 900 hr/year = 22,68 thous. t/year [25,2 t/hr]

Proper equipment will be installed at the plant to receive these products and the proper engineering infrastructure will be provided.

According to the basic typical flow chart, the inert materials supplied with vehicles will be stored at relevant storehouses (with sand and gravel separately). The auto-loader will transport gravel and sand to the hoppers (4 hoppers sizes 3x3 m) through the ramp. Then, it will be supplied to the concrete unit via the band conveyor and batcher. At the same time, the computer system doses the right proportions of the ingredients (sand, gravel, cement) by considering the needed grade of concrete production and will send it to the mixing aggregate. An hourly design capacity is 60 m3/hr. The ready concrete will be transported with concrete haulers to the end consumer.

Emission calculation from the cement silo (G-1)

The technological process of concrete production implies loading the cement into a silo from the cement truck by using a pneumatic method and its dosed supply by using a worm-and-peg method through the scales and directly into the mixer, where sand, grit, water and chemical additive (plasticizer) components are added in advance in line with the receipt.

As per the plant data, 54,0 thousand tons of cement must be supplied to a silo a year. The silo is equipped with a standard fabric filter, with a stated efficiency of 99,8% (a small sleeved fabric filter, grade КФЕ-С, so called "silo filter" is destined for the aspiration of excess pressure of the silos. Regeneration with compressed air. The filtered dust returns to the silo. The filter length is 200 m. The air consumption range is 300-1000m3/h. The filtration area is 5-200m^2.

As per [3], the annual emission of cement dust will be 54 000 t * 0,8kg/t * 10^{-3} = 43,2 t/year; The emission, by considering the stated efficiency of the fabric filter will be:

84000 t x 0,8kg/t x 10^{-3} = 67,2 t/year

43,2 t/year * (1-0,998)= 0,0864 t/year. Calculation of a per-second emission of maximum single emission (g/sec):
Average load-carrying capacity of one cement truck is 30 t, the time of unloading is 1 hr (3600 sec); per-second emission of cement dust will be: 30t x 0,8kg/t x 103 / 3600sec = 6,667 g/sec;
By considering the efficiency of the fabric filter, we obtain: 6,667 g/sec x(1-0,998)= 0,014 g/sec.
The concrete mixer itself is a system closed from all sides and having no contact with the atmospheric air. Consequently, no dust is emitted into the atmospheric air.
(The elastic pipe installed on the concrete mixer is connected to the upper bunker and the dust originated during the materials loading, is directed backwards).

Table 7.1.1.1.1 Calculated emission

Code	Description of substance	%	Mass (gr/sec)	Mass (t/year)
2908	Inorganic (cement) dust	100	0,014	0,0864

Calculation of emission from the parking area of road-building machines (g-2) Excavator, 2

pcs.

The sources of emission of polluting substances are road-building machine engines at engine launching, heating, movement across the area and idling.

The calculations are made in line with methodical guidelines [7]

The quantitative and qualitative properties of the pollutant emission from the road-building machines are given in Table 7.1.1.1.2.

Table 7.1.1.1.2. Quantitative and qualitative properties of emisison of polluting substances from the road-building machines parking area

Pollutant		Max. emission, gr/sec	Annual emission, t/year
Code	Description		
301	Nitrogen dioxide (Nitrogen (IV) oxide)	0.01212	0.0198
304	Nitrogen (II) oxide	0.001969	0.0032166
328	Soot	0.0017	0.002745
330	Sulphur dioxide	0.0015158	0.0022193
337	Carbon oxide	0.02045	0.02421
2732	Hydrogen oil fraction	0.0039	0.005445

The calculation is accomplished for the emissions from the road-building machines parking area at the environmental temperature. The driving distance of the road-building machines when leaving the parking area is 0,1 km and it is -0,1 km when entering the parking area. The duration of the engine operation when idling in case of leaving the parking area is 0 minute and it is 0 minute in case of returning to the parking area.

The source data to calculate the emission of polluting substances are given in Table 7.1.1.1.3.

Table. 7.1.1.1.3. Source calculation data

Machine name	Type of machine	Maximum number of machines				Electrical starter	Simultaneity
		Total	Leave/entry	Leave in 1 hour	Entry in in 1 hour		
	excavator with capacity 61-100 kV (83-136 hp)	3	3	3	0	10	+

The accepted legend, calculation formulae and calculation parameters and their substantiation are given below:
The emission of the i^{th} substance from one unit of a k^{th} type when leaving the territory ***M'ik*** and at returning to territory ***M''ik*** a day is calculated by formulae:

$M1ik = mПP\,ik \cdot tПP + mL\,ik \cdot L1 + mXX\,ik \cdot tXX\,1$, **gr**

$M2ik = mL\,ik \cdot L2 + mXX\,ik \cdot tXX\,2$, gr

Where:

mПPik– is the specific emission of the i^{th} substance during the heating of the vehicle engine of a k^{th} type, g/min.

mL ik– is the specific emission of the i^{th} substance during the driving of the vehicle of a k^{th} type with the speed of 10-12 km/h, g/km.

mXXik– is the specific emission of the i^{th} substance during the idling of the vehicle of a k^{th} type, g/min.

tПP- is the time of launching engine or engine heating, min.

L1, ***L2***- is the heating regime of the vehicle on the territory of the parking area, km;

tXX1, *tXX2*- is the engine idling at leaving or returning to the territory of the parking area, min;

Total emission of the i[th] substance from the oadc buildingb machines for each period of the year is calculated with an individual formula:

$M_i = \sum_{k=1}^{k} (M'_{ik} + M''_{ik}) \cdot N_k \cdot D_P \cdot 10^{-6}$, t/year;
Where:
Nk – is the number of vehicles of a k^{th} type working every day;

DP- is the number of working days in the design period (warm, transient, cold).

j- is the period of a year (T- Warm, Π- Transient, X-Cold).

Mi total annual emission of et same substances are summarized in different seasons of the year:

$M_i = M^{T}i + M^{\Pi}i + M^{X}i$, t/year;

Total single emission of the *k*-th substance Gi is calculated by formula:

$G_i = \sum_{k=1}^{k} (M'_{ik} \cdot N'_k + M''_{ik} \cdot N''_k) / 3600$, gr/sec;

Where;
N'_k, N''_k – is the number of vehicles of a k^{th} type leaving and entering the parking area in 1 hour and is characterized by maximum intensity of the vehicles leave/entry;

Out of the obtained values of *Gi* , the maximum single emission (g/sec) by considering the simultaneity of movement of vehicles of different groups will be selected.

Specific emission of polluting substances *i* during the launching engine heating and engine heating, movement or idling are given in Table **7.1.1.1.4.**

Table 7.1.1.1.4. Specific emissions of pollutants, gr/min

Type	Pollutant	Launch	Heating the engine			Driving			Idling
			T	Π	X	T	Π	X	
Excavator with capacity 61-100 kV (83-136 hp)									
	Nitrogen dioxide (Nitrogen (IV) oxide)	1,36	0,384	0,576	0,576	1,976	1,976	1,976	0,384
	Nitrogen (II) oxide	0,221	0,0624	0,0936	0,0936	0,321	0,321	0,321	0,0624
	Soot	-	0,06	0,324	0,36	0,27	0,369	0,41	0,06
	Sulphur dioxide	0,042	0,097	0,108	0,12	0,19	0,207	0,23	0,097
	Carbon oxide	25	2,4	4,32	4,8	1,29	1,413	1,57	2,4
	Hydrogen oil fraction	-	0,3	0,702	0,78	0,43	0,459	0,51	0,3

Engine heating regime is not considered in the calculations. The maximum single and annual emissions of polluting substances are calculated below:

M'301 = 0,384 · 2 + 1,976 · 1 / 10 · 60 + 0,384 · 5 = 14,544 gr;
M''301 = 1,976 · 1 / 10 · 60 = 11,856 gr;
M301 = (14,544 + 11,856) · 250 · 3 · 10^{-6} = 0,0198 t/year;
G¯301 = (14,544 · 3 + 11,856 · 0) / 3600 = 0,01212 gr/sec.
M'304 = 0,0624 · 2 + 0,321 · 1 / 10 · 60 + 0,0624 · 5 = 2,3628 gr;
M''304 = 0,321 · 1 / 10 · 60 = 1,926 gr;
M304 = (2,3628 + 1,926) · 250 · 3 · 10^{-6} = 0,0032166 t/year;
G¯304 = (2,3628 · 3 + 1,926 · 0) / 3600 = 0,001969 gr/sec.
M'328 = 0,06 · 2 + 0,27 · 1 / 10 · 60 + 0,06 · 5 = 2,04 gr;
M''328 = 0,27 · 1 / 10 · 60 = 1,62 gr;
M328 = (2,04 + 1,62) · 250 · 3 · 10^{-6} = 0,002745 t/year;

$G^{-}328 = (2{,}04 \cdot 3 + 1{,}62 \cdot 0) / 3600 = 0{,}0017$ gr/sec.
$M'330 = 0{,}097 \cdot 2 + 0{,}19 \cdot 1 / 10 \cdot 60 + 0{,}097 \cdot 5 = 1{,}819$ gr;
$M''330 = 0{,}19 \cdot 1 / 10 \cdot 60 = 1{,}14$ gr;
$M330 = (1{,}819 + 1{,}14) \cdot 250 \cdot 3 \cdot 10^{-6} = 0{,}0022193$ t/year;;
$G^{-}330 = (1{,}819 \cdot 3 + 1{,}14 \cdot 0) / 3600 = 0{,}0015158$ gr/sec.
$M'337 = 2{,}4 \cdot 2 + 1{,}29 \cdot 1 / 10 \cdot 60 + 2{,}4 \cdot 5 = 24{,}54$ gr;
$M''337 = 1{,}29 \cdot 1 / 10 \cdot 60 = 7{,}74$ gr;
$M337 = (24{,}54 + 7{,}74) \cdot 250 \cdot 3 \cdot 10^{-6} = 0{,}02421$ t/year;
$G^{-}337 = (24{,}54 \cdot 3 + 7{,}74 \cdot 0) / 3600 = 0{,}02045$ gr/sec.
$M'2732 = 0{,}3 \cdot 2 + 0{,}43 \cdot 1 / 10 \cdot 60 + 0{,}3 \cdot 5 = 4{,}68$ gr;
$M''2732 = 0{,}43 \cdot 1 / 10 \cdot 60 = 2{,}58$ gr;
$M2732 = (4{,}68 + 2{,}58) \cdot 250 \cdot 3 \cdot 10^{-6} = 0{,}005445$ t/year;
$G^{-}2732 = (4{,}68 \cdot 3 + 2{,}58 \cdot 0) / 3600 = 0{,}0039$gr/sec.

Trucks, 5 pcs.
The sources of emission of polluting substances are road-building machine engines at engine launching, heating, movement across the area and idling.

The calculations are made in line with the following methodical guidelines [7]

The quantitative and qualitative properties of the pollutant emission from the road-building machines are given in Table 7.1.1.1.5.

Table 7.1.1.1.5. Quantitative and qualitative properties of the pollutant emission from the road-building machines parking area

Pollutant		Max. emission, gr/sec	Annual emission, t/year
Code	Description		
301	Nitrogen dioxide (Nitrogen (IV) oxide)	0,0098889	0,0124
304	Nitrogen (II) oxide	0,0016069	0,002015
328	Soot	0,0007222	0,0009625
330	Sulphur dioxide	0,00175	0,0021375
337	Carbon oxide	0,0420833	0,04425
2732	Hydrogen oil fraction	0,0057917	0,0063375

The calculation is accomplished for the emissions from the road-building machines parking area at the environmental temperature. The driving distance of the road-building machines when leaving the parking area is 0,1 km and it is -0,1 km when entering the parking area. The duration of the engine operation when idling in case of leaving the parking area is 0 minute and it is 0 minute in case of returning to the parking area. The number of working days is 250, including 250 transient days.

The source data to calculate the emission of polluting substances are given in Table 7.1.1.1.6.

Table. 7.1.1.1.6. Source calculation data

Machine name	**Type of machine**	**Maximum number of machines**				**Electrical starter**	**Simultaneity**
		Total	Leave/entry	Leave in 1 hour	Entry in in 1 hour		
	Truck with capacity of from 8 to 16 tons	5	5	5	0	-	-

The accepted legend, calculation formulae and calculation parameters and their substantiation are given

below:
The accepted legend, calculation formulas, design parameters and their substantiation are given below:

The emission of the i^{th} substance from one unit of a k^{th} type when leaving the territory $M'ik$ and at returning to territory $M''ik$ a day is calculated by formulae:

$$M'_{ik} = m_{П\,ik} \cdot t_{П} + m_{ПР\,ik} \cdot t_{ПР} + m_{ДВ\,ik} \cdot t_{ДВ\,1} + m_{XX\,ik} \cdot t_{XX\,1},\ gr$$

$$M''_{ik} = m_{ДВ\,ik} \cdot t_{ДВ\,2} + m_{XX\,ik} \cdot t_{XX\,2},\ gr$$

Where:
$m_{П\,ik}$– is the emission of the i^{th} substance from the driving engine, gr/min;
$m_{ПР\,ik}$ –is the emission of the i^{th} substance from the driving engine during headting for k^{th} group, gr/min;
$m_{ДВ\,ik}$– is the emission of the i^{th} substance during the vehicle driving conventionally with a permanent speed for k^{th} group, gr/min;
$m_{XX\,ik}$– is the emission of the i^{th} substance during the idling of the vehicle of a k^{th} type, g/min;
$t_{П}$, $t_{ПР}$ - is the time of launching engine or engine heating, min;
$t_{ДВ\,1}$, $t_{ДВ\,2}$– is the machine time at leaving or returning to the territory calculated by the ratio of the averag driving speed and driven distance, min;
$t_{XX\,1}$, $t_{XX\,2}$–is the machien engine operation time at idling at leaving or returning to the territory, min.

When accomplishing the ecological control, the specific emission of vehicles reduces. Therefore, the emission values must be calculated by formula:

$$m'_{ПР\,ik} = m_{ПР\,ik} \cdot K_i,\ gr/min.\quad m''_{XX\,ik} = m_{XX\,ik} \cdot K_i,\ gr/min.$$

Where:

Ki – is the coefficient, considering the reduction of the i^{th} polluting substance during the ecological control.

When calculating emissions from the road construction machine equipped with an electric drive starter, $m_{\Pi ik} \cdot t_{\Pi}$ member of the formula is not taken into account.
The total emission of the i^{th} polluting substance is calculated for each individual year by formula:
$M^j_i = \sum^k_{k=1}(M'_{ik} + M''_{ik}) \cdot N_k \cdot D_P \cdot 10^{-6}$, t/year;
Where:
Nk – is the number of vehicles of a k^{th} type working every day;

DP- is the number of working days in the design period (warm, transient, cold).

j– is the period of a year (T- Warm, П- Transient, X-Cold).

Mi total annual emission of the same substances are summarized in different seasons of the year

$$M_i = M^T_i + M^{\Pi}_i + M^X_i, \text{ t/year;}$$

Maximum single emission of the *k*-th substance Gi is calculated by formula:

$G_i = \sum^k_{k=1}(M'_{ik} \cdot N'_k + M''_{ik} \cdot N''_k) / 3600$, gr/sec;
Where:

N'_k, N''_k – s the number of vehicles of a k^{th} type leaving and entering the parking area in 1 hour and is characterized by maximum intensity of the vehicles leave/entry;

Out of the obtained values of ***Gi*** , the maximum single emission (g/sec) by considering the simultaneity of movement of vehicles of different groups will be selected.

Specific emission of polluting substances *i* during the launching engine heating and engine heating, movement or idling are given in Table 7.1.1.1.7.

Table 7.1.1.1.7. Specific emissions of pollutants, gr/min

Type	Pollutant	Launch	Heating the engine			Driving			Idling	Ecological control, K_1
			T	П	X	T	П	X		
Truck with 8-16 t capacity										
	Nitrogen dioxide (Nitrogen (IV) oxide)	-	0,48	0,64	0,64	2,8	2,8	2,8	0,48	1
	Nitrogen (II) oxide	-	0,078	0,104	0,104	0,455	0,455	0,455	0,078	1
	Soot	-	0,03	0,108	0,12	0,25	0,315	0,35	0,03	0,8
	Sulphur dioxide	-	0,09	0,0972	0,108	0,45	0,504	0,56	0,09	0,95
	Carbon oxide	-	2,8	3,96	4,4	5,1	5,58	6,2	2,8	0,9
	Hydrogens oil fraction	-	0,38	0,72	0,8	0,9	0,99	1,1	0,35	0,9

Engine heating regime is not considered in the calculations.

The calculations of the annual and maximum pollutant emissions are given below;
M1 = 0,48 · 4 + 2,8 · 1 + 0,48 · 5 = 7,12 gr;
M2 = 2,8 · 1 = 2,8 gr;
M301 = (7,12 + 2,8) · 250 · 5 · 10^{-6} = 0,0124 t/year;
G301 = (7,12 · 5 + 2,8 · 0) / 3600 = 0,0098889 gr/sec.
M1 = 0,078 · 4 + 0,455 · 1 + 0,078 · 5 = 1,157 gr;
M2 = 0,455 · 1 = 0,455 gr;
M304 = (1,157 + 0,455) · 250 · 5 · 10^{-6} = 0,002015 t/year;
G304 = (1,157 · 5 + 0,455 · 0) / 3600 = 0,0016069 gr/sec.

M1 = 0,03 · 4 + 0,25 · 1 + 0,03 · 5 = 0,52 gr;
M2 = 0,25 · 1 = 0,25 gr;
M328 = (0,52 + 0,25) · 250 · 5 · 10^{-6} = 0,0009625 t/year;
G328 = (0,52 · 5 + 0,25 · 0) / 3600 = 0,0007222 gr/sec.
M1 = 0,09 · 4 + 0,45 · 1 + 0,09 · 5 = 1,26 gr;
M2 = 0,45 · 1 = 0,45 gr;
M330 = (1,26 + 0,45) · 250 · 5 · 10^{-6} = 0,0021375 t/year;;
G330 = (1,26 · 5 + 0,45 · 0) / 3600 = 0,00175 gr/sec.
M1 = 2,8 · 4 + 5,1 · 1 + 2,8 · 5 = 30,3 gr;
M2 = 5,1 · 1 = 5,1 gr;
M337 = (30,3 + 5,1) · 250 · 5 · 10^{-6} = 0,04425 t/year;
G337 = (30,3 · 5 + 5,1 · 0) / 3600 = 0,0420833 gr/sec.
M1 = 0,38 · 4 + 0,9 · 1 + 0,35 · 5 = 4,17 gr;
M2 = 0,9 · 1 = 0,9 gr;
M2732 = (4,17 + 0,9) · 250 · 5 · 10^{-6} = 0,0063375 t/year;
G2732 = (4,17 · 5 + 0,9 · 0) / 3600 = 0,0057917 gr/sec.

Total emissions from the parking area:

Pollutant		Max. emission, gr/sec	Annual emission, t/year
Code	Description		
301	Nitrogen dioxide (Nitrogen (IV) oxide)	0.022009	0,0322
304	Nitrogen (II) oxide	0.003576	0,005232
328	Soot	0.002422	0,003708
330	Sulphur dioxide	0.003266	0,004357
337	Carbon oxide	0.062533	0,06846
2732	Hydrogens oil fraction	0.009692	0,011783

Emission calculation from a diesel reservoir (G-3)

The reservoir inspiratory valve is the source of atmospheric air pollution during the storage of oil products (small inspiration) and loading them (big inspiration). Climatic zone: 3.

The emissions of polluting substances are calculated in line with [8]. The quantitative and qualitative properties of polluting substances are given in Table 7.1.1.1.8.

Table 7.1.1.1.8.

Pollutant		Max. single emission, g/sec	Annual emission, t/year
Code	Description		
333	Dihydrosulfide (Hydrogen sulfide)	0.0000549	0,0000044
2754	Alkanes C_{12}-C_{19} (Saturated hydrogens C_{12}-C_{19})	0.0195451	0,001572

The source data to calculate the emission are given in Table 7.1.1.1.9.

Table 7.1.1.1.9.

Product	Qty a year, t/year		Reservoir design	Pump output, m3/h	Reservoir capacity, m3	Number of reservoirs	Simultaneity
	Bმ ზ	Bგ ზ					

Diesel fuel, group A. The liquid temperature is close to the air temperature	160	160	Above-ground vertical exploitation mode “dosing”. Emission limiting system – No	20	20	1	+

The accepted legend, calculation formulae and calculation parameters and their substantiation are given below.

Maximum emission of the oil products vapor (g/sec) is calculated by formula:

$$M = (C1 \cdot K^{max}_{p} \cdot V^{max}_{ч}) / 3600, \text{ gr/sec};$$

Annual emission of the oil products vapor is calculated by formula:

$$G = (У2 \cdot B_{оз} + У3 \cdot B_{вл}) \cdot K^{max}_{p} \cdot 10^{-6} + G_{xp} \cdot K_{нп} \cdot N, \text{ t/year}.$$

Where: $У2, У3$ –is the evarage specific emission from a reservoir during the year, in autumn-winter and spring-summer periods respectively, g/t. Its value is obtained from Annex 12.
$B_{оз}, B_{вл}$ – is the amount of liquid to be loaded in the reservoir in autumn-winter and spring-summer periods, respectively, t.
K^{max}_{p} - is the multiplier gained from the experiment. Its value is obtained from Annex 8.
G_{xp} - is the emission of oil products stored in one reservoir, t/year. Its value is obtained from Annex 13
$K_{нп}$ -is the multiplier gained from the experiment. Its value is obtained from Annex 12.
N - is the number of reservoirs.
Maximum single and annual emissions of the polluting substances in the atmospheric air are calculated below.

Diesel fuel
$M = 3{,}92 \cdot 0{,}9 \cdot 20 / 3600 = 0{,}0196$ gr/sec;
$G = (2{,}36 \cdot 160 + 3{,}15 \cdot 160) \cdot 0{,}9 \cdot 10^{-6} + 0{,}27 \cdot 0{,}0029 \cdot 1 = 0{,}0015764$t/year;
333 Dihydrosulfide (Hydrogen sulfide)
$M = 0{,}0196 \cdot 0{,}0028 = 0{,}0000549$ gr/sec;
$G = 0{,}0015764 \cdot 0{,}0028 = 0{,}0000044$ t/year;

2754 Alkanes C12-C19 (Saturated hydrogens C12-C19)
$M = 0{,}0196 \cdot 0{,}9972 = 0{,}0195451$ gr/sec;
$G = 0{,}0015764 \cdot 0{,}9972 = 0{,}001572$ t/year;

Emission calculation from the crushing plant (G-4)

The calculations are made in line with methodical guidelines [3]

The coefficients of specific dust emissions during the production of raw materials are as follows:
For primary and secondary crushing: (a) dry material - 0,14 kg/t, (b) wet material - 0,009 kg/t;

Following the technical process, the inert material is processed by using a wet method. So, the calculations use coefficient 0,009 kg/t

94 500 t/year × 0,009 kg/t ÷ 1000 = 0,8505 t/year
0,8505 t/year ÷ 6h/day ÷ 150day/year ÷ 3600 × 1000000 = 0,2625gr/sec

Under Recommendation [3], during the technological process, followed by the emission of the weighted particles in the absence of closed buildings, or in the building not equipped by general exchange ventilation (emission takes place from the windows or door openings), or in the absence of the exhaust system, during the calculation of the emission of solid components into the atmospheric air, it is purposeful to correct the calculated value of the emission of harmful substances with 0,4 coefficient.

The value calculated in terms of the corrected emission is multiplied by coefficient 0,4:

Inorganic dust: (2908)
0,2625 × 0,4 = 0,105 gr/sec;
0,8505 × 0,4 = 0,3402 t/year.

Emission calculation from a belt conveyor (G-5)
The calculation is accomplished in line with methodical guidance [4].
The transportation is done by means of open conveyor belts with the width of 1 m. Its total length is 10 m. The design wind velocities (m/sec) are: 0,5(**K3= 1**); 5 (**K3= 1,2**). An average wind velocity: 2 (**K3= 1,2**)

The quantitative and qualitative properties of emisison of polluting substances are given in Table 7.1.1.1.10.

Table 7.1.1.1.10. Quantitative and qualitative properties of emission of polluting substances as per methodology

Pollutant		Maximum emission, gr/sec	Annual emission, t/year
Code	Description		
2908	Grit	0.0032507	0,0087768

The source data to calculate the emission of polluting substances are given in Table 7.1.1.1.11.

Table 7.1.1.1.11.

Materials	Parameters	Simultaneity
Grit	Operation time-900h/year; humidity: up to 10% (*K5* = 0,1). size of particles-5-10mm. (*K7* = 0,6). specific dusting-0,0000045 kg/m^2*sec	+

The accepted legend, calculation formulae and calculation parameters and their substantiation are given below.
The emission of the total mass of weighted particles occurring during the material transportation with an open belt conveyor, is determined by formula:

MK = 3,6 • K3 • K5 • WK • L • l • γ • T, t/year;

Where:
Where,
K3 – is the multiplier, considering local weather conditions;
K5 – is the multiplier, considering the material humidity;
WK – is the specific dust-formation from the belt conveyor, kg/m2*sec;
L - is the width of the belt conveyor, m.
l- is the length of the belt conveyor, m.
γ - multiplier, considering the forming of fine particles of the material;
T- is the annual operating time, h/year;

Maximum single emission originated during the material transportation from an open belt conveyor, is determined by formula:
M'K = K3 • K5 • WK • L • l • γ • 10^3, gr/sec;

Maximum single and annual emissions of the polluting substances in the atmospheric air are calculated below:
M'2902$^{0.5 m/sec}$ = 1 · 0,1 · 0,0000045 · 10 · 1 · 0,6 · 10^3 = 0,0027089 gr/sec;
M'2908$^{5 m/sec}$ = 1,2 · 0,1 · 0,0000045 · 10 · 1 · 0,6 · 10^3 = 0,0032507 gr/sec;
M2908 = 3,6 · 1 · 0,1 · 0,0000045 · 10 · 1 · 0,6 · 900 = 0,0087768 t/year.

Emission calculation from keeping and storage of inert materials (G-6)

Warehousing

The calculation is accomplished as per methodological guidance **[4].**

Unloading of the bulk materials is done without a loading sleeve. As for the local conditions, the warehouse is open from all sides ($K4$ = 1); The height of the material unloading is 1,0 m (B = 0,5); volley unloading from the truck is done of over 10 t of the material (K_9 =0,1); design wind velocities (m/sec): 0,5 ($K3$ = 1); 5 ($K3$ = 1,2); average annual wind velocity: 1,95 ($K3$ = 1).

The quantitative and qualitative properties of emissions of polluting substances are given in Table 7.1.1.1.12..

Table 7.1.1.1.12. Quantitative and qualitative properties of emission of polluting substances

Pollutant		Max. emission, gr/sec	Annual emission, t/year
Code	Description		
2908	Inorganic dust withthe content of silicium dioxide of 70-20%	0,028	0,0756

The source data to calculate the emission of polluting substances are given in Table. 7.1.1.1.13.

Table 7.1.1.1.13. Source calculation data

Materials	Parameter	Simultaneity
Inert material	Quantity of the unloaded material: Gч = 105t/hr; G_{annual}= 94500t/year. The mass share of a dust fraction in the material: K_1= 0,04. The share of dust converting into aerosol: K_2= 0,02. humidity10% (K_5= 0,1). material sizes 500-100 mm (K_7= 0,2).	+

The accepted legend, calculation formulae and calculation parameters and their substantiation are given below:

A maximum single dust emission is calculated by formula:
$МГР = K1 \cdot K2 \cdot K3 \cdot K4 \cdot K5 \cdot K7 \cdot K8 \cdot K9 \cdot B \cdot Gч \cdot 10^6 / 3600$, gr/sec
Where:
$K1$- is the weight part of dust fraction in the material (0-200 mkm);
$K2$- is the dust part (of the total dust weight part) transforming into an aerosol (0-10 mkm);
$K3$-is the multiplier, considering the local weather conditions;
$K4$-is the multiplier, considering the local conditions, degree of protection of the unit against the external impact, conditions of dust-formation;
$K5$-is the multiplier, considering the material humidity;
$K7$-is the multiplier, considering the material sizes;
$K8$- is the correction multiplier for various materials by considering the dipper types when using a different type of a transfer; $K8$ = 1;
$K9$- is the correction multiplier for volley unload from the truck;
B –is the multiplier, considering the dropping height;
$Gч$–c is the amount of the material to transfer in one hour (t/h).
The total annual dust emission is calculated by formula:
$ПГР = K1 \cdot K2 \cdot K3 \cdot K4 \cdot K5 \cdot K7 \cdot K8 \cdot K9 \cdot B \cdot Gгод$, t/year.
Where:
$Gгод$ - is the annual amount of the material to transfer, t/year;
Maximum single and annual emissions of the polluting substances in the atmospheric air
are calculated below.

<u>Inert material</u>

$M2908^{0.5\ m/sec} = 0{,}04 \cdot 0{,}02 \cdot 1 \cdot 1 \cdot 0{,}1 \cdot 0{,}2 \cdot 1 \cdot 0{,}1 \cdot 0{,}5 \cdot 105 \cdot 10^6 / 3600 = 0{,}0233333$ gr/sec;

$M2908^{5\ m/sec} = 0{,}04 \cdot 0{,}02 \cdot 1{,}2 \cdot 1 \cdot 0{,}1 \cdot 0{,}2 \cdot 1 \cdot 0{,}1 \cdot 0{,}5 \cdot 105 \cdot 10^6 / 3600 = 0{,}028$ gr/sec;

$П2908 = 0{,}04 \cdot 0{,}02 \cdot 1 \cdot 1 \cdot 0{,}1 \cdot 0{,}2 \cdot 1 \cdot 0{,}1 \cdot 0{,}5 \cdot 94500 = 0{,}0756$ t/year.

Storage:

The calculation is accomplished as per methodological guidance [4]

The quantitative and qualitative properties of emisison of polluting substances are given in Table 7.1.1.1.14.

Table 7.1.1.1.14. Quantitative and qualitative properties of emisison of polluting substances

Pollutant		Max. emission, gr/sec	Annual emission, t/year
Code	Description		
2908	Inorganic dust withthe content of silicium dioxide of 70-20%	0,0036746	0,006932

The maximum single emission of dust during the storage of the bulk material is calculated by formula:

$M_{XP} = K_4 \cdot K_5 \cdot K_6 \cdot K_7 \cdot q \cdot F_{раб} + K_4 \cdot K_5 \cdot K_6 \cdot K_7 \cdot 0{,}11 \cdot q \cdot (F_{пл} - F_{раб}) \cdot (1 - \eta)$, gr/sec

Where:

K_4-is the multiplier, considering the local conditions, degree of protection of the unit against the external impact and conditions of dust-formation;

K_5-is the multiplier, considering the material humidity;

K_6-is the multiplier, considering the profile of the stored material;

K_7-is the multiplier, considering the sizes of the material;

$F_{раб}$- is the area in the plan with regular warehousing operations (m²);

$F_{пл}$- is the area of dust-formation in the plan (m²);

q – is the maximum single emission (g/sec) of specific dust formation, g/(m²*sec);

η – is the emission reduction degree by using a dust-reducer system.

The value of multiplier K_6 is determined by formula:

$K_6 = F_{макс} / F_{пл}$

Where:

$F_{макс}$ - is the factual area of the stored material in terms of a full warehouse, m²;

The maximum value of the dust specific dust-formation is determined by formula: g/(m₂*sec);

$q = 10^{-3} \cdot a \cdot U^b$, gr/(m²*sec);

Where:

a and b – are empirical coefficients depending on the type of the material to transfer;

U_b –is the wind velocity, m/sec;

Total annual dust emission in case of warehousing the bulk material is calculated by formula:

$П_{XP} = 0{,}11 \cdot 8{,}64 \cdot 10^{-2} \cdot K_4 \cdot K_5 \cdot K_6 \cdot K_7 \cdot q \cdot F_{пл} \cdot (1 - \eta) \cdot (T - T_д - T_c)$ t/year;

Where:

T –is the full time of storage of the material in the time under consideration (day);

$T_д$- is the number of rainy days;

T_c- is the number of days with stable snow cover.

The design parameters and their values in are given in Table 7.1.1.1.15.

Table 7.1.1.1.15. Design parameters and their values

Design parameters	Values
Material to transfer: inert material empirical coefficients, which depend on the type of the material to transfer	***a*** = 0,0135 ***b*** = 2,987
Local conditions: the warehouse is open from all four sides	*K4* = 1
Material humidity: up to 10%	*K5* = 0,1
Surface profile of the stored material	*K6* = 750 / 500 = 1,5
Material sizes: 500-100 mm	*K7* = 0,4
Design wind velocities, m/sec	*U'* = 0,5; 3,91
Average annual wind velocity, m/sec	*U* = 1,95
Working surface of the unloading works, m^2	*Fраб* = 25
Area of dust-formation in the plan, m^2	*Fпл* = 500
Actual area of dust-formation in the plan, m^2	*Fмакс* = 750
Full time of storage of the material in the time under consideration (day)	*T* = 366
Number of rainy days	*Tд* = 41
Number of days with stable snow cover	*Tc* = 80

Maximum single and annual emissions of the polluting substances in the atmospheric air are calculated below.

Inert material

$q2908^{0.5\ m/sec} = 10^{-3} \cdot 0{,}0135 \cdot 0{,}5^{2.987} = 0{,}0000017$ gr/(m^2*sec);

$M2908^{0.5\ m/secc} = 1 \cdot 0{,}1 \cdot 1{,}5 \cdot 0{,}4 \cdot 0{,}0000017 \cdot 25 +$

$+ 1 \cdot 0{,}1 \cdot 1{,}5 \cdot 0{,}4 \cdot 0{,}11 \cdot 0{,}0000017 \cdot (500 - 25) = 0{,}0000079$ gr/sec;

$q2908^{5\ m/sec} = 10^{-3} \cdot 0{,}0135 \cdot 3{,}91^{2.987} = 0{,}0007928$ gr/(m^2*sec);

$M2908^{5\ m/sec} = 1 \cdot 0{,}1 \cdot 1{,}5 \cdot 0{,}4 \cdot 0{,}0007928 \cdot 25 +$

$+ 1 \cdot 0{,}1 \cdot 1{,}5 \cdot 0{,}4 \cdot 0{,}11 \cdot 0{,}0007928 \cdot (500 - 25) = 0{,}0036746$ gr/sec;

$q2908 = 10^{-3} \cdot 0{,}0135 \cdot 1{,}95^{2.987} = 0{,}0000992$ gr/(m^2*sec);

$П2908 = 0{,}11 \cdot 8{,}64 \cdot 10^{-2} \cdot 1 \cdot 0{,}1 \cdot 1{,}5 \cdot 0{,}4 \cdot 0{,}0000992 \cdot 500 \cdot (366-41-80) = 0{,}006932$ t/year.

Total of warehousing+ storage (2908) will be:

gr/sec: Wareousing + storage	0,028	0,0036746	**∑ 0.0316746**
t/year: Wareousing + storage	0,0756	0,006932	**∑ 0.082532**

Emission calculation from keeping and storage of fractioned grit (G-7)

Warehousing

The calculation is accomplished as per methodological guidance [**4**]

Unloading of the bulk materials is done without a loading sleeve. As for the local conditions, the warehouse is open from all sides (*K4* = 1); The height of the material unloading is 1,0 m (*B* = 0,5); volley unloading from the truck is done of over 10 t of the material (K_9 =0,1); design wind velocities (m/sec): 0,5 (***K3*** = 1); 5 (***K3*** = 1,2); average annual wind velocity: 1,95 m/sec (***K3*** = 1).

Quantitative and qualitative properties of emisison of polluting substances are given in Table 7.1.1.1.16.

Table 7.1.1.1.16.. Quantitative and qualitative properties of emisison of polluting substances

Pollutant		Max. emission, gr/sec	Annual emission, t/year
Code	Description		
2908	Inorganic dust withthe content of silicium dioxide of 70-20%	0,0528	0,14256

The source data to calculate the emission of polluting substances are given in Table 7.1.1.1.17.

Table 7.1.1.1.17. Source calculation data

Materials	Parameter	Simultaneity
Grit	Quantity of the unloaded material: $G_ч$ = 66t/hr; Gyear = 59400t/year. The mass share of a dust fraction in the material: K_1= 0,04. The share of dust converting into aerosol: K_2= 0,02. Humidity up to10%(K_5= 0,1). material sizes 10-50 mm (K_7=0,6).	+

The accepted legend, calculation formulae and calculation parameters and their substantiation are given below:

Single dust emisison is calculatd by formula

$M_{ГР}= K_1 \cdot K_2 \cdot K_3 \cdot K_4 \cdot K_5 \cdot K_7 \cdot K_8 \cdot K_9 \cdot B \cdot G_ч \cdot 10^6 / 3600$, gr/sec

Where:

A maximum single dust emission is calculated by formula:

$$M_{ГР} = K_1 \cdot K_2 \cdot K_3 \cdot K_4 \cdot K_5 \cdot K_7 \cdot K_8 \cdot K_9 \cdot B \cdot G_ч \cdot 10^6 / 3600, \text{ gr/sec}$$

Where:

K_1- is the weight part of dust fraction in the material (0-200 mkm);
K_2- is the dust part (of the total dust weight part) transforming into an aerosol (0-10 mkm);
K_3-is the multiplier, considering the local weather conditions;
K_4-is the multiplier, considering the local conditions, degree of protection of the unit against the external impact, conditions of dust-formation;
K_5-is the multiplier, considering the material humidity;
K_7-is the multiplier, considering the material sizes;
K_8- is the correction multiplier for various materials by considering the dipper types when using a different type of a transfer; K_8 = 1;
K_9- is the correction multiplier for volley unload from the truck;
B –is the multiplier, considering the dropping height;
$G_ч$–c is the amount of the material to transfer in one hour (t/h).
The total annual dust emission is calculated by formula:
$П_{ГР} = K_1 \cdot K_2 \cdot K_3 \cdot K_4 \cdot K_5 \cdot K_7 \cdot K_8 \cdot K_9 \cdot B \cdot G_{год}$, t/year.

Where: Gгод - is the annual amount of the material to transfer, t/year;
Maximum single and annual emissions of the polluting substances in the atmospheric air are calculated below.

<u>Grit</u>

$M2908^{0.5\ m/sec} = 0{,}04 \cdot 0{,}02 \cdot 1 \cdot 1 \cdot 0{,}1 \cdot 0{,}6 \cdot 1 \cdot 0{,}1 \cdot 0{,}5 \cdot 66 \cdot 10^6 / 3600 = 0{,}044$ gr/sec;
$M2908^{5\ m/sec} = 0{,}04 \cdot 0{,}02 \cdot 1{,}2 \cdot 1 \cdot 0{,}1 \cdot 0{,}6 \cdot 1 \cdot 0{,}1 \cdot 0{,}5 \cdot 66 \cdot 10^6 / 3600 = 0{,}0528$ gr/sec;
$П2908\ 0{,}04 \cdot 0{,}02 \cdot 1 \cdot 1 \cdot 0{,}1 \cdot 0{,}6 \cdot 1 \cdot 0{,}1 \cdot 0{,}5 \cdot 59400 = 0{,}14256$ t/year.

Storage:

The calculation is accomplished as per methodological guidance [4]

Quantitative and qualitative properties of emisison of polluting substances are given in Table 7.1.1.1.18.

Table 7.1.1.1.18. Quantitative and qualitative properties of emisison of polluting substances

Pollutant		Max. emission, gr/sec	Annual emission, t/year
Code	Description		
2908	Inorganic dust withthe content of silicium dioxide of 70-20%	0,0022048	0,0041592

The maximum single emission of dust during the storage of the bulk material is calculated by formula:

$$MXP = K4 \cdot K5 \cdot K6 \cdot K7 \cdot q \cdot F_{раб} + K4 \cdot K5 \cdot K6 \cdot K7 \cdot 0{,}11 \cdot q \cdot (F_{пл} - F_{раб}) \cdot (1 - \eta), \text{ gr/sec}$$

Where:

K4-is the multiplier, considering the local conditions, degree of protection of the unit against the external impact and conditions of dust-formation;
K5-is the multiplier, considering the material humidity;
K6-is the multiplier, considering the profile of the stored material;
K7-is the multiplier, considering the sizes of the material;
Fраб- is the area in the plan with regular warehousing operations (m^2);
Fпл- is the area of dust-formation in the plan (m^2);
q – is the maximum single emission (g/sec) of specific dust formation, g/(m^2*sec);
η – is the emission reduction degree by using a dust-reducer system.
The value of multiplier ***K6*** is determined by formula:
K6 = ***Fмакс*** / ***Fпл***
Where:
Fмакс - is the factual area of the stored material in terms of a full warehouse, m^2;
The maximum value of the dust specific dust-formation is determined by formula: g/(m2*sec);

$$q = 10^{-3} \cdot a \cdot U^{b}, \text{ gr/(m}^2\text{*sec)};$$

Where:

a and ***b*** – are empirical coefficients depending on the type of the material to transfer;
*U*b –is the wind velocity, m/sec;
Total annual dust emission in case of warehousing the bulk material is calculated by formula:
$ПХР = 0{,}11 \cdot 8{,}64 \cdot 10^{-2} \cdot K4 \cdot K5 \cdot K6 \cdot K7 \cdot q \cdot F_{пл} \cdot (1 - \eta) \cdot (T - T_Д - T_С)$ t/year;
Where:
T –is the full time of storage of the material in the time under consideration (day);
Tд- is the number of rainy days;
Tс- is the number of days with stable snow cover.

The design parameters and their values in are given in Table 7.1.1.1.19.

Table 7.1.1.1.19. Design parameters and their values

Design parameters	Values
Material to transfer: inert material empirical coefficients, which depend on the type of the material to transfer	***a*** = 0,0135 ***b*** = 2,987
Local conditions: the warehouse is open from all four sides	***K4*** = 1
Material humidity: up to 10%	***K5*** = 0,1
Surface profile of the stored material	***K6*** = 300 / 200 = 1,5
Material sizes: 5-10 mm	***K7*** = 0,6
Design wind velocities, m/sec	***U'*** = 0,5; 3,91
Average annual wind velocity, m/sec	***U*** = 1,95
Working surface of the unloading works, m^2	***Fраб*** = 10
Area of dust-formation in the plan, m^2	***Fпл*** = 200
Actual area of dust-formation in the plan, m^2	***Fмакс*** = 300
Full time of storage of the material in the time under consideration (day)	***T*** = 366
Number of rainy days	***Tд*** = 41

Number of days with stable snow cover	$Tc = 80$

Maximum single and annual emissions of the polluting substances in the atmospheric air are calculated below.

<u>Grit</u>

$q2908^{0.5\ m/sec} = = 10^{-3} \cdot 0{,}0135 \cdot 0{,}5^{2.987} = 0{,}0000017$ gr/(m^2*sec);
$M2908^{0.5\ m/secc} = = 1 \cdot 0{,}1 \cdot 1{,}5 \cdot 0{,}6 \cdot 0{,}0000017 \cdot 10 +$
$+ 1 \cdot 0{,}1 \cdot 1{,}5 \cdot 0{,}6 \cdot 0{,}11 \cdot 0{,}0000017 \cdot (200 - 10) = 0{,}0000047$ gr/sec;
$q2908^{5\ m/sec} = 10^{-3} \cdot 0{,}0135 \cdot 3{,}91^{2.987} = 0{,}0007928$ gr/(m^2*sec);
$M2908^{5\ m/sec} = 1 \cdot 0{,}1 \cdot 1{,}5 \cdot 0{,}6 \cdot 0{,}0007928 \cdot 10 +$

+ 1 · 0,1 · 1,5 · 0,6 · 0,11 · 0,0007928 · (200 - 10) = 0,0022048 gr/sec;

q2908 = 10^{-3} · 0,0135 · $1{,}95^{2.987}$ = 0,0000992 gr/(m^2*sec);

П2908 = 0,11·8,64·10^{-2}·1·0,1·1,5·0,6·0,0000992·200·(366-41-80) = 0,0041592 t/year.

Total of receipt + storage (2908) will be:

gr/sec: warehosing+storage	0,0528	0,0022048	∑ **0.0550048**
t/year: warehosing+storage	0,14256	0,0041592	∑ **0,1467192**

7.1.1.2 Emission calculations

Recommendations of Articles 5 and 8 of the Technical Regulation №408 "on approving the Technical Regulation of Calculation Maximum Admissible Emissions of Harmful Substances into the Air" of the Government of Georgia of December 31, 2013 should be used for the assessment of the air pollution within the study area.

Background pollution indicators methodology is considered for the assessment of the areas for which there is no observed data. According to the methodology, assessment of ambient air quality is conducted according to the number of population **(Table 7.1.1.2.1.).**

Table 7.1.1.2.1. Recommended background values of pollutants according to the number of population

Population, (1,000 persons)	Background pollution levels, mg/m^3			
	NO_2	SO_2	CO	Dust
250-125	0,03	0,05	1,5	0,2
125-50	0,015	0,05	0,8	0,15
50-10	0,008	0,02	0,4	0,1
<10	0	0	0	0

As the population adjacent to the object does not exceed 10 000 (vilage Didi Mughanlo, population of 1286 men according to -2014 population census) the values of background concentration are taken from the relevant table (<10).

Based on the above-given calculation, the dispersion was calculated according to [**12**]. The design rectangle is 3000 * 2000 m, with 100 m interval.

Under the effective legislation, the MAE (maximum admissible emission) standards are determined at the border of the nearest settled area from the object and within a 500-m radius. Control points on the border of the settled area (№ 1÷4) and on the border of a 500-m radius (points №5÷8)

Control Sites

№	Point coordinates (m)		Height (m)	Type of point	Comment
	X	Y			
1	-1479,00	-393,00	2	A point on the border of the settled area	The nearest settlement in the west

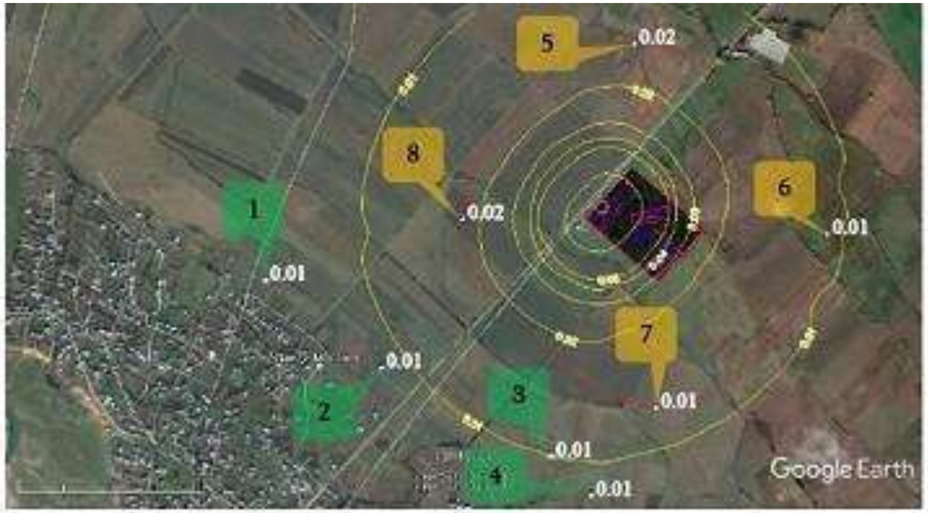
					(direct distance 1,33 km)
2	-1005,00	-747,00	2	A point on the border of the settled area	The nearest settlement south-west **(direct distance 1,00 km)**
3	-312,00	-1108,00	2	A point on the border of the settled area	The nearest settlement south **(direct distance 0,83 km)**
4	-149,00	-1267,00	2	A point on the border of the settled area	The nearest settlement south **(direct distance 0,89 km)**
5	28,00	566,00	2	500-m zone	N
6	817,00	-206,00	2	500-m zone	E
7	117,00	-910,00	2	500-m zone	S
8	-673,00	-146,00	2	500-m zone	W

Table 7.1.1.2.2 gives the values of maximum concentrations of pollutants with MAC weights.

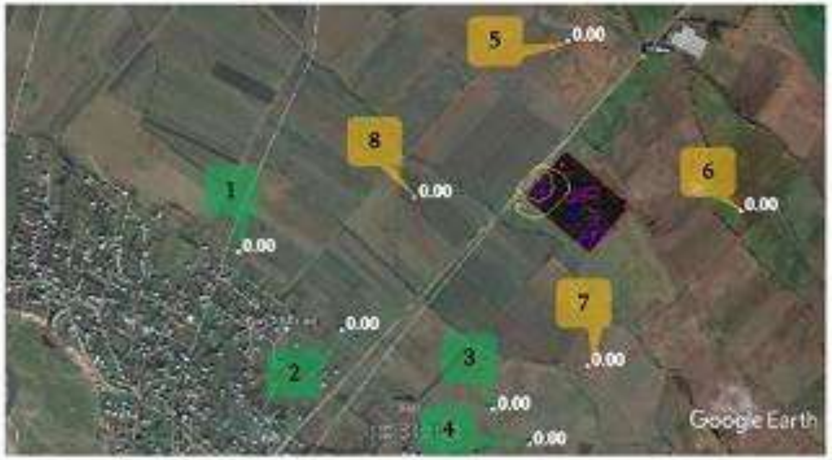
Table 7.1.1.2.2 Maximum concentrations of pollutants with MAC weights at control points

Description of harmful substances	Share of the maximum MAC of harmful substances from the object	
	At the border of the nearest settled area	On the border of a 500-m zone radius
1	2	3
Nitrogen dioxide	0,0099	0,02
Nitrogen oxide	0,00089	0,0014
Soot	0,0015	0,0026
Sulphur dioxide	0,00084	0,0015
Dihydrosulfide (Hydrogen sulfide)	0,00081	0,0025
Carbon oxide	0,0011	0,002
Oil fraction	0,00073	0,0013
Saturated hydrogens C12-C19	0,0023	0,0071
Inorganic dust: 70-20% SiO2	0,05	0,1
Summarized impact group: 6043 Sulphur dioxide and Hydrogen sulphide	0,0067	0,01
Summarized impact group: 6046 Carbon oxide and cement production dust	0,00084	0,0033
Incomplete summarized impact group 6204 "1.6" with coefficient: Nitrogen dioxide, Sulphur dioxide	0,05	0,1

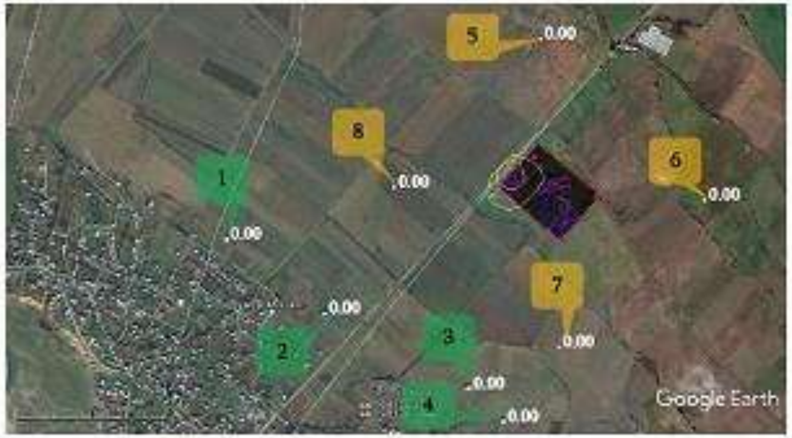
Graphical materials of the calculation results



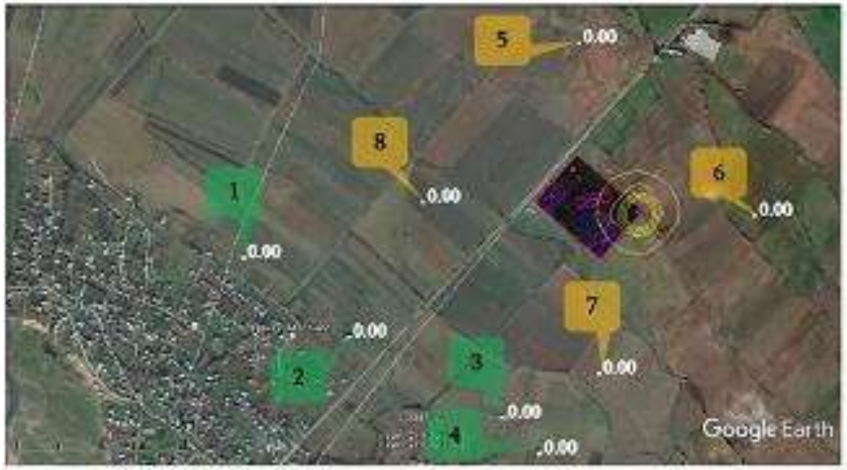
Maximum concentration of sulphur dioxide (code 330) at control points (nos. 1-4), at the nearest settlements and at the border of 500-m rated zone (nos. 5-8)



Maximum concentration of nitrogen oxide (code 304) at control points (nos. 1-4), at the nearest settlements and at the border of 500-m rated zone (nos. 5-8)



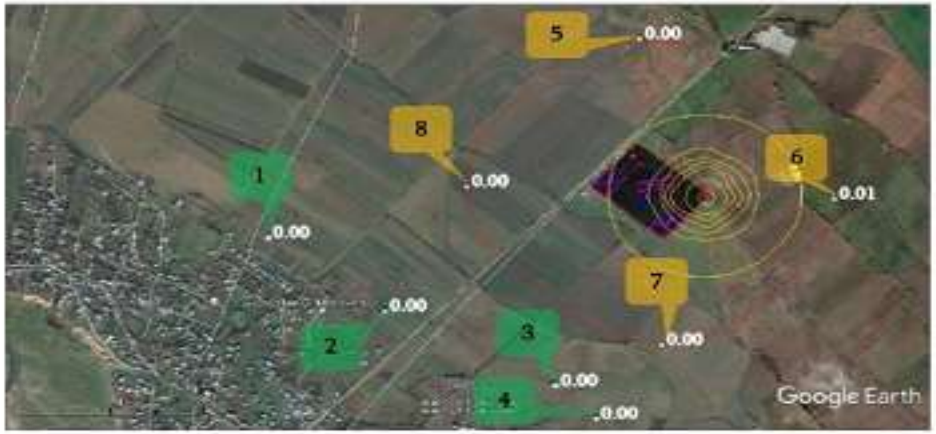
Maximum concentration of sulphur dioxide (code 330) at control points (nos. 1-4), at the nearest settlements and at the border of 500-m rated zone (nos. 5-8)



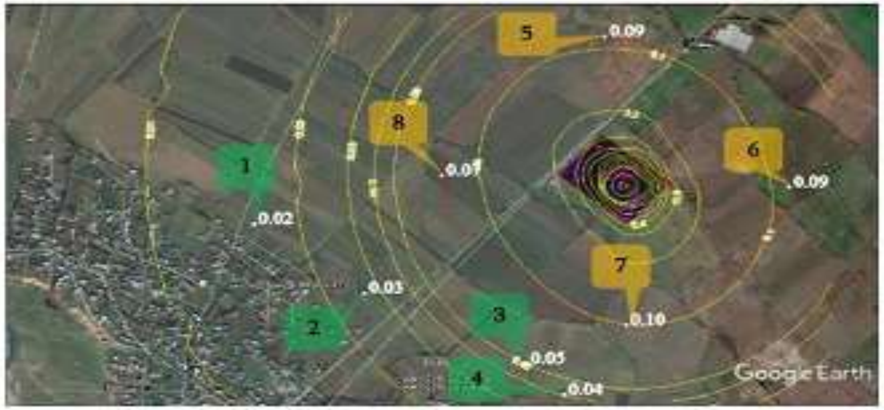
Maximum concentration of sulphur hydrogen (code 333) at control points (nos. 1-4), at the nearest settlements and at the border of 500-m rated zone (nos. 5-8)

Maximum concentration of carbon oxide (code 337) at control points (nos. 1-4), at the nearest settlements and at the border of 500-m rated zone (nos. 5-8)

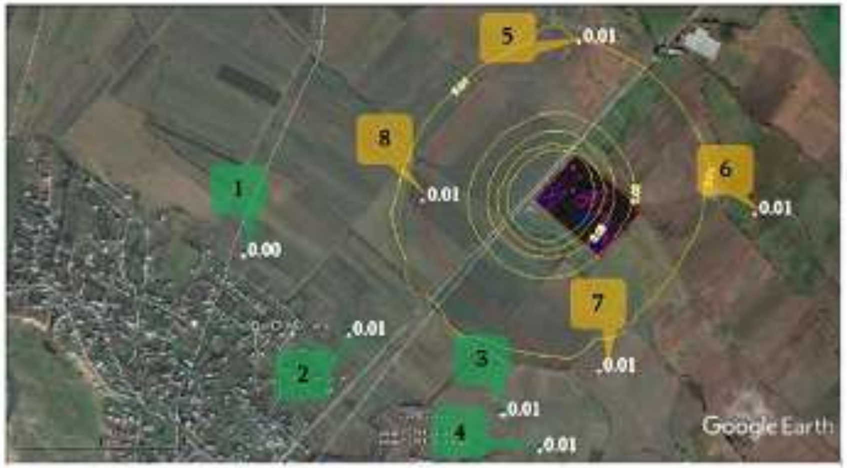
Maximum concentration of oil fraction of saturated hydrocarbon (code 2732) at control points (nos. 1-4), at the nearest settlements and at the border of 500-m rated zone (nos. 5-8)



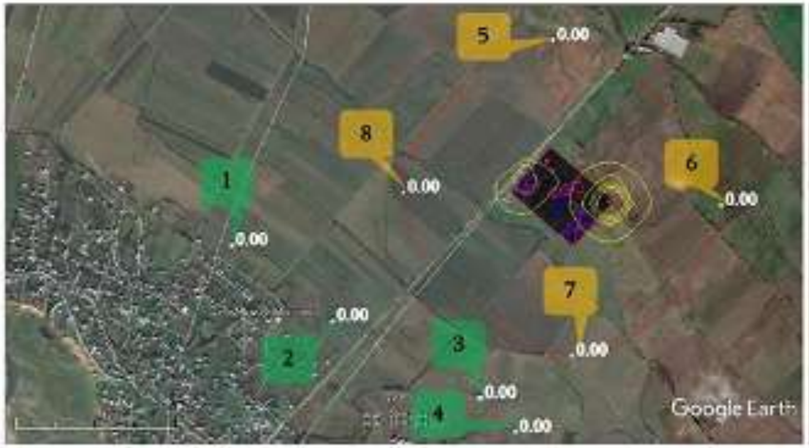
Maximum concentration of heavy fractions of saturated hydrocarbon (code 2754) at control points (nos. 1-4), at the nearest settlements and at the border of 500-m rated zone (nos. 5-8)



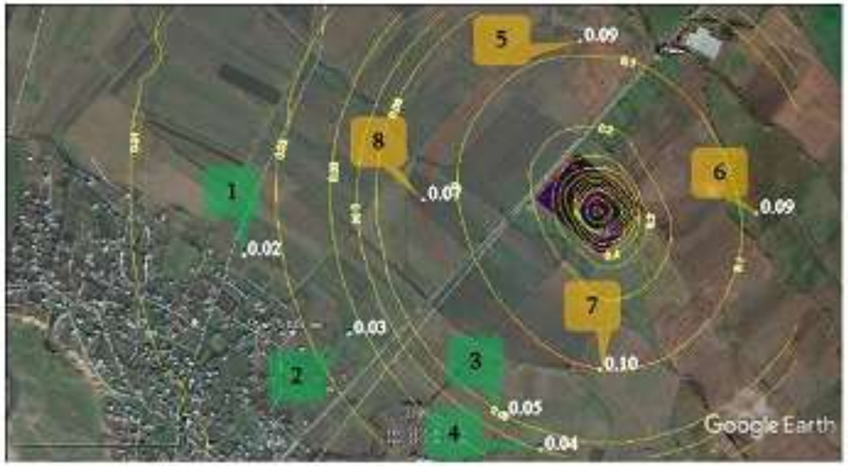
Maximum concentration of inorganic dust (code 2908) at control points (nos. 1-4), at the nearest settlements and at the border of 500-m rated zone (nos. 5-8)



Maximum concentration of incomplete total impact group 6009 (codes 301÷330) at control points (nos. 1-4), at the nearest settlements and at the border of 500-m rated zone (nos. 5-8)



Maximum concentration of total impact group 6043 (codes 330÷333) points (nos. 1-4), at the nearest settlements and at the border of 500-m rated zone (nos. 5-8)



Maximum concentration of total impact group 6046 (codes 337÷2908) at control points (nos. 1-4), at the nearest settlements and at the border of 500-m rated zone (nos. 5-8)

Conclusion

The calculation results show that during the operation phase of the construction camp, the air quality of the adjoining areas on the border of 500-m radius and the nearest residential area will not exceed the limits prescribed by the law.

Table data of calculations are given in Annex 6.

7.1.2 Exploitation phase

The emissions into the atmosphere in the highway exploitation phase are associated with the operation of the motor transport engines.

However, it should be noted that the selected alternative corridor will be more distanced from the residential areas than the existing road. The changeover of the traffic flows to the new highway will contribute to the reduced negative impact in the following villages: Algetis Meurneoba, Keshalo, Ilmazlo, Kapanakhchi, Pirveli Kesalo and Meore Kesalo. At the same time, as the roadway is widened and the gradients and turning angles will be reduced, the risk of traffic jams will diminish a lot and the load on the vehicle engines will not be so high in case of overtaking. Consequently, the emissions of combustion products will be diminished

Overall, a positive impact is expected as a result of the project implementation.

7.1.3 Impact mitigation measures

<u>Operation phase</u>

The following mitigation measures to reduce dust and combustion products emission into the atmospheric air must be taken during the road construction:

- The stationery sources of emission (e.g. concrete plant and other) will be installed as far as possible from the population and will be equipped with relevant filters;
- The construction contractor will be charged with developing relevant air protection document in line with the effective legislation, which will be submitted to the Ministry and the stationery objects of emission will be agreed before putting them to operation
- Limiting operation and driving speeds near the residential areas;
- Using alternative routes for the transport operations;
- Limiting idling of the engines of machines and equipment;
- The technical state of the exploited machiens will be subject to permanent control.
- During the transportation of easily dusting materials across the settled areas or in windy weather, method of covering the trucks with tarpaulin will be used;
- Loading and unloading heights of the materials in the vehicles will be minimized to the extent possible;

The dusting materials will be subject to the relevant management to reduce dust propagation. An efficient way to reduce dust emissions may be the regular watering of the roads near the settled areas in dry weather.

<u>Operation phase</u>

Following the accomplished valuation, it may be said that the operation of the improved section of Rustavi-Red Bridge highway will not significantly increase the discomfort caused by dust and emissions. In the final run, maximal maintenance of the vegetation and additional landscaping of the construction corridor is an efficient means of dust control.

7.2 Noise propagation

7.2.1 Noise level standards

Decree # 297/N of the Ministry of Health, Labor and Social Affairs of Georgia "on Proving the Qualitative Norms of the Environment" of August 16, 2001, are specified. There are defined as the admissible norms of noise as the maximum of the admissible norms for several zones of the territories. The standard requirements for noise for the residential areas are given in **Table** 7.2.1.1 (It should be noted the Georgian standards apply to the maximum admissible norms in the building, not on the building facade).

For IFC noise impacts should not exceed the levels presented in 7.2.1.2. Table or result in a maximum increase in background levels of 3 dB at the nearest receptor location off site. This project will comply with both IFC Guidelines and Georgian Standards. Note that Georgian standards refer to the allowable limits indoors, not at the building façade.

Table 7.2.1.1. Georgian Standards for Noise Levels

Receptor	Time interval	Average admissible noise level (dB)	Maximum admissible noise level (dB)
Residential	7:00-23:00	55	70
Residential	23:00- 7:00	45	60
Commercial	24 hours	60	75

Table 7.2.1.2. IFC Noise Level Guidelines

Receptor	One hour L_{aeq} (dB)	
	During the day 07.00-22.00	At night 22.00 – 07.00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

For workplace noise the following IFC standards are applicable (**Table** 7.2.1.3).

Table 7.2.1.3. IFC Work Environment Noise limits

Type of Work, workplace	IFC General EHS Guidelines
Heavy Industry (no demand for oral communication)	85 Equivalent level Laeq,8h
Light industry (decreasing demand for oral communication)	50-65 Equivalent level Laeq,8h

7.2.2 Noise sources, noise modeling methods

Noise modeling was provided within the scope of the project to study the noise level at the residential and industrial objects adjacent to the project zone.

7.2.2.1 Methods of 3D Noise Modeling

CadnaA (Computer Aided Noise Abatement) is the leading software for calculation, presentation, assessment and prediction of environmental noise. Whether your objective is to study the noise emission of an industrial plant, of a mart including a parking lot, of a new road or railway scheme or even of entire towns and urbanized areas: CadnaA is designed to handle all these tasks.

With more than 30 standards and guidelines, powerful calculation algorithms, extensive object processing tools, outstanding 3D visualization and very user-friendly interface CadnaA is the perfect software to handle national and international noise calculation and noise mapping projects of any size..

With its technical capabilities and ease to use, CadnaA represents the state-of-the-art technology. CadnaA is developed in C/C++ and communicates perfectly with other Windows applications like word processors, spreadsheet calculators, CAD software and GIS-databases. CadnaA includes a multi-lingual user interface and is successfully applied in more than 60 countries all over the world.

In order to use the software, it was necessary to accomplish a number of studies to gather the necessary information for modeling.

7.2.2.2 Present situation

The main source of noise in the project zone is vehicles. The traffic in the project zone is quite intense, but without traffic jams. The situation is aggravated by the hard situation with the vehicle fleet in Georgia evidenced by statistics, under which:

1. 57% of the existing vehicles are manufactured before 1998;
2. 23% of the existing vehicles are manufactured before 2003;
3. 18% of the existing vehicles are manufactured before 2008;
4. Only 3% of the existing vehicles are manufactured before 2013.

Following the above-mentioned, in case of same traffic intensity, old, 20-25-year-old car models are more dangerous than new vehicle models, including the less noisy ones. At the same time, old and often faulty vehicles produce more noise than tehe new vehicles of the same class.

7.2.2.3 Existing infrastructure

As already mentioned, there are a number of settled areas and small and average businesses structures adjacent to the project zone. Mostly, these are repairs and maintenance offices, car washing areas and gas and petrol fueling stations. All these objects are a source of the noise.

7.2.2.4 Traffic study on the Red Bridge from the starting point to the destination

On April 6, 7, 10 and 11 of 2017, at the stage of feasibility study and detailed design, traffic survey was accomplished from the starting point to the destination (OD) at the crossing point with the Red Bridge border. OD survey yielded the following results:

- Time;
- Type of vehicle (motorcycles/vehicles and mini-buses with/wo trailer/LGV/2 axles/3 axles/4+axles/buses and carriages and excursion buses);
- Vehicle registration country;
- Number of passengers in the vehicle;
- Origin (country/city/region);
- Reason (home/trip/job/business/study/trade/private affair/visiting friends/seminar & free time/other);
- Country of destination (country/city/region);
- Travel ferquency;
- Types of lorry cargos (food/oil products/aggregareminerals/construction products/agricultural products/ISO containers/other).

The information about trip motifs and types of cargos is used for traffic prediction purposes. Information about OD is used as a basis for a traffic model to predict further traffic intensity on the new and existing roads.

7.2.2.5 Traffic intensity from Rustavi to Red Bridge

Traffic survey was done from Rustavi to Red Bridge (S4) from April 5 to April 11, 2017, between 06:00 am and 19:00. Traffic survey on April 6/7, with 24-hour counting was done at the following locations:

- Location: №1 Red Bridge
- Location: №2 Algeti
- Location: №3 Rustavi

Traffic intensity was calculated according to location, time and direction. The tables below show AADT (Annual average daily traffic) intensities. The given intensities were adjusted due to the seasonal impact, in which the intensities fixed at the Red Bridge border were used (daily intensities for more than 5 years).

Table 7.2.2.5.1 Traffic intensities from Rustavi to Red Bridge

AADT S4 Rustavi Red Bridge	Motor -cycle	Car& 4X4	Mini-bus	Med. Bus/Large bus	Small lorry	Big lorry	Carriers
1. Red Bridge	0	1350	183	55	36	394	2019
2. Algeti	0	2235	199	30	301	577	3342
3. Rustavi	4	9720	997	36	457	727	11921

7.2.2.6 Traffic forecasts

Based on the analysis done within the scope of the project, the following traffic forecast was provided:

- Detailed forecasts of annual traffic for 10-year period from the toad completion;
- More general forecasts of future traffic for the following 20 years.

Despite the fact that accent was made on accurate prediction, at an early stage of the project, all traffic forecast will be given for high growth dynamics.

Table 7.2.2.6.1. gives expected traffic growth along road section Rustavi – Red Bridge by 2025.

Table 7.2.2.6.1. Expected traffic intensities from Rustavi to Red Bridge by 2015

AADT S4 Rustavi Red Bridge	Motor -cycle	Car& 4X4	Mini-bus	Med. Bus/Large bus	Small lorry	Big lorry	Carriers
Red Bridge – Village Kapanakhchi	0	3 000	400	100	88	1 700	5 200
Village Kapanakhchi - Algeti	0	4 200	500	100	600	1 900	7 400
Algeti - Rustavi	0	4 900	400	73	700	2 200	8 400
Rustavi	9	21 300	2 100	86	1 100	2 700	27 000

7.2.2.7 Environmental conditions

The project zone is the territory with frequent winds of different strengths. Following the local relief, the main wind direction is from south to west.Clearly, under the action of the winds, which blow from the source of noise towards the sensitive site, the noise level will increase and the stronger the wind is, the stronger this effect is, if wind is not a dominant source of noise or is not so strong to cause propagation of the “problematic” noise.

7.2.3 Present situation

As already mentioned, within the scope of the project, noise modeling was done for four stages: (i) existing situation – present-project; (ii) construction phase; (iii) operation phase following the completion of construction, and (iv) operation phase by 2015.
183 buildings and premises are found on the territory adjacent to the project zone. Annex 7 gives possible level of noise impact on each building.

At present, the noise level caused by transport on ?? of the existing buildings and premises exceeds the maximum value specified by the Georgian legislation.

7.2.4 Construction phase

The major sources of noise in the construction phase are the construction and auxiliary techniques. The main operation sites of such techniques are the construction corridor and the construction camp.

Construction camp

Within the scope of the project, one principal and 4 auxiliary construction camps are planned to provide. Means of production will be provided at the main camp. As for the auxiliary camps, they will be mostly used to park construction techniques and store means of production.

The strongest source of noise at the main camp is the concrete plant. Other premises will be used as office or auxiliary buildings. A vehicle parking area will also be placed adjacent to the main camp.

As the modeling results suggest, noise level near the buildings and premises adjacent to the main camp will not exceed the admissible standard. The nearest building is located 800 m from the main camp. Modeling results for noise caused by the camp operation are shown in Figure 7.2.4.1.

As Figure 7.2.4.1 shows, the noise level caused by the camp operation on the territory adjacent to the campo will be within the admissible norms.Noise propagation modeling on the territory adjacent to the main camp

Figure 7.2.4.1. Noise propagation modeling on the territory adjacent to the main camp

Construction corridor

A problem of noise propagation in the construction phase is one of the most important issues. As the results of the accomplished measurements evidence (Annex 7), the level of baseline noise near the receptors of the project area exceeds the admissible standards during the day. As a result of using heavy techniques in the construction phase, the noise level is expected to increase further. Consequently, a number of mitigation measures must be developed and realized to avoid an increase in the noise level in the project zone. The results provided in Annex 7 show that the noise level in the construction phase will exceed the admissible standard at 62 buildings.

The Construction Contractor, prior to the onset of the construction, must develop and submit the Supervision Consultant a Noise Management Plan for the construction phase. The Plan must envisage all the existing technologies and best practice to avoid occurrence of noise and/or minimize the noise level.

7.2.4.1 Mitigation at a noise source

Source control is, in general, the most effective form of noise mitigation and involves controlling a noise source before it is able to emit potentially offensive noise levels. Construction noise (except blasting operations) is typically generated by two source types: (i) Stationary equipment; and (ii) Mobile equipment.

The noise level can be mitigated byusing the following measures:

- **Less noisy equipment:** One of the most efficient ways to reduce noise caused by individual equipment is using less noisy equipment. By selecting and/or using less noisy equipment, noise can be reduced or eliminated in some cases. Source control may yield additional benefit, in particular, in respect of promoting the introduction of technological achievements of less noisy equipment;
- Mufflers: Most construction noise originates from internal combustion engines. A large part of the noise emitted is due to the air intake and exhaust cycle. Specifying the use of adequate muffler systems can control much of this engine noise (**Figure 7.2.4.1.1).**
- **Shields:** Employing shields that are physically attached to the particular piece of equipment is effective, particularly for stationary equipment and where considerable noise reduction is required (**Figure 7.2.4.1.2).**

Figure 7.2.4.1.1: Muffler system

Figure 7.2.4.1.2: Uisng shields

- **Aprons:** Sound aprons generally take the form of sound absorptive mats hung from the equipment or on frames attached to the equipment. The aprons can be constructed of rubber, lead-filled fabric, or PVC layers with possibly sound absorptive material covering the side facing the machine.

Sound aprons are useful when the shielding must be frequently removed or if only partial covering is possible.

- **Enclosures:** Enclosures for stationary work may be constructed of wood or any other suitable material and typically surround the specific operation area and equipment. The walls could be lined with sound absorptive material to prevent an increase of sound levels within the structure. They should be designed for ease of erection and dismantling.

Mitigation along the Path

In some situations, such as in urban areas or on isolated sections of a project (tunnel installation area), it may be beneficial and necessary to construct barriers adjacent to the work area or at the right-of-way (RoW). These can take the form of natural shielding, temporary shielding, and/or permanent shielding.

Temporary abatement techniques include the use of temporary and/or movable shielding for both specific and nonspecific operations. Some mobile shielding is capable of being moved intact or being repeatedly erected and dismantled to shield a moving operation. An example of such a barrier utilizes noise curtains in conjunction with trailers to create an easily movable, temporary noise barrier system.

Mitigation at the existing receptors

A receiver can vary in its complexity, ranging anywhere from relocating residents for a day to insulation of a building. Even after mitigation measures have been applied, the outcome may still be unpredictable with no guarantees that the implemented methods achieve expected results. Therefore, mitigation at the receiver should only be considered as a last alternative. However, there are cases where creative techniques have been successfully implemented.

Training Programs for Contractors

Require contractors to participate in training programs related to project-specific noise requirements, specifications, and/or equipment operations. Such training may be provided by agency or project management personnel, outside consultants, and/or equipment manufacturers or suppliers. For example, project personnel (or consultants assigned to the project) may train the contractor in the measurement of construction-related noise levels that may be required to meet the contract specifications.

In addition to the additional mitigation measures proposed by the Contractor, the latter must observe the norms, which are common for the construction phase of any project. Such norms are:

- Use of non-faulty construction techniques and vehicles;
- Implementing the noisy works during the day as far as possible;
- Running the vehicle drives at minimal speed.

7.2.5 Operation phase

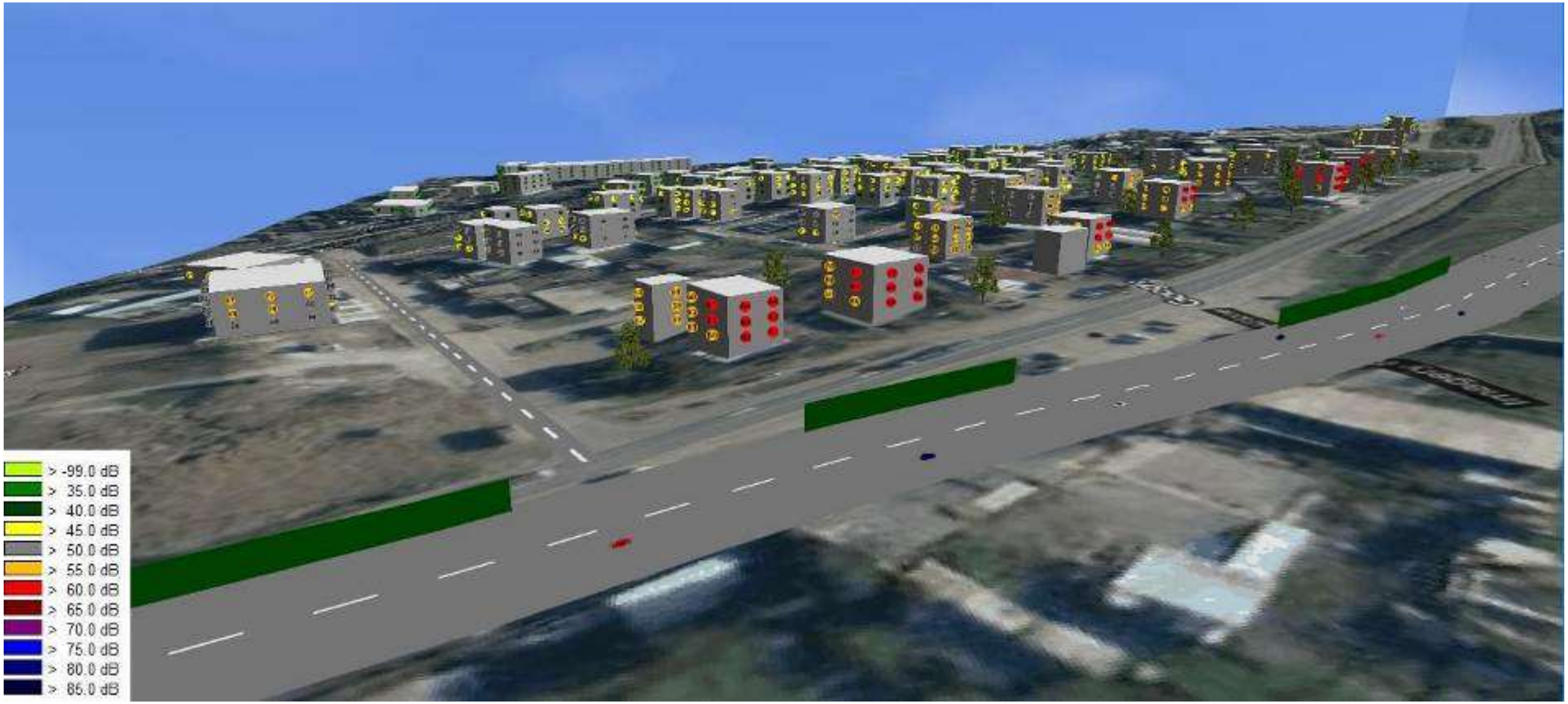
In the operation phase (2020), the noise level will exceed the admissible level only at one building and only at night. As for the modeling results, which were based on quite a high coefficient of increased traffic along the given highway, the noise level exceeded the admissible standard at 9 buildings during the day and at 10 buildings at night.

Note: within the scope of the project ICF approach was used to determine maximally admissible noise level. The given approach, unlike the legislation of Georgia, admits an excess of the baseline noise level by 3 dB even if the baseline noise level exceeds the admissible level.

Figures 7.2.5.1 and 7.2.5.2 show the level of nose impact on buildings and premises in the city of Rustavi with and without barriers by 2025.

Figure 7.2.5.1: Excess noise level on buildings and premises by 2025

Figure 7.2.5.2: Noise level by using barriers by 2025



7.3 Changes in the geological environment and expected impacts on the geological environment
7.3.1 Construction Phase

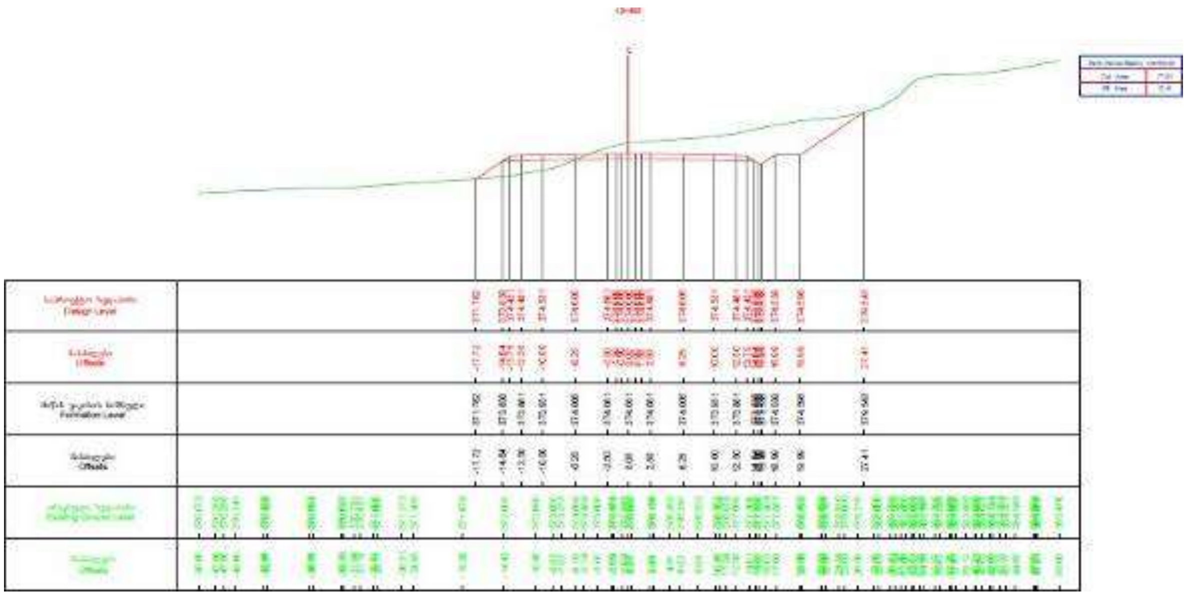
As per the accomplished engineering-geological survey suggests, the project corridor is in a satisfactory state. No hazardous active geodynamic events (landslides, rock fall, etc.) are fixed within its limits or adjacent to. Thus, the project does not require important reinforcement works.

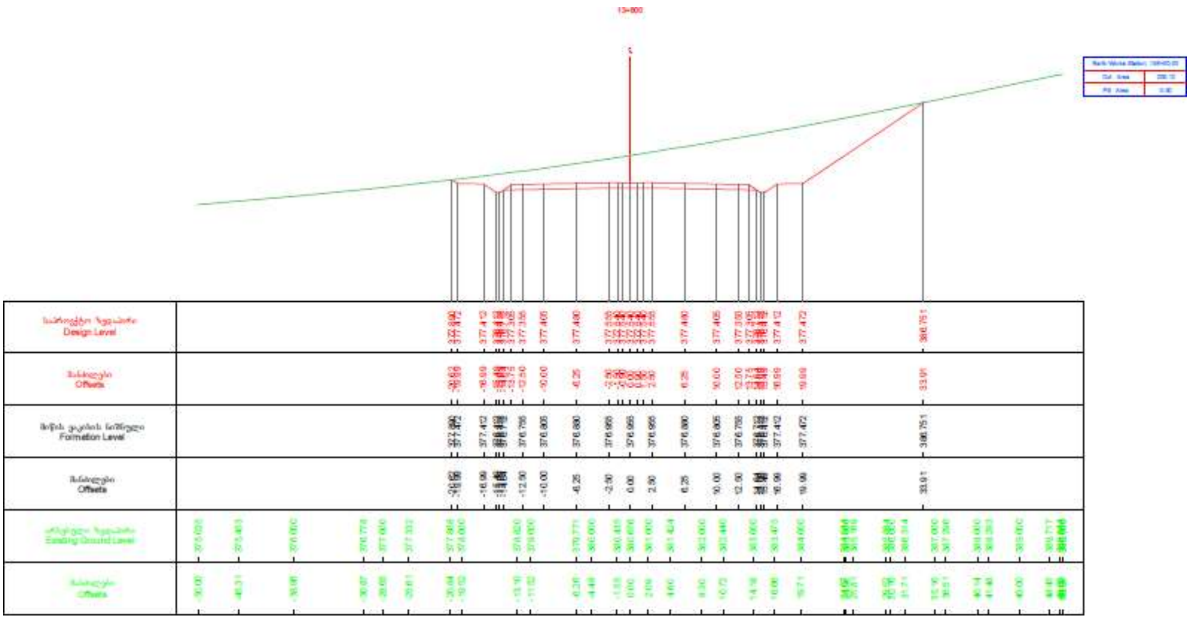
There is a relatively high risk to disturb the geological environment during the process of the Highway construction in the areas where the cuts will be necessary to provide and steep slopes will be necessary to cut for this purpose. By considering the background state of the corridor, in the first instance, such an area is the section, which will run across quite a non-homogenous relief of Iagluja Plateau: approximately from km2,4 to km11,5. During and after cutting the slopes, there will be risks for the gravitational events to develop. Such risks will be higher in bad weather (intense rains).

Consequently, along the given section, from km2,4 to km11,5, it will be necessary to cut down and terrace the slopes – a roadbed will be provided with embankments. By considering the physical-mechanical properties of the constituent rocks, the risks of activation of gravitational events are not high and selecting the right inclination angle for the treated slopes will be sufficient.

When making the sections, providing due inclination angle for the cut-down slopes will be of importance. By considering the physical-mechanical properties of the rocks, an inclination angle of the cut-down slopes will be 3H/2V. A cross section of the project bedrock along the given section is given in Drawings 7.3.1.1.

Figure 7.3.1.1. Typical cross section on the sites where the cuts are to be provided





In addition to due terracing the cut-down slopes, the measures specified by the recommendations of Paragraph 52.2.7 will be taken, which envisage the use of geosynthetic materials on the slope.

As already mentioned, at other sections of the project area, mostly fills will be provided. An average height of a fill will be 24 m (See Figure 3.4.3 for the typical cut) what is additional load of 480 KPa applied to the existing ground (fill volume weight g = 20 KN/m^3). In this case, the compression coefficient of the existing ground must be estimated. If the existing ground is not stable, additional reinforcement will be provided from beneath the fill (such as grooved piles, stone columns, rigid frames or preliminary load + drainage pipes). In addition to due terracing the ct-down slopes, the measures specified by the recommendations of Paragraph 52.2.7 will be taken, which envisage the use of geosynthetic materials on the slope.

For the foundations of the supports of the artificial structures (bridges) crossing the surface water objects, the existing washing depths will be considered and anti-erosion measures will be taken (paragraph 4.8).

As the great part of the project corridor runs across the flat relief, the probability of anthropogenic change of the drainage conditions of the construction grounds is noteworthy during the construction works, as his may cause anthropogenic bogging of small adjacent sites. An important mitigation measures to reduce the risks of impact is providing the drainage channels of a relevant length along the perimeter of the working zone (on some sites it may become necessary to use small capacity pumps as well). The drainage systems must ensure maximally natural distribution of the rainwater flown to the project corridor so that no anthropogenic change of ground water levels occurs on individual sites. Conducting capacity of temporary drainage systems must be maintained for the whole cycle of the project, and for this purpose, they will be cleaned/put to order on a periodic basis.

Overal, It may be said that the project corridor runs across great and less sensitive areas in an engineering-geological respect. However, following the relevant mitigation measures, the constrution works will not lead to significantly increased risks of hazardous processes to develop.

7.3.2 Operation phase

Provided the measures specified by the project and recommendations presented based on the engineering-geological studies are duly realized, the risk of development of hazardous geodynamic processes is not high. At the given stage of activity, monitoring of the trouble-free operation of the highway components (drainage systems, water conducting pipes, etc.) and taking rehabilitation and cleaning works as necessary is important.

7.3.3 Impact mitigation measures

In order to ensure the stability of the geological environment, in the construction phase, the following mitigation measures will be taken:

- The slopes on the sites of sections will be duly terraced. The terraced sites will be provided with relevant drainage.
- When providing the embankments, the bearing capacity of the grounds will be considered. On the sites where the ground is not sufficiently stable, additional reinforcement (rabbets, stone columns, rigid insertions or preliminary load + drainage pipes) under the embankment will be used;
- Geosynthetic materials will be used on the slopes of cuts and embankments as per the recommendations provided by the engineering-geological conclusion (See paragraph 5.2.2.7)'
- Large-scale earthworks on more complex sites, on Iagluja Plateau, will be accomplished under the supervision of the geological engineer;
- When founding the engineering structures, the engineering-geological properties of the existing grounds will be considered. Bridge piers will be founded below the scouring depth;
- The structures crossing the surface waters are designed to release peak discharges as per the effective standards;
- In order to prevent bogging of local sites, it is necessary:
  - to provide temporary drainage system along the perimeter of embankments and bulk materialas by considering local topography and to use small-capacity pumps if necessary; to provide periodic cleaning works with the aim to maintain the conducting capacity of the drainage systems.
  - to place of the fills and materials in the manner as to avoid the bogging of the adjoining areas.
- Diverting rain waters by bypassing highly sloped and other sensitive sites by using relevant water diversion techniques (channels, pipelines, temporal berms, settling basins);
- Compacting the ground fills properly;
- Limiting or stopping the works with the slopes during the wet weather;
- Recultivating the damaged areas after the completion of the works. In the operation phase, seasonal repairs/cleaning of drainage systems and water pipes is necessary. It is recommended to provide the observation in the project corridor in the initial years of operation (for 2-3 years).

Following the monitoring results, if necessary, additional protection measures must be taken.

7.4 Impact on water environment

The impact on water environment is described in the given paragraph in the following directions:

- Impact on surface and ground water quality;
- Impact on surface water flow;

- Impact on underground water yield;

Changes in the natural drainage conditions of ground waters and surface flow

7.4.1 Operation phase

The design corridor crosses or comes close some important rivers of East Georgia. These rivers are the Mtkvari, Khrami and Algeti. In addition to them, during the construction works, the dry gullies crossing the highway (mostly, the ones running within the limits of Iagluja Plateau, including Saridire valley, Kovu valley) and the irrigation channels across some areas can be considered as potential objects of impact during the construction works.

In addition to them, during the construction works, the dry gullies crossing the highway (mostly, the ones running within the limits of Iagluja Plateau) and the irrigation channels across some areas can be considered as potential objects of impact during the construction works.

The risks of impact when working near the surface water objects are mostly associated with unforeseen events, such as negligence during the earthworks, improper waste management, spills of products due to the faulty techniques and vehicles, etc. Besides, during the construction of the bridge piers, there is a probability of loose materials getting in the water and increased turbidity. Consequently, during the works on such sites, taking safety measures by the builders is important.

In such a case, in line with the requirements of the national legislation, before putting them to operation, the draft MAD standards will be developed and agreed with the Ministry. The sources of waste waters will be equipped with relevant treatment systems. Potential sources of surface water pollution are also the fecal waters that occur in the construction camps. the domestic and fecal waters will be collected and disposed with cesspool vehicles. Consequently, no discharge of the economic and fecal waters in the river is planned.

Following the project specifics, no impact on surface waters is expected. No structure crossing the river is planned to provide. No crossing over the rivers are planned. Bridge piers will be provided gradually – the river discharge will be diverted from the construction ground by means of temporary embankments so that the river continuity is maintained without the water current fragmentation.

The project does not envisage the construction of tunnels. Therefore, no impact on the deep water-bearing horizons or water exchange regime of the underground waters is expected.

The design corridor runs in East Georgia, across the landscape of a semi-desert type. In this area, the levels of ground waters are not close to the ground surface what is evidenced by the boreholes drilled in the project corridor.

The pollution of ground waters is mainly expected during the earthworks, in particular, when building deep foundations for design bridge piers and other engineering structures. The reason for pollution may be the spills of oil products and their penetration to the deep soil layers. The ground waters are expected to be polluted also due to improper management of domestic and fecal waters and other liquid waste. During the construction works, earthworks specifically, the impact on drainage and water exchange processes of ground and rain waters is to be considered. The reason for this may be providing cuts and fills in the project corridor what may cause elevation of ground water levels/bogging on local sites. For this purpose, it is important to efficiently use temporary drainage pipes/channels in the construction process.

Overall, an impact of the construction of the road on the environment may be assessed as medium. The impact will be temporal and reversible. In case the mitigation measures are realized efficiently, the value of impact will be low or insignificant.

7.4.2 Operation phase

As for the operation phase of the Highway, the water pollution risks are associated with: the road repairs and maintenance; spills of various pollutants in case of car accidents and their wash-down into the river/gorge/irrigation channel under the action of the surface runoff.

The pollution during the road repairs may occur in case of careless management of construction materials and waste and failure to comply with the Good Building Practice. This impact will be managed by considering all mitigation measures envisaged for the construction stage. Proper planning of the repairs works near the riverbed or in the river is an efficient means to avoid the possible impact on water/to protect the water environment. At this point, it should also be noted that following the road modernization, the risks of accidents will diminish a lot. Consequently, the probability of the scenario described above to develop will be little.

It should be noted that the highway, all along, will be equipped with relevant drainage systems (See project description sub-chapter) what ensure the relevant drainage of the rain and ground waters and prevention of bogging the slopes adjoining to the alignment.

In the operation phase, the impact on water environment may be considered as low.

7.4.3 Impact mitigation measures

Construction phase:

- The priority for the collection of industrial and fecal waters must be given to cesspools and UD toilets. Discharge of the wastewater into the surface waters must be brought to minimum;
- In case of making a decision to discharge the effluent waters in the surface water bodies, in line with the national legislation of Georgia, a project of MAD standards will be developed and agreed with the Ministry of Environment Protection and Agriculture of Georgia before putting the sources of effluent waters to operation;
- Water reserve reservoirs wil be provided on the construction camps and consequently grounds in order to use water resources rationally;
- Efficient drainage and stormwater systems will be used on the territories of the camps and construction grounds to avoid impact on the ground water level, bogging local sites and pollution of surface flow;
- Use of non-faulty construction techniques and vehicles;
- The machines/equipment and potentially polluting materials will be placed far from the surface water objects (50 m and more), in the areas protected against the atmospheric precipitations. otherwise, additional protective means will be used to prevent getting the pollutants in the water;

- A fencing will be provided along the perimeter of the oil products supply reservoirs to prevent the propagation of pollutants in case of emergency spills;
- Discharge of any kind of untreated wastewater into the rivers is to be prohibited;
- The surfaces of the storage sites of potential pollutants (oil products) will be provided with water impermeable layers;
- In case of spills of oil/lubricants, the spilled product will be localized/cleaned in the shortest possible time;
- The appliances creating the risk of ground water pollution when in operation will be equipped with drip pans;
- The vehicles must be preferably washed at private car washing areas;
- Filling the trenches left after the eathqowke earthworks sholes in a timely manner;
- The road pavement will be constructed in dry weather;
- During the construction of the bridge, measures to protect the water quality will be taken what mainly means accomplishing earthworks with maximum caution; all processed sites near the bed will have stability maintained to exclude the probability of getting the loose material in water/increasing turbidity;
- During the bridge piers construction, the construction ground located adjacent to the surface object will be isolated from the water current in the rivers with temporary embankments so that the continuous river flow is maintained as far as possible and to avoid its fragmentation;
- After the construction is complete, the tmporraily used areas will be recultivated and the sanitary conditions will be restored, and attention will be paid to prodiving the stability of sides of developed slopes and embankments.

Operation phase:

- The repairs of the road pavement will be provided in dry weather to avoid the pollution of surface flow;
- When repairing the damaged road sections, in order to avoid scattering the used material, the works will be duly planned.

7.5 Impact on soil productivity and quality

By considering the specifics of the planned activity, the impact on soil is expected in two directions: on the one hand, violation of the soil, layer stability, deteriorated productivity and resultant loss of cultivation resource is expected, while on the other hand, in case of improper management of used materials, waste management and pollutants (oil products) spills, there is a probability of pollution of surface soils layers. Both impacts are typical for the construction phase. In the operation phase, the probability of pollution will be evident. In the exploitation phase, the issues of negative impact on the surface ground layers must be considered and relevant attention must be paid to taking the relevant mitigation measures to reduce the probability of negative impact on the secondary receptors dependant on the given environmental objects.

7.5.1 Construction works

The major part of the corridor selected to build the Highway will run across the agricultural plots, where the soil cover is quite distinct.

In such areas, the average thickness of the surface humus layers is 20 cm. During the construction works, the highest impact is expected along these sections. Along the section where the corridor will pass across the area of Iagluja Plateau, the ecological value of soil is relatively less: the strength of the humus layer is little and the slope-constituent broken material is mixed with the humus layers.

The highest risks of damage and erosion of the topsoil layer will occur during the earthworks and heavy techniques traffic in the design corridor. As a result of these operations, soil compaction, erosion and deterioration of soil fertility are expected. The most important measure to diminish such impacts is advance topsoil stripping in the working zone and proper storage before its future use. By considering the length and average width of the highway and average strength of a humus layer, an approximate volume of the soil to strip is possible to determine:

- along the sections running across the agricultural plots:
  - o Approximate length of the corridor (L) – 20000 m;
  - o Average width of the corridor (W) – 45m;
  - o Average strength of humus layer (H) - 0,2m;
  - o Coefficient (K) considering the presence fo various communications in the corridor (roads, irrigation channels, other areas lacking humus) –0.7.

Approximate volume of the humus layer to strip is:

$$20000 \times 45 \times 0{,}2 \times 0{,}7 = 126000\ m^3;$$

- along the sections running across Iagluja Plateau:
  - o Approximate length of the corridor (L) – 9000 m;
  - o Average width of the corridor (W) – 45m;
  - o Average strength of humus layer (H) - 0,1m;
  - o Coefficient (K) considering the presence fo various communications in the corridor (local roads, irrigation channels, other areas lacking humus –0.6.

$$9000 \times 45 \times 0{,}1 \times 0{,}6 = 24300\ m^3;$$

- In the areas where the existing road is planned to widen, on bridge sites and other locations: ≈2-5 thousand m^3.

Overall, the total volume to the fertile layer to strip will be 155 thousand m^3.

The stripped topsoil cover will be stored on the sites selected in advance, with the maximum protection against the water and wind impacts. After the works are over, the topsoil will be used for the recultivation works along the roadsides (mostly in spoil grounds). The guiding document in the process of stripping, storing and using the topsoil is Technical Regulation - "Topsoil Removal, Storage, Use and Cultivation", approved by the decree №424 of the Government of Georgia.

The risks of qualitative deterioration of soil are associated with unforeseen events (e.g. spills/leakages of oil products from the techniques and/or vehicles operating in the project zone, supply reservoirs or other plants and mechanisms; improper handling of hazardous substances or their spills; improper management of the topsoil stripped during the construction; improper wastewater management, etc.).

All in all, the risks of impact on the fertility and qualitative properties of soil can be estimated as average or high. The value of the residual impact will depend on the success of accomplishing the environmental management plan. In case of its successful implementation, mainly meaning the relevant management of the stripped topsoil, the rating of the final (residual) impact will be insignificant.

7.5.2 Operation phase

As for the exploitation phase, destruction of the topsoil or its instability is less expected. The project highway, all along, will be equipped with relevant roadside drainage systems (See Project Description sub-chapter) what will reduce the probability of developing erosive processes in the roadside zone.

Road exploitation is usually associated with the soil pollution along the roadside with heavy metals. Another reason for pollution may be the garbage along the roadside. During the activity, it is difficult to management the given types of measures as the cause of impact is mainly the passengers travelling along the road.

7.5.3 Mitigation measures

Construction phase

One of the environmental commitments of the building contractor during the implementation of earth works will be minimal impact on the fertile soil layer. In addition, erosion and damage of soil should be prevented and measures should be taken to maintain the quality of soil fertility, in particular:

- Routes determined for transport and equipment must be protected;
- Topsoil should be removed and disposed separately from other materials, on pre-selected areas protected from surface runoff
- Temporary water drain channels should be arranged on the perimeter of bulk soil;
- In case of long-term storage of topsoil, its maintenance shall be considered. Perioduc losening and grass sowing is meant under this clause;
- After completion of the construction works, pre-excavated topsoil shall be used for restoration of the damaged areas and improve productivity;
- In order to avoid soil contamination, sound construction equipment shall be used;
- The fuel tank should be placed in areas protected by berms and embankments in order to prevent spills in case of necessity;
- The impermeability of industrial-fecal waters cesspits will be ensured; the cesspits will be emptied before they are full;
- Spill should be immediately contained and cleaned up from absorbent material;
- Accidentally contaminated ground / soil shall be removed and disposed as soon as possible;
- Following the completion of the construction works, the territory will be recultivated and sanitary conditions will be restored what will reduce the probability of impact on soil quality and stability. The recultivation works will be done mainly in the roadside zone (embankments and cutting slopes) and spoil grounds.

Operation phase

- Good maintenance of drainage system is instrumental in avoiding erosion and degradation of soil to minimize the development of erosion processes caused by rain waters in the roadside zone.

7.6 Impact on biological evironment

As a result of the project implementation, an impact on the biological environment is expected in some directions, in particular:

- Loss and fragmentation of habitats;
- Impact on flora and vegetation cover during the cleaning works of the project area and earthworks;
- Direct and indirect impact on fauna, including fish fauna and impact on their habitats during the works near the water object;
- Impact on protected areas and protected species common in those areas

7.6.1 Loss and fragmentation of habitats

7.6.1.1 Operation phase

The evaluation of the impact caused by the loss of habitats as a result of the highway construction must consider the types and values of habitats in the project corridor as well as the area of the corridor to b used within the scope of the project. As it was mentioned in the introductory part of the baseline conditions, the project corridor runs across three types of sections:

1. Steppe-type habitats on Iagluja Plateau;
2. Agricultural plots habitat;
3. Degraded floodplain-like habitats present on the sites of objects crossing the water objects.

None of them are a habitat of high value. Their natural structure is quite changed under the intense economic activity of people.

By considering the length and width of the project highway and area to use, the loss of habitats can be assessed quantitatively in approximate terms. For comparison, we can use monograph “Spatial-time analysis of Georgian landscapes” giving the total areas of similar habitats in Georgia (See Paragraph 5.2.). The quantitative assessment of impact causd by the loss of habitats is given in Table 7.6.2.1.1.

According to the table data, a landscape of low and less average value will be under the impact, whose quantitative loss will be insignificant. In the final run, the impact caused by the loss of habitats may be assessed as low. For the habitat compensation, the project does not need the restoration of similar habitats or other significant mitigation measures.

Table 7.6.1.1.1. Impact causd by the loss of habitats as a result of the the project highway construction

Type of habitat	Highway section, which will run across the relevant type of habitat				Total area of a similar habitat in Geogia according to monograph "Spatial-time analysis of Georgian landscapes", ha	Percentage loss of habitat, %
	Approximate length, m	Average width,m	Area of the corridor to use to construct the highway, m^2	Approximate loss of habitat, ha		
Habitat 1 - Steppe-type habitats on Iagluja Plateau. Value - Low	9000	45	405000	40,5	37000	0,11%
Habitat 2 - Agricultural plots habitat. Value - Low	20000	45	900000	90,0	165500	0,054%
Habitat 3 - Degraded floodplain-like habitats present on the sites of objects crossing the water objects. Value – mostly Low	1000	45	45000	4,5	154000	0.003

Besides the habitat loss, the habitats in some areas will be changed. Such an impact is expected in the affected areas, where there is no need for permanent use of habitats. Rather, they will be used on a temporary basis e.g. to provide construction camps or spoil grounds. It should be noted that the sites selected for temporal infrastructure will not occupy large areas and they are similar habitats of a low value. After the completion of the construction works, such areas are planned to recultivate and restore to their initial state. As there are mainly weeds growing in the project area and the works do not need cutting large amounts of trees and vegetation cover, the risk of penetration of invasive or advent plant species in the project area or weeding is not high.

As for the probability of the habitat fragmentation, the areas with similar structures are spread on the both sides of the alignment to use. The construction corridor will not cross a forested area and does not separate the habitats of different types. Besides, the project area is not an important migration route for land animals. Therefore, during the construction works, the habitat fragmentation will not be significant.

7.6.1.2 Operation phase

In the operation phase of the highway, no additional impact on the local habitats is expected. At the given stage of the works, the probability of habitat fragmentation caused by the road bed (embankments, cuttings) is more important. As a result of such fragmentation, there will b certain barrier created for some animal species to move across vast areas to find food or breed. At proper locations, the project envisages providing box culverts under the roadbed to take animals from one side of the highway onto another.

7.6.1.3 Impact mitigation measures

As already mentioned, the project is planned to realize in the area of mainly low-value habitats. Consequently, there is no need for significant compensation measures. The borders of the corridor to use are important to observe during the construction works as well as traveling area for techniques and vehicles.

In the operation phase, underpasses are planned to provide at relevant locations under the roadbed.

7.6.2 Impact on vegetation cover

7.6.2.1 Construction phase

During the construction of the project highway, both, direct and indirect impacts on the vegetation cover and flora are expected.

Direct impact is the clearing the road ROW off the vegetation cover. In this respect, it should be noted that the project corridor does not cross naturally forested/forets funs areas. As per Paragraph 5.3.2, Total 8 833 timber plants will be under the impact; however, most of them (6 855 timber plants) and bushes with their diameter less than 8 cm. It should be noted that 2 walnut species (Juglans regia) (24 trees) and 1 nettle tree (Celtis dlabrata) in the project corridor. There are also nettle trees with the diameter of less than 8 cm growing in the project corridor (total 82 trees), which are Red-Listed species.

An indirect impact on the vegetation cover is also expected, e.g. pollution of the adjoining area with construction materials, soil damage/compaction during the construction works, spills of oil products, emissions of harmful substances in the atmospheric air. However, following the low sensitivity of the species growing in the corridor, the impact on any of them will not be significant.

In the final run, the vegetation cover in the project area, in respect of both, species and quantity, is not of a high value. Mostly, cultural or artificially grown species and those of a secondary type will be subject to the direct impact. No significant mitigation or compensation measures will be necessary for the floristic environment. During the preparation of the corridor, the project borders to prevent any excess damage to the plants will be observed. The vegetation cover cleaning works will be agreed with the relevant bodies.

7.6.2.2 Operation phase

In the operation phase of the road, the risks of damage of the vegetation cover is minimal. Possible indirect impact may be associated with the dust and exhaust fumes as a result of the vehicle traffic and pollution with surface effluent. The pollutants from the road pavement may have an impact on the development of the green cover.

7.6.2.3 Impact mitigation measures

Construction phase

- Observing the borders of the project corridor to prevent additional damage to plants;
- Delisting the protected species from the environment will be done in line with the requirements of sub-clause f) of clause 1 of article 24 of Georgian Law "On the Red list and Red book of Georgia", in agreement with the Ministry of Environment Protection and Agriculture of Georgia.

Operation phase

Direct impact on flora is not expected in the highway operation phase. Indirect impact may be associated with the dust and exhaust fumes as a result of the vehicle traffic and pollution with surface effluent. The pollutants from the road pavement may have an impact on the development of the green cover and soil organisms. During the repairs, the requirements specified for the construction phase will be observed (Mitigation measures).

7.6.3 Direct and indirect impact on fauna

7.6.3.1 Operation phase

As a result of Rutavi-Red Bridge construction, both, direct and indirect impacts on fauna are expected.

During the construction works, the source of direct impact is earthworks and harm and death of animals due to various activities (e.g. vehicle accident, falling in trenches, etc.). As a result of the earthworks., habitats may be destroyed (nests, holes, barrows). Reduction of the vegetation cover will also have an impact on the feeding base. The impact will mainly affect: small mammals – various rodents, passerines as well as reptiles (among which the Georgian Red-Listed species Mediterranean tortoise *(Testudo graeca)* is worthwhile. For large mammals, the project area is not very attractive and consequently, they will be less subject to the impact.

Worthwhile indirect impacts are:

- Emission of noise, dust and combustion products, as well as human intensive activities will cause animal disturbance and migration to other places;
- Unsystematic spread of waste, unproper management of waste (change in environmental quality indicators) will cause a further deterioration of the living conditions of terrestrial and aquatic animals; There will be also letal cases.
- Night lighting systems at construction camps may cause disturbance of animals and disorientation of birds;
- Cases poaching are also possible by the personnel.

In respect of impact on fish fauna, the sections of the project corridor crossing big rivers or running near them (Rivers Algeti, Khrami, Mtkvari) are noteworthy. As alreadymentioned, the project does not envisage fragmentation of river currents or providing barriers within them what could cause the fragmentation of habitats of fish fauna.However, indirect impact is expected associated with the increased water turbidity near the beds (when constructing piers) and getting various pollutants in water. Flowing of discharge waters from the construction camps into the river and insignificant propagation of pollutants from the construction operations may be attributed to temporary impacts on water habitats and species.Consequently, in respect of protection of fish fauna and water habitats, the mitigation measures to maintain surface water quality are very important.

In the final run, the negative impact on fauna species is expected in several directions. However, reduction of any species what may affect their conservation status is not expected. Despite this, the construction works must be accomplished by taking relevant mitigation measures, while t recultivation works after the completion of the construction will alleviate the impact to a certain degree. After the completion of the construction works, certain types of impact sources (construction camp, techniques, construction personnel) will not exist what will support certain species to return to their original habitats.

7.6.3.2 Operation phase

After putting the highway to operation, some sources of direct and indirect impacts on fauna (e.g. earthworks and construction works, camps, etc.) will not exist. However, the traffic intensity will increase. Consequently, the risks of collision of the vehicles with animals and noise propagation will also increase. In this respect, the relevant mitigation measures will be considered.

7.6.3.3 Impact mitigation measures

Construction phase:

- Protection of working borders to prevent excess demage of vegetation cover;
- Inspection of project corridors (specified) on the preparation stage and reveal animals inhabiting zones (nests, holes) within the corridors
- Restriction of speeds of machinery and transport;
- Fencing of holes and trenches with sharp color things in order to avoid falling of animals in them;
- Filling of holes and trenches in limited terms. Before launching filling works holes should be checked probability of being animals in them should be excluded;
- Arrangement of small boards on trenches to provide artificial crossings for small animals;
- Minimum usage of light on the construction camps.
- Proper management of wastes;
- Implementation mitigation measures of noise propagation, emission of harmful substances and water contamination;
- Providing instruction for the personnelabout importance of species and establish fines against poaching;
- Accomplishing recultivation works after the completion of the construction works.

Construction phase:

- In order to reduce impact caused by habitat fragmentation, arrangement of artificial crossings under the road should be installed;
- Recurrent collection of wastes accumulated along the road line;
- During maintenance works of the highway, all mitigation measures should be considered (developed for the construction phase), which will reduce emission of harmful substances and water pollution.

7.6.4 Risks of impact on protected areas

The project corridor does not cross the protected areas either under the national legislation, or international conventions. However, along one section, the corridor approximates the border of Gardabani Reserve/Emerald Candidate Site. Consequently, no direct impact on the protected areas is expected as a result of the project implementation. However, following such an approximation, additional substantiation for sensitive sections is needed, i.e. “Appropriate Assessment” what is required by the Scoping Opinion.

Emerald Candidate Sites are not a network of strictly protected areas and realizing activities near them and sometimes, within their limits is admissible. However in case of impact on a candidate site, relevant studies must be accomplished, and the assessment covers four stages: I. Scoping; II. Appropriate Assessment; III. Assessment of Alternative Solutions, and IV. Defining imperative reasons of over-riding public interest (IROPI).

Based on the requirement of the Ministry of Environment and Agriculture of Georgia and by considering the location and properties of the project, the II stage – the Appropriate Assessment was accomplished within the scope of the present EIA document.

As per the proper explanation, the consideration of the impacts on the integrity of the European site, wither alone or in combination with other plans and projects, with regard to the site's structure and function and its conservation objectives. Where there are adverse impacts, an assessment of mitigation options is carried out to determine adverse effect on the integrity of the site. If these mitigation options cannot avoid adverse effects then development consent can only be given if stages 3 and 4 are followed.

7.6.4.1 Description of the expected impact

The project corridor is distanced from the Emerald Candidate Site by 135 m. At the same time, river Mtkvari flows between the man area of the Candidate Site and the project corridor. Consequently, no direct impact on the Emerald Candidate Site will occur as a result of the project implementation (such as destruction/fragmentation of the habitats within the limits of the Candidate Site, destruction of the habitats of species living within the limits of the Candidate Site, etc.).

The biological study of the project area confirmed that habitats within the impact zone of the highway, following its composition and degree of anthropogenic load, do not to correspond to habitat type typical to the Emerald Candidate Site E3.5. – „Humid or wet oligotrophic meadow". Consequently, no negative impact on a (similar) habitat typical to the candidate Site beyond the borders of the Emerald Candidate Site will occur.

During the field visit, we did not identify species protected by the Bern Convention immediately in the project corridor. However, some section of the corridor may be attractive with the aim of finding food for them or propagation. Consequently, certain species may be under the project impact zone during the construction works. We identified a Greek tortoise (*Testudo graeca)* in the Agricultural habitat. Forlong its lifestyle, this species may occur in the river bank areas.

As for the disturbing factor and risks of pollution of the areas within the limits of the Emerald Candidate Site caused by the activity:in this respect, it should be conisdered that there is already a motor road (Rustavi-Red Bridge) along the given section of the highway corridor. Consequently, noise and dust emission pollute the environment at present. Widening the road will not change the situation essentially. Consequently, there will be no impact near the Emerald Network Candidate Site. As already mentioned, river Mtkvari flows bet the Emerald Candidate Site and the project corridor creating a certain barrier between the source of impact and the potential receptor. By considering such circumstances, the probability of the land animals within the limits of the Candidate Site to accidentally occur within the impact area on the on hand and of the negative impact (vibration, solid and liquid pollutants) to spread in the direction of the Candidate Site.

Overall, none of the project phases (construction or operation) will not have a significant impact on the Emerald Candidate Site. Following the above-described factual circumstances, no compensation measures are necessary. However as already mentioned, some individuals protected under the Bern Convention may be subject to direct and indirect impact and the Construction Contractor must take certain precautionary measures.

7.6.4.2 Mitigation measures

Following the above-mentioned, below we give the summary table giving the following data for animal species typical to the project area (including species protected by the Bern Convention and Red List of Georgia):

- Expected impact of the project implementation;
- Source of impact;
- Expected impact area;
- Planned mitigation and compensation measures;
- Period of taking mitigation and compensation measures.

The mitigation measures for the impact on biodiversity will be carried out by the Construction Contractor in line with the infrastructure given in the table what in the final run, will ensure reducing the expected impact on biodiversity as a result of project implementation.

7.6.5 Potential Impacts of Climate Change Upon the Project

Components at Low- and Moderate-Risk from Climate Impacts

Bridges

By 2050, precipitation is expected to decrease by 4.5%, and by 2100, it will decrease by 13%. At the same time, extreme rainfall events are projected to become more frequent and intense. This may lead to increased scouring and riverbank erosion. In addition, the bridge deck drainage capacity may be overwhelmed and create unsafe driving conditions.

By 2100, annual river runoff may decrease by about 13%, and normal water levels in the river channels may be lower by as much as -1.1 m. Water level and flow fluctuations may lead to changes in sub-surface conditions that could affect foundation settlement and pier bearing capacity.

By 2050, summer (July – September) temperatures are projected to increase by up to 4.5°C, and the number of consecutive hot days (i.e., days with maximum temperature over 25°C, and days with daily minimum temperatures over 20°C) will become more frequent, which may impact bridge structure and bridge deck paving material.

The expected changes in temperatures will stress the bridge deck paving material, which is expected to be a BM. The increase in maximum air temperatures may soften the BM, and the likelihood of shorter winters will reduce the service life of the BM mixture due to abrasion and wear.
In addition, an increase in the number, duration and extent of wildfires in the surrounding vegetated and forested areas is expected. The ambient heat generated from these may also affect bridge structures and materials, bridge deck conditions, and may also create unsafe driving conditions.

Cut Sections

By 2050, precipitation is expected to decrease by 4.5%, and by 2100, it will decrease by 13%. At the same time, extreme rainfall events are projected to become more frequent and intense. Changes to ground water levels and flows may also lead to changes in sub-surface conditions.

By 2050, summer (July – September) temperatures are projected to increase by up to 4.5°C, and the number of consecutive hot days (i.e., days with maximum temperature over 25°C, and days with daily minimum temperatures over 20°C) will become more frequent, which will lead to an increase in the number, duration and extent of wildfires in the surrounding vegetated and forested areas.

An increase in droughty conditions combined with more frequent extreme rainfall events will increase risk of flash floods, mudflows and landslides on the surrounding slopes. An increase in debris flows and drainage obstructions is likely.

Surface Water Management

By 2050, precipitation is expected to decrease by 4.5%, and by 2100, it will decrease by 13%. At the same time, extreme rainfall events are projected to become more frequent and intense. Intense and long-duration rainfall can be regarded as the most critical loading condition. The frequency of such events is projected to increase, which may create loads that exceed the original design parameters.

By 2100, annual river runoff may decrease by about 13%, and normal water levels in the river channels may be lower by as much as -1.1 m. In addition, an increase in the number, duration and extent of wildfires in the surrounding vegetated and forested areas is expected. This will likely increase the debris load near drainage channels and openings. Because of changing climatic conditions, projected debris loads, changing land use patterns, and uncertainties in hydrologic estimates, culvert size and capacity should be expansive.

An increase in droughty conditions combined with more frequent extreme rainfall events will increase risk of flash floods, mudflows and landslides on the surrounding slopes. An increase in debris flows and drainage obstructions is likely.

<u>Components at Low-Risk from Climate Impacts</u>

Road Surface

Nearly all climate parameters affect the road surface. Even under normal climate change conditions, rigid pavements suffer from thermal-expansion stresses.

Thermal-expansion stresses, such as scaling, D-cracking, pumping, faulting, curling, corner cracking and ‘punch-outs, are the primary concern due to air temperatures, including absolute yearly maximal and the number of heat days. Curling deformation, resulting in thermal-expansion stresses in the concrete slab, is a characteristic phenomenon under environmental and repeated vehicle loads. Distortion of the slab, due to both upward and downward curling, may occur when the top surface of the slab is cooler than the base course, and also when there is a higher temperature on the top surface, leading to separation of the base course from the concrete. Distress of the pavement in the form of joint deterioration, or cracking, also contributes to void formation by allowing moisture infiltration. The combination of distress and layer voids will further reduce the pavement load carrying capacity. Changes in the capacity of the base course, or subgrade, as a second-order response may also add new stresses to the road surface.

While an overall increase in temperature is projected, these are not expected to severely impact the road surface since the projected temperatures are within the German Pavement Design Guideline (RStO 12) reference temperature range (-20°–50°C) used in the pavement design.

The increase in the number of consecutive hot days (i.e., days with maximum temperature over 25°C, and days with daily minimum temperatures over 20°C), and the increase in the number, duration and extent of wildfires on the surrounding slopes, may require second level responses.

Interchanges and Access Roads

The majority of climate parameters affect asphalt surfaces, though the increase in the number of hot days and nights is of particular concern. As asphalt surfaces have a short design life and can be replaced relatively easily, they are not considered a medium- or high-risk component. Changes in air and ground temperatures may also affect the subgrade of the approach and connecting roads, but not to an extent that would result in medium- or high-risk component.

Road Embankment and Road Base

Most climate events affect the road embankment to some degree. The climate load includes changing ground water levels, that can induce consolidation settlement; ground temperature; ground water regimes; snow cover; and surface vegetation that can reduce their service life. By 2050, precipitation is expected to decrease by 4.5%, and by 2100, it will decrease by 13%. Increasing temperatures and changes in precipitation patterns may impact ground and surface water flows, leading to consolidation settlement.

By 2050, summer (July – September) temperatures are projected to increase by up to 4.5°C, and the number of consecutive hot days (i.e., days with maximum temperature over 25°C, and days with daily minimum temperatures over 20°C) will become more frequent, may accelerate soil warming, and in some soil types, creating soil heave.

In contrast to the road embankment, the road base is not directly exposed to the atmosphere, and therefore is less impacted by short-term climate events. Changes in the road base capacity would mostly result from loss in strength or formation of voids due to internal erosion, especially if the road surface is cracked.

Changes in surface and ground water levels and their impact on the road base and the road embankment, as a second-order response to changes in precipitation levels are difficult to predict, but should be considered.

Management & Mitigation Actions

A number of recommendations were made as part of the climate risk assessment. The following table provides those recommendations along with the responses of the Detailed Design Consultant.

Table 7.6.5.1: Climate Change Recommendations and Responses

Recommendation	Detailed Design Consultant Reply
Bridges	
A review of the bridge pier design parameters in light of the potential changes in in soil conditions, with implications for foundation settlement.	All piers are designed in order to avoid settlements on the long run and plinths are generally in the floodplain. Plinths in the flowing section of the river, whenever unavoidable, are founded on piles and with the upper face below the riverbed level, as per best practice; the risk of foundations being exposed is consequently minimum. Intervention of protection of the plinths in the floodplain in case of future river bed changes is quite simple and not expensive, so we suggest to monitor this aspect and act accordingly just in case. Recommendations for the Employer will be included in the "Monitoring Action Plan - Operation Phase" document, in order to give an instrument of monitoring and managing the maintenance.
The recurrence interval for the bridge drainage system should be upgraded to a 50-year recurrence interval, and the drainage calculations revisited, to ensure concurrency with the other elements of the drainage system.	50 years return period is used as clearly stated in the design documents.
Cut Sections	
A decrease in the cut slope gradient, and a concurrent increase in the overall slope buffer area, is recommended.	The choice of the cut slope is a compromise between the geotechnical constraints and the occupation of land. Reducing the slope of the cuts in many cases will cause larger road footprint (often more than a hundred meters), which would not acceptable for its landscaping and resettlement impacts and for the volumes of spoil material generated. In any case the geotechnical verification (not present in the draft) have been carried out with conservative safety coefficient.
Increased use of hydro seeding on all the cut slopes, not just their upper most area, is recommended.	The steepness of the slope (almost vertical) and the presence of rock don't allow the use of hydro seeding. This would more be the case of a "vertical garden", which is not a technology practiced in Georgia. That's why the designer's choice was the more industrial, but effective steel net protection.
Surface Water Management Structures	
A consistent 50-year recurrence	50 years return period is used as clearly stated in the

Recommendation	Detailed Design Consultant Reply
interval for the road drainage system should be used throughout the design, and all design calculations reviewed.	design documents.
Assumptions and calculations for areas with high degree of mass movement and high potential for channel obstruction should be explicitly integrated into the drainage system design.	Mass movements are mostly unpredictable, as well as the yearly amount of debris flow. We only can suggest to the Employer to monitor these phenomena and to act accordingly, in case of event. Monitor of mass movement will be included in the "Monitoring Plan – Operation Phase" document.
Use of box culverts, which are better at managing debris flows and related obstructions than pipe-based systems, is recommended.	Further, given that a design solution with external ditches has been chosen for both embankment/fill and cut section, the motorway platform always lies higher than external ditches, so that drainage pipes are not expected to convey significant debris flow.

Hydrology

Potential Impacts

The following potential impacts to hydrological conditions exist within the Project corridor:

- Drainage & Flooding - Inadequate assessment of the hydrological conditions in the Project Area and poor design could result in damage to Project structures, including bridges and culverts. This in turn would result in several impacts including cost to rebuild the structures, potential flooding of agricultural land and property and impacts to surface water quality.

- Construction Camps – Improper siting and design of construction camps can have negative impacts to hydrology, both surface and groundwater, through improper disposal of liquid waste and spills of hazardous liquids.

The span of the bridges is designed to avoid, as far as possible, the presence of foundation piles in the riverbed. That said, it is important to point out that the intervention is located in a complicated orography (a narrow valley with a central stream) and that the geometric standards of the route have imposed strong constraints that oblige to pass over the river, to have no greater environmental impact on forests or populated areas.

Management & Mitigation Actions

Drainage and Flooding - Consideration in the design phase has be given to the issue of drainage and culverts to ensure that drainage patterns are improved from the existing conditions and that increased run-off does not occur or result in flooding of areas previously undisturbed. During design, all drainage works have been designed based on the historical flood data and flood forecasting. A design discharge of 50 years return period is considered for culverts, and 100 years of bridges.

Bridges - All bridges will be designed for the life expectancy of 100 years. The design loading and design of all structural components will conform to the bridge design standards provided in the Employer's Special Requirements. Bridge designs will ensure that drainage from bridge decks over 50 meters does not discharge directly to the watercourses beneath the bridges. The bridges shall be designed with dry paths under the bridge on either side of the streams to facilitate movements of people, livestock and wildlife, the latter primarily at night when people are not around.

During the operational phase of the Project, the RD will be responsible for monitoring drainage along the road to ensure that it does result in increased run-off and flooding. The RD will be responsible for rectifying this issue if it occurs.

Table 7.6.5.2. Summary table of impact on biodiversity and mitigation measures for different species

Impact receptor	*Description of impact*	*Sources of impact*	*Impact area*	*Mitigation measures*	*Period*
Habitat type - E3.5. – „Humid or wet oligotrophic meadow ".	*The given type of habitats is not presented within the scope of the project. Implementation area Consequently, project implementation will not have any impact on it.*	-	-	-	-
Timber plants, including Red-Listed species, Walnut (Juglas regia and Mt. Atlas mastic tree Pistacia mutica Fisch & Mey)	*Direct impact: Delisting/damage of plant species;*	• *Clearing the project corridor;* • *Earthworks;*	*Project road corridor, particularly the sites adjacent to the plots of a medium value identified during the botanical survey.*	• *Delisting the protected species from the environment will be done in line with the requirements of sub-clause f) of clause 1 of article 24 of Georgian Law "On the Red list and Red book of Georgia", in agreement with the Ministry of Environment Protection and Agriculture of Georgia*	*At the preparatory stage*
				• *Observing the borders of the working site.*	*During the works*
Mammals					
Brown bear (Ursus arctos) and Eurasian lynx (Lynx lynx), wolf (Canis lupus) - protected by Bern Convention and are typical to „Gardabani" Candidate Site.	*The habitats in the project corridor are not favorable for this species. No impact is expected and no special mitigation measures are needed.*	-	-	-	-
Otter (Lutra lutra) - protected by Bern Convention, but is not envisaged by „Gardabani" Candidate Site standard form.	*No living sites of this speceis were fixed in the project corridor. The probability of impact is minimal and no special mitigation measures are needed.*	-	-	-	-

Jackal (Canis aureus) (identified during the field survey; Red fox (Vulpes vulpes) and other small predator mammals	*Direct impact:* • *Damage to the habitats (holes) during the earthworks as a result of earthworks and cutting the slopes;* • *Vehicle collision, falling in the trenches and getting harmed*	• *Clearing the project corridor off the vegetation cover;* • *Earthworks ;* • *Transportation operations.* •	*The sections of the project corridor under less anthropogenic impact*	• *Preliminary layout of the working zone;*	*Before the commencement of works*
				• *Observing the borders of the working zone to avoid damage to additional areas;*	*During the works*
				• *Adhering to the driving routes and speed limits of vehicles;*	*During the transportation operations*
				• *Bordering holes, trenches the like elements with barriers to protect animals against falling in them, e.g. with a bright-color tape or plain material* • *Placing planks in the holes and trenches to help the fallen animals get out of them;*	*During the earthworks*
				• *Thorough examination of holes and trenches;*	*Before filling in trenches and holes*
				• *Taking recultivation measures, including topsoil restoration*	*After completion of works*
	Indirect impact: • *Disturbance and migration to other territories because of noise propagation or other anthropogenic factors;* • *Impact on less mammals, on their food base in particular;*	• *Noise caused by construction works;* • *Works, concrete works, use of various polluting materials, waste;* • *Poaching by the personnel*	*The sections of the project corridor under less anthropogenic impact*	*Taking the noise mitigation measures specified by the EIA Report;*	*during the works, the earthworks in the first instance*
				• *Plant protection from impact;* *Protection of the environment from pollution, proper waste management;*	*Permanently, during the works*
				• *Giving the explanation to the personnel regarding the importance of species and sanction sin case of unfair behavior;*	*Providing training before the commencement of works*

	• *Poaching.*				
Bats, including those protected by the Bern Convention:	*The study did not identify colonies or habitats of this species (hollows, caves). Mostly indirect impact on them is expected:*	• *Noise caused by construction works;*	*Project corridor, particularly old buildings and premises where bats may live;*	• *Taking noise mitigation measures specified by the EIA Report;*	*during the works, the earthworks in the first instance*

Western barbastelle (Barbastella barbastellus), Lesser mouse-eared bat (Myotis blythii) and Lesser horseshoe bat (Rhinolophus hipposideros)	• Disturbance and migration to other territories because of noise propagation or other anthropogenic factors;				During the works
				• Giving the explanation to the personnel regarding the importance of species and sanction sin case of unfair behavior;	Providing training before the commencement of works
Different species of small land mammals, mostly rodents,	Direct impact: • Possibility of damage of places of habitatation (burrows) during the construction of the roadbed as a result of tree felling, clearing the grass cover, earthworks and cutting the slopes • Vehicle collision, falling in the trenches and getting harmed.	• Clearing the project corridor off the vegetation cover; • Earthworks ; • Transportation operations.	All along the project corridor, along the perimeter of spoil grounds	• Preliminary layout of the working zone;	Before the commencement of works
				• Observing the borders of the working zone to avoid damage to additional areas;	During the works
				• Adhering to the driving routes of vehicles;	During the transportation operations
				• Thorough examination of the affected territories in advance to identify the concentration sites of small animals locally	On each construction oround before the commencement of the works
				• Bordering holes, trenches the like elements with barriers to protect animals against falling in them , e.g. with tin, polyethylene, etc. • Placing planks in the holes and trenches to help the fallen animals get out of them;	During the earthworks
				• Thorough examination of holes and trenches;	Before filling in trenches and holes

				• *Taking recultivation measures, including topsoil restoration.*	*After completion of works*
	Indirect impact: • *Disturbance and migration to other territories because of noise propagation or other anthropogenic factors;* • *Reduced food base as a result of vegetation clearing;* • *Pollution of soil and water environment;* • *Vandalism of the personnel.*	• *Noise caused by construction works;* • *Works, concrete works, use of various polluting materials, waste;* • *Poaching by the personnel*	*All along the project road*	• *Taking noise mitigation measures;*	*During the works, the earthworks in the first instance*
				• *Protecting plants against excess impact;* • *Protection of the environment from pollution, proper waste management;*	• *Permanently, during the works*
				• *Giving the explanation to the personnel regarding the importance of species and sanction sin case of unfair behavior;*	• *Providing training before the commencement of works*

Birds					
Bigger predator birds, including the species protected by Bern Convention such as *Levant sparrowhawk Accipiter brevipes, Eastern imperial eagle, Aquila heliaca, Lesser spotted eagle (Aquila pomarina), as well as Common kestrel (Falco tinnunculus) identifd during the field study, etc.*	No habitation sites of such species were identified in the corridor. Consequently, no direct impact on them is expected. However, it is not excluded for them to get temporarily in the impact area and their disturbance. *Indirect impact:* • *Disturbance and migration to other territories because of noise propagation or other anthropogenic factors;* • Impact on the food base habitats small mammals/reptiles; • *Poaching.*	• *Noise caused by construction works;* • *Poaching by the personnel.*	• *All along the project corridor*	• *Taking the noise mitigation measures specified by the EIA Report;*	*During the works, the earthworks in the first instance*
				• *Protection of small mammals, reptiles and amphibians against the impact;*	*For the whole project cycle*
				• *Giving the explanation to the personnel regarding the importance of species and sanctions in case of unfair behavior.*	*Providing training before the commencement of works*

Heron species, including the species protected by Bern convention: Purple heron (Ardea purpurea), Speceis identfied during the field survey: Grey heron (Ardea cinerea) and Great egret (Ardea alba)	*The project corridor, following its landscape properties, is not an important habitat for these species. Consequently, the probability of the direct and indirect impacts on them will be low. There is no need for special mitigation measures.*	-	-	-	-
mall birds, including Fringillidae, Paridae, Turdidae, Passer, including the species protected by Bern convention.	*Direct impact:*	• *Clearing the project corridor off the vegetation cover;* • *Earthworks.*	*All along the project corridor*	• *Preliminary layout of the working zone;*	*Before the commencement of works*
	Possibility of damage of habitation sites (nests) due to tree felling, grass cover clearing, earthworks and slope cutting;			• *Observing the borders of the working zone to avoid damage to additional areas;*	*During the works*
				• *Thorough examination of the affected territories in advance to identify bird nests and other shelter*	*On each construction oround before the commencement of the works*
				• The personnel must be instructed against killing fauna species. Rather, they must be given an escape route from the area during the works. At least, their disturbance must be limited to giving them a corridor to escape.	*For the whole project cycle, particularly before starting the corridor clearance works and earthworks*

				• *Forbidding any kind of impact on the tees with functioning bird nests in them from April to July.*	*from April to July*
				• *Taking recultivation measures, including topsoil restoration*	*After completion of works*

	Indirect impact: • *Disturbance and migration to other territories because of noise propagation or other anthropogenic factors;* • *Reduced food base as a result of vegetation clearing;* • *Environmental pollution;* *Poachin and vandalism of the personnel..*	• *Noise caused by construction works;* • *Poachin and vandalism of the personnel*	*All along the project corridor*	• *Taking noise mitigation measures;*	*during the works, the earthworks in the first instance*
				• *Protection of trees and vegetation cover against impact;*	*For the whole project cycle*
				• Giving the explanation to the personnel regarding the importance of species and sanction sin case of unfair behavior*;*	*Providing training before the commencement of works*
Reptiles:					
Different reptile species (their potential habitats are the areas covered with tall herbaceous civer and cliffy slopes), including Red-Listed species: Mediterranean tortoise *(Testudo graeca) and speceis protected by Bern Convention: Caspian turtle (Mauremys Caspica), European pond turtle (Emys orbicularis)*	*Direct impact Damage of attractive sheltrs; direct impact due to vehicle collision, falling in trenches or other reasons.* *Indirect impact:* • *Disturbance and migration to other territories because of noise propagation or other anthropogenic factors;* • *Poaching/vandalism of the personnel*	• *Clearing the project corridor off the vegetation cover;* • *Earthworks* • *Transportation operations;* • *Poaching by the personnel.*	*All along the project corridor, particularly the area covered with tall herbaceous plants and areas adjacent to river banks.*	• *Preliminary layout of the working zone;*	*Before the commencement of works*
				• *The supervisors of the personnel employed for the construction works must be informed about the visual characteristics and behavior of tortoises;*	*Before the commencement of works*
				The personnel must be instructed against killing such species or exerting some other kind of direct impact on them. Rather, they must be given an escape route from the area during the works. At least, their disturbance must be limited to giving them a corridor to escape. If an animal gets stuck on the construction site by chance, the workers must find the way for it to escape the area without being damaged.	*Before the commencement of works and During the works*

				• *Observing the borders of the working zone to avoid damage to additional areas;*	*During the works*

				• *Thorough visualization of the perimeter of the area to treat (particularly the areas covered with grass) to identify individual tortoises or their habitation sites;*	*During the works*
				• *In case of identifying this species, if it cannot leave the impact area, a similar habitat must be identified beyond the perimeter of the project corridor and tortoises must be set free in the nature;*	*In case of identifying the given species*
				• *Thorough examination of holes and trenches;*	*Before filling in trenches and holes*
				• *Protection of the environment from pollution;*	*Permanently, during the works*
				• *Taking recultivation measures, including topsoil restoration.*	*After completion of works*
Amphibians and water biodiversity					
Amphibians	*Direct impact : Damage of the attarctive shelters for amphibians (small ponds, river coastal zone); Indirect impact : Pollution of water and soil environment.*	• *Earthworks, concrete works, use of various polluting materials, waste;*	*All along the project corridor, particularly near the water bodies, during the construction of the bridge piers*	• *Preliminary layout of the working zone;*	*Before the commencement of works*
				• *Observing the borders of the working zone to avoid damage to additional areas*	*During the works*
				• *Preserving the ponds formed in the vehicle tire traces in the road during the propagation period of amphibians as long as possible. Before damaging such spots, the animals must be given an escape corridor.*	*During the earthworks, particularly in spring*

				• *Thorough examination of holes and trenches;*	*Before filling in trenches and holes*
				• *Protection of the environment from pollution;*	*Permanently, during the works*

				• Taking recultivation measures, including topsoil restoration.	After completion of works
Fish and living water organisms, including the species protected by Bern Convention: Bulatmai barbel, Barbus capito and Danube bleak, Chalcalburnus chalcoides	*Direct impact - Not expectedl* *Indirect impact due to the water quality deterioration risks, improper waste management, release of discharge waters into the river and activation of erosive processes in coastal line*	• *Earthworks and works to accomplish in the river bank area;* • *Construction of bridge piers;* • *Use of polluting materials, waste;* • *Operation of construction camps.* .	• *All along the project corridor, at the crossing points with rivers.*	• *Taking erosion reduction measures in the river bank area ;*	*During the earthworks*
				• *Limiting works in the riverbed (making bridge piers) during the season sensitive for ichthyofauna;*	*Particularly low-water periods of the year*
				• *Agreeing the question of wastewaters with the Ministry*	*Before putting the construction camps to operation*
				• *Uisng dischareg water treatment plants;* • *Portection of the discharge water quality;* • *Protection of the environment from pollution;* *Proper waste management*	*Permanently, during the operation of the construction camp*
				• *Taking recultivation works in the river bank area..*	*After completion of work*

7.7 Visual-landscape changes
7.7.1 Construction Phase

The visual-landscape change is associated with the preparatory and construction works, during which the builders, construction techniques and vehicles will move. Temporary objects will be provided on the territories of the com camps, the vegetation cover will be cleared, significant amount of stripped soil will be originated, whose storage will cause the change of the esthetic view.

When assessing the landscape impact and the visual change of the view, the value of the selected area, degree of its naturalness and the scales of human activities on the area matter. We must take into account how visible the project corridor can be for such receptors, as local population.

There are no important tourist attractions and/or highly valuable sceneries present in the design corridor and its adjacent areas. As already mentioned, these areas are mostly the agricultural landscapes with quite intense human activities. Consequently, the areas to develop belong to the category of the landscapes with their value lower than average.

Potential receptors of the visual-landscape changes may be the population of villages adjacent to the corridor as well as fauna. In this respect it should be noted that the part of the corridor running aross Iagluja Plateau and agricultural plots, will not be within the view of the local population and the construction works accomplshed there will have an impact only on animals. The works planned at the initial and last sections of the road (near Rustavi and Red Bridge) will be more visible for the passengers along the road.

After the construction works are complete, the machines and equipment, materials and waste will be removed from the construction grounds, temporary structures will be dismantled and removed, the workers will retreat and the used areas will be recultivated what will more or less remedy the situation.

7.7.2 Operation phase

Main source of the visual impact is the traffic movement on the operation phase. Planting of trees and plants along the road corridor will support restoration of the landscape components. Over time, the new infrastructure is adaptable and visual discomfort caused by visual changes will be less disturbing for the population.

7.7.3 Impact mitigation measures

<u>Construction phase</u>

- Temporary structures, materials and waste (including spoil) should not be placed in visible places as far as possible;
- Colors of temporary structures shall be in harmony with the environment (green, brown);
- The waste and materials will be properly managed, the sanitary conditions will be observed and the waste will be removed from the territory in a timely manner;
- The height of the placed inert materials must not exceed 5 m what is optimal in respect of mitigating the risks of instability and negative visual impact. The driving routes of transport and techniques will be observed;
- The night illumination on the working sites will be controlled to avoid bright light and light pollution. Propagation of light to the adjoining residential zones will be minimized;
- Demobilization of the temporal infrastructure and recultivation works following the completion of the works.

<u>Operation phase</u>

- An important mitigation measure in the operation phase is landscaping and maintaining the areas adjacent to the highway.

7.8 Waste

A certain amount of hazardous and other types of waste are expected to originate in the construction phase. The waste rock to originate during the earthworks, which will be disposed to the landfills, is notable. However, it should be noted that the most of the corridor selected for the Highway runs across the satisfactory relief conditions and as a result, the disposal of the waste rock will not be associated with any significant difficulties. Waste Managment Plan is provided in attachment 3 with the indication of the amounts of the different types of expected waste and terms of their transportation and final disposal/treatment.

7.9 Impact on social-economic environment

The impact of the project implementation on the social-economic environment is expected in the following directions:

- Resettlement impact;
- Impact on private business;
- Expected income on agriculture;
- Constraints in traffic and limited access to the resources;
- Expected impact on local infrastructure;
- Human health and safety;
- Positive impact: employment, improvement of transport infrastructure and the resultant economic benefit.

7.9.1 Resettlement and impact on private business

The project corridor will not run across densely populated areas. Rather, it will mainly run across arable and sowing lands and state land plots. However, as per the preliminary assessment, some commercial buildings will be under the impact and consequently, few, so called physical resettlements will be necessary. In this respect, the initial section of the corridor adjacent to the territory of Rustavi, is particularly worthwhile.

As for the economic resettlement, quantitatively, the privately owned agricultural plots are notable. As per the official data (source: REESTRI.GOV.GE), 389 private plots will be subject to resettlement (their number will be further specified within the scope of preparation of the Resettlement Action Plan).

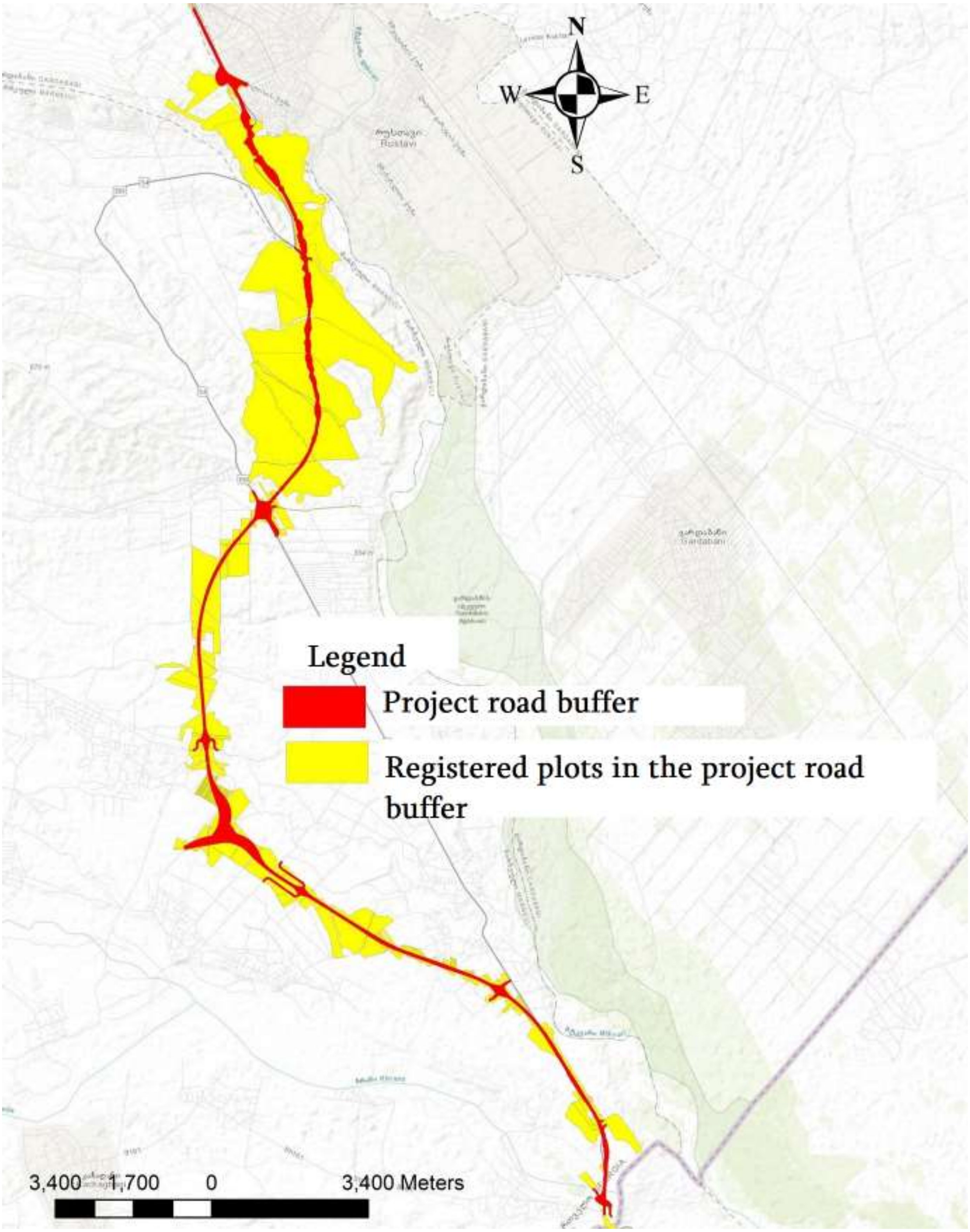
Drawing 7.10.1.1. shows the map showing the location of the plots under the impact of the project highway.

It is planned to develop the resettlement action plan and organize meetings with the locals. The resettlement procedure will be accomplished in line with the requirements of the international finance organizations, and all beneficiaries will receive relevant (fair) compensation. At the stage of developing the Resettlement Action Plan, a particular attention should be paid to the current business along the section of the Highway where the traffic flow is expected to decrease. The business incomes are expected to reduce along these sections for the business owners.

Following the safety and technical standards requirements, trading with agricultural products by the local people is prohibited adjacent to the Highway. Consequently, the population, who gains certain benefit through such a business, will lose their incomes. Within the scope of the project, it is necessary to plan the construction of the organized trade center(s) adjacent to the project Highway so that the population should not lose sources of income. The compensation for the business suspension will be given out as the last alternative and this decision must be clearly grounded in the Resettlement Action Plan.

Figure 7.9.1.1. Commercial areas in the ROW

Drawing 7.9.1.2. Location of private plots under the impact of the project corridor



7.9.2 Impact on agriculture

In terms of Georgia, the project region is not a land-poor area. The loss of the agricultural plots as a result of using the project zone will not have a high negative impact on the land cultivation. Even a positive impact is expected in the exploitation phase: the facilitated transportation and better realization prospects for the agricultural produce as a result of the improved transport network.

As for cattle-breeding, road construction and exploitation may constrain the driving of cattle to the pastures to some extent. In order to avoid the farmers' limited access to the resources, this issue was considered in the design phase and as it is stated in the description part of the project, relevant underpasses for domestic animals are planned at many points.

7.9.3 Eemporal obstruction of traffic

During the intense transportation of building materials and structures in certain periods of the construction phase, the risks of impact on the local roads and constraints of movement will increase. However, as mentioned above, secondary ground roads are quite well developed in the project area and consequently, identifying alternative routes will not be associated with great difficulties. The impact is significantly reduced by the fact that the project envisages cutting a new corridor – for the most of the construction period, trouble-free travel will be possible along existing Rustavi-Red Bridge Road for 5 – 5,5 km, except during the construction works along the initial and last sections of the same road.

In the construction phase, the transportation routes will be selected by bypassing the densely populated areas. At the same time, the periods favorable for transportation will be identified. The Construction Contractor will have proper and efficient communication with the local population so that their ability to move freely is not impaired. It should be noted that the Construction Contractor will develop the Traffic Management Plan and will agree it with the client and other concerned entities (patrol police, local authority, etc.).

7.9.4 Expected impact on local infrastructure

The following crossing points of the project road with the infrastructural communications weer planned under the project:

- Power transmission lines;
- Regional and local roads;
- Irrigation channels, and
- Drain channels.

For details, see paragraph 4.10.6.

The issue of crossing the communications will be agreed with the communal service departments. Restructuring and relocation projects will be discussed with relevant offices. The given types of works will be planned and accomplished in the way minimizing the duration of a limited access to the relevant resources.

7.9.5 Human health and safety

Both, in the construction and operation phases, the risks of impact on personnel health and safety may be associated mainly with unforeseen cases, in particular:

- Deterioration of the air quality in the working zone and increased noise levels as a result of faulty equipment and appliances;
- Poisoning with drinking water or food;
- Occupational injury (fractures,, electrical injury, etc.);

- The risks of infectious diseases must also be considered.

In the construction phase, human health and safety risks will be duly managed. For this purpose, special staff of safety officers will be assigned. The safety measures on the territories of the construction camps and construction grounds incorporate the following:

- The technological equipment and appliances for construction will be provided by observing the relevant standards;
- Fire control, water supply and lighting systems must meet the set standards;
- Installing warning signs on the sites hazardous for health. All hazardous sites will have instructions regarding the observance safety standards exhibited;
- The sites hazardous for health are planned to fence;
- The personnel will be equipped with PPE.

Putting the highway to operation may be assesed positively in erspect of human health and safety. The highway will be constructed in line with the international standards. As a result, the risks of car accidents and accidents on the existing highway will reduce drastically.

7.9.6 Positive social-economic impact

The benefit of the project implementation will affect the population of all the country. The traffic flows will increase (including transit traffic) and the movement will be facilitated; the risks of accident will decrease drastically and the employment opportunities for the people in the region will increase. In addition, the dissatisfaction of the people employed at other road sections caused by the loss of employment will be reduced.
The project will have a positive impact on the employment of the local population. As per the Good Practice in Georgia, 70% of the local workers are planned to hire as it was the case with the other sections of the highway.
By considering all the above-mentioned, the impact on the social-economic environment must be considered positive and significant.

7.10 Risks of impact on the historical and archeological monuments

As the preliminary study suggests, no visible monuments of cultural heritage were fixed in the zone under the impact of the Highway. In fact, the building process does not envisage the use of the kinds of methods, which will result in the propagation of any negative impact to far distances (e.g. intense explosion works). In respect of cultural heritage and archeology, the probability of the appearance or damage of invisible resources (those in the ground) is much reduced by the specific nature of the design corridor: it will mainly run across the agricultural plots where the ground is intensely cultivated. Despite this, the chance finding of the archeological artifacts cannot be ultimately excluded and the preventive measures against the damage of the items in the deep earth layers with the historical value must be taken

On the other hand, the chance find of archeological artifacts and obtained information will enrich the existing knowledge and may be a positive aspect of the cultural development.

During the highway operation, the risks of daamge of invisible archeological monuments is in fact excluded.

7.10.1 Mitigation Measures

When performing earthworkin case of chance finding of the archeological items, the Contractor must immediately cease all physical activities and must inform the Roads Department about the chance finding. The Roads Department will swiftly inform the Ministry of Culture and Monument Protection of Georgia thereof, which will assume the general responsibility for the activities. The works are allowed to resume only after receiving a written permit from the Ministry of Culture and Monument Protection of Georgia to resume the works.

7.11 Information about the possible transboundary impact

If considering the designation and location of the project, certain risks of negative impact do exist; however, they will be mostly associated with unforeseen events.

In this respect, the risks of pollution of the Khrami River (the existing bridge to the frontier point) during the construction works of the last section of the highway should be noted- 500 m from this site, the river crosses Georgian-Azerbaijan border. Therefore, the questions of protecting the surface waters during the construction works on this site are of a particular concern to prevent the transboundary impact. In other respects, the probability of transboundary impact in the construction phase is very little: no important sources of pollution are planned to use near the border.

As for the exploitation phase, upgrading the highway connecting the two countries to the international standards will be of a great benefit both for Georgia and Azerbaijan. At the given stage of activity, a positive transboundary impact in different directions is expected.

7.12 Cumulative Impact

In respect of a cumulative impact of the present Project, in the first instance, a planned similar project to Sadakhlo border checkpoint (Georgian-Armenian border) must be considered. This Highway starts at the planned flying junction near village Azizkenda of Rustavi-Red Bridge route and continues to Sadakhlo. These projects are plotted on figure 7.12.1.

Figure 7.12.1. Plans of mutual locations of Rustavi-Red Bridge and Rustavi-Sadakhlo Highways

It should be noted that both highways will mainly run across the privately owned land plots. In the final run, both projects are associated with significant economic resettlement. Resettlement Action Plans will be developed for both projects and realized in practice. The population in the impact zone wil be duly compensated.

In other respects, the significance of the expected cumulative impact in the construction phase will be lower than average, in particular:

- The project corridors will not run across the territories with high-value natural components (e.g. forest fund area);
- As compared to other Regions of Georgia, agricultural plots in Kvemo Kartli occupy quite vast areas. Consequently, the impact of the agricultural losses caused by the impact of such projects on agriculture will not be significant;
- The project region is quite rich in the supplies of inert materials. Consequently, during the highway construction, no strong impact of natural resources is expected.

The mitigation measures planned within the scope of both projects will ensure the maintenance of the qualitative state of various receptors (water, air, soil).

In the exploitation phase of the Highways, significant cumulative effect is expected what will be associated with the significant improvement of the land traffic with the neighboring countries and resultant positive social-economic trends. Inter alia, the considered projects will support the growth of the tourist and transit potential of the country.

Overall, it may be said that the development of the transport network in the region with two above-said projects playing a key role will bring a much more positive cumulative effect.

7.13 Residual impact

Based on the preliminary study, it may be said that none of the residual impacts will be of the value higher than average. The planned mitigation measures will be efficient and the need for taking the compensation measures is minimal. Out of the residual impacts, only the issues of impact on the social-economic environment can be noted, the economic resettlement in particular: quite many agricultural plots will be under the impact. In this connection, it may be said that the Resettlement Action Plan will be developed, which will give a thorough description of the compensation measures. Provided the compensation measures are realized, in this respect, too, the residual impact will be low.

7.14 Summary table of the expected environmental impacts

Impact category	*Construction phase/ Exploitation phase*	*Impact direction[3]*	*Geographical distribution of impact[4]*	*Initial value of impact[5]*	*Impact duration[6]*	*Reversibility of impact[7]*	*Mitigation efficiency[8]*	*Final impact rating[9]*
Pollution of atmospheric air	Construction phase	Negative	Local	Average	Short-term	Reversible	Average	Low
	Exploitation phase	Negative (somewhat positive)	Local	Low	Long-term	Reversible	Low	Low
Propagation of noise and vibration	Construction phase	Negative (somewhat positive)	Local	Average	Short-term	Reversible	Average	Low
	Exploitation phase	Negative	Local	Low	Long-term	Reversible	Low	Low
Impact on geological environment	Construction phase	Negative	Local	Average	Short-term	Reversible	Average	Low
	Exploitation phase	Insignificant or not expected	-	-	-	-	-	-
Impact on water environment	Construction phase	Negative	Local, Regional	Average	Short-term	Reversible	Average	Low
	Exploitation phase	Negative	Local, Regional	Low	Long-term	Reversible	Low	Low
Impact on soil	Construction phase	Negative	Local, Regional	Average or High	Short-term	Reversible	Average, High	Low
	Exploitation phase	Negative	Local, Regional	Low	Long-term	Reversible	Low	Low
Reduction of the vegetation cover and loss of habitats	Construction phase	Negative	Local	Average, Low	Long-term	Reversible	Average ან Low	Low
	Exploitation phase	Insignificant or not expected	-	-	-	-	-	-
Direct impact on animal species	Construction phase	Negative	Regional	Average	Short-term	Reversible	Average	Low
	Exploitation phase	Negative	Regional	Low	Long-term	Reversible	Low	Low

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[3]Positive/negative
[4]Local/regional/country-specific
[5]Low/average/high
[6]Short-term/long-term
[7] Reversible/irreversible
[8]Low/average/high
[9]Low/average/high

Visual-landscape impact	Construction and exploitation phases	Negative	Local	Low	Long-term	Reversible	Low	Low
Social-economic environment								
• *Impact on the basic factors of economic development*	Construction and exploitation phases	Positive	National	Average	Long-term	-	-	-
• *Employment*	Construction phase	Positive	Regional	Average	Short-term	-	-	-
• *Impact on land use, cattle-breeding and local resources*	Construction and exploitation phases	Negative	Regional	High	Long-term	Reversible	High (including compensation)	Low
• *Human safety/health*	Construction and exploitation phases	Negative	Regional	Low-Average	Long-term	Reversible	Average	Low
Impact n archeological monuments		Negative	Local	Low	Short-term	-	Low	Low

8. ENVIRONMENTAL MANAGEMENT PLAN

8.1 Introduction

Following the requirements of the Georgian environmental legislation and environmental policies of the international finance organizations, an important component of an EIA report is the environmental management plan (EMP). The goal of the EMP is to develop the mitigation and monitoring measures for the impacts identified within the scope of the EIA procedures to be used in practice by the project implementing agency - the RD, and thus, bring its activities into compliance with the environmental and social requirements envisaged by the national as well as with the environmental and social policies of the international finance organizations.

The given EMP is based on the information given in the previous chapters, in particular, activity specifics, and background properties of the natural and social environment of the working area, expected negative impacts during the activity and their propagation area. The EMP is drafted for different stages of activity, including designing and preparatory works planning phases (see tables 8.2, 8.3 and 8.4). The EMP is a live document and it can be detailed immediately during the accomplishment of the activities following the monitoring outcomes or other practical terms.Any changes or corrections to this EMP will be done based on the formal agreement between the client and financial organizations.

The mitigation measures given in the EMP are scheduled in line with the works to accomplish and expected impacts of these works. The location and terms of the mitigation measures to accomplish are specified and the entity responsible for accomplishing the mitigation measures is also identified.

The EMR document will be incorporated in the work tender documents and the tender participants will have the possibility to specify their environmental protection duties in their proposals. After the onset of the construction works, the ESMP will be the part of the agreement between the client and the construction contractor and it will be necessary to accomplish in the course of the construction works.

Responsibility for the implementation of EMP in construction and operation phases will be carried by RD. The RD is presented by the Environmental Protection and Resettlement Departments. Besides, the control will be undertaken by the Department of Environmental Supervision of the Ministry of Environment Protection and Agriculture of Georgia and international finance organization. Control means examining the quality of EMP realization, identifying the environmental violations and developing further correction actions.

8.2 Environmental Documents and Records

It may be said that an important and perhaps, absolutely necessary mechanism of EMP realization is putting the relevant environmental documents to order and ensuring their permanent update. After identifying the Construction Contractor and issues of building organization, the Roads Department of Georgia, in line with the national legislation, is obliged to develop the following environmental documents and submit them to the MoEPA to reach an agreement:

- Developing the project for the maximum allowable discharge (MAD) standards of polluting substances discharged into the surface waters together with the waste water (if necessary);
- Technical report of the stationary sources of harmful substances emitted into the atmospheric air (if necessary);
- Detailed plan of waste management;

- Documents envisaged by the terms of the Permit issued under the conclusion of the ecological expertise (quarterly reports of the environmental monitoring, detailed designs of construction camps and spoil grounds, plan of recultivation works, etc.);

The Construction Contractor must be engaged in the development of all above-listed documents.

On its turn, the contract concluded with the Builder must envisage his obligation to submit and agree the following documents and records to the Client:

- Traffic management plan;
- Health and safety management plan;
- Emergency response plan.

In addition, the Implementer (and the Construction Contractor on his errand) shall keep and use the following records in practice during the construction:

- Plan and schedule of the works to accomplish;
- List of the machines and equipment needed for construction;
- Records related to the occurring environmental problems;
- Records about the waste management issues;
- Written marking of the areas of waste disposal and waste transportation instructions issued by the local authority;
- Records about the supplies of necessary materials and their consumption;
- Complaints log books;
- Incident registration logs;
- Reports about the correction actions;
- Logs of equipment control and technical maintenance;
- Reports about the personnel training.

8.3 Costs of ESMP Implementation

In total the planned environmental activities will cost around 28,311,998 (9,343,894 EURO) GEL[10].

Excess materials - At the construction stage, 3,683,050 m^3 excess materials are expected to originate. This amount will be placed on the preliminary selected site agreed with the local authority. Distance from the area were excess materials will be produced to placed areas will be approximately 8-10 km. A presumable cost of disposal of 1 m^3 excess material is 6.50 GEL (transportation, disposal and area restoration). Total costs for excess materials disposal – 23,940,000 GEL.

Noise Abatement. The limit speed in the project road is 120 km/hour. Construct 4m height sound proof wall summary for 3.6 km section of the road. Installation of 4.00 m height noise barriers in various places along the design road: Construction of concrete barrier will cost around 210,000 Gel (69,307 EURO). Total cost of noise abatement measures is around 210,000 GEL. **These costs could be optimized by applying concrete walls or combination of concrete wall with polymer screen.**

[10] The cost was calculated fir case if for each LOT will be hired separate construction company and supervision company.

Ecology. Replanting of trees. We propose to consider planting of 250 trees to offset the project damage, improve aesthetic and recreational value of the area. Landscape plan should be elaborated by Road Department in collaboration MoEPNR. Seedlings of 250 trees will cost around 2500 GEL. Thus, approximately 2500 GEL should be considered in budget for tree planting and landscaping.

Topsoil storage. 535 000 m^3 of topsoil will be stripped and stockpiled. Cost of these operations equal 535 000 m^3 x 4 Gel = 2,140,000 GEL

Capacity building program for road department environmental team including training of personnel will cost around 3,000 GEL

In the tables 1-4 submitted the cost for Environmental and social management plan separately for each lot.

Table 8.3.1: Costs of Implementation ESMP for Section 1 – Rustavi – Algeti Junction

Item	Cost GEL	Cost EURO	Budget Line
Excess Materials Management (transportation, disposal and area restoration)	18 810 000	6 208 000	Construction Contractor
Preparation of Noise Abatement Plan and Detailed Design for Noise Abatement Facilities	20 000	6 600	Construction Contractor
Implementation of Noise Abatement Plan	170 000	56 106	Construction Contractor
Preparation and Implementation of Landscaping Plan	1 250	413	Construction Contractor
Topsoil Storage	1 700 000	561 056	Construction Contractor
Climate Adaptation Actions			
Earthworks (0.3 % Total Component Investment Cost)	387 223	127 796	Construction Contractor
Culvert, Drainage and Underpasses (0.1% Total Component Investment Cost)	811	268	Construction Contractor
Bridges (1.8% Total Component Investment Cost	790 765	260 980	Construction Contractor
Interchanges (0% Total Component Investment Cost)	0	0	Construction Contractor
Monitoring			
Environmental Specialist	120 000	39 600	Construction Contractor
Environmental Specialist	120 000	39 600	SC
Sound meter	2 000	660	SC
Device for dust measurement	3 000	990	SC
Portable device for CO2 measurement	2 000	660	SC
Training and Capacity Building			
Capacity building program for road department	3 000	990	Road

environmental team			Department
Capacity building program for construction company environmental team	3 000	990	Construction Contractor
Summary	22 133 049	7 304 637	

Table 8.3.2: Costs of Implementation ESMP for Section 2 – Algeti Junction – Red Bridge

Item	**Cost GEL**	**Cost EURO**	**Budget Line**
Excess Materials Management (transportation, disposal and area restoration)	5 130 000	1 693 000	Construction Contractor
Preparation of Noise Abatement Plan and Detailed Design for Noise Abatement Facilities	20 000	6 600	Construction Contractor
Implementation of Noise Abatement Plan	-	-	Construction Contractor
Preparation and Implementation of Landscaping Plan	1 250	413	Construction Contractor
Topsoil Storage	440 000	145 214	Construction Contractor
Climate Adaptation Actions			
Earthworks (0.3 % Total Component Investment Cost)	72 900	24 060	Construction Contractor
Culvert, Drainage and Underpasses (0.1% Total Component Investment Cost)	306	101	Construction Contractor
Bridges (1.8% Total Component Investment Cost	261 494	86 301	Construction Contractor
Interchanges (0% Total Component Investment Cost)	0	0	Construction Contractor
Monitoring			
Environmental Specialist	120 000	39 600	Construction Contractor
Environmental Specialist	120 000	39 600	SC
Sound meter	2 000	660	SC
Device for dust measurement	3 000	990	SC
Portable device for CO2 measurement	2 000	660	SC
Training and Capacity Building			
Capacity building program for road department environmental team	3 000	990	Road Department
Capacity building program for construction company environmental team	3 000	990	Construction Contractor
Summary	**6 178 950**	**2 039 257**	

8.4 Environmental management plan (EMP) - Planning stage of building organization

Negative impact	Mitigation measure	Supervising body	Approximate value
Emissions of harmful substances into the atmospheric air, propagation of dust, noise and vibration	– Selecting the sites for construction camps, concrete units, asphalt plants, crushing and sorting shops (if any) far from the settled area of Marneuli Municipality. – Treatment (crushing and sorting) of inert materials must be done on the mining site as far as possible. – The air protection documents for emission objects must be developed and agreed with the Ministry;	Roads Department of Georgia	Extra costs may be associated with the greater distances of transportation; however, these costs will not be too great.
Disturbance of the stability of the geological environment	– Selecting geologically stable areas with least possible inclination for ground disposal.	„--------“	
Impact on aquatic environment	– The priority for the collection of industrial and fecal waters must be given to cesspools and UD toilets. Discharge of the wastewater into the surface waters must be brought to minimum (if any, the draft MAD standards must be developed in advance and agreed with the Ministry). – Water supply reservoirs must be considered on the construction camps in order to ensure the rational use of water resources. – A drainage system must be arranged on the construction camp.	„--------“	To be considered in the total contract value
Visual-landscape change	– Selecting the sites for temporal construction infrastructure and waste storage at maximally invisible locations, far from the settled area of Khevi community. – Selecting the color and design of the temporal construction infrastructure suitable for the natural environment.	„--------“	Extra costs may be associated with the greater distances of transportationand price differences
Impact on private property/ business	– Developing the Resettlement Action Plan and giving out compensations/compensating the damage.	„--------“	Costs may be associated with hiring the consultant
Impact on traffic flows	– Developing the traffic management plan to consider the interests of the local people.	„--------“	To be considered in the total contract value
Employment	– The local populatin must be prioritized in employing unskilled labor.	„--------“	Not associated with extra costs.

8.5 Environmental management plan (EMP) - Construction phase

Type of work	Location	Expected negative impact	Mitigation measure	Responsible entity	Controlled by:
Preparatory works: mobilization of the temporal infrastructure, transport and construction appliances and equipment and mechanisms needed for construction.	The area of the construction camps	Emissions, noise propagation, changes in the illumination background	- Installing the stationery emission sources from the settled areas as far as posisble; - Equipping the emission stationery facilities with relevant air-cleaning systems. - Making noise-protection barriers if necessary between the noise sources and the receptors (population). - Choosing non-faulty construction techniques and vehicles	Construction Contractor	Roads Department, Ministry of Environment and Agriculture of Georgia
		Risks of pollution of surface and ground waters and soils	- Use of non-faulty construction techniques and vehicles. - The machines/equipment and potentially polluting materials will be placed far from the surface water objects, in the areas protected against the atmospheric precipitations. - Equipping the territory with storm-water and treatment systems at the initial construction stages. - Fencing the perimeter of the oil products supply reservoirs to prevent the propagation of the pollutants in case of emergency spills		

			- Discharge of any kind of untreated wastewater into the rivers is to be prohibited. - Providing water-proof layers on the surfaces of the storing areas. - The priority for the collection of industrial and fecal waters must be given to cesspools and UD toilets. Discharge of the wastewater into the surface waters must be brought to minimum;		
		Negative visual-landscape change	- Temporal structures, materials and waste will be placed at locations far and not visible from the visual receptors. - The color and design of the temporal structures will be chosen to suit the environment. - Demobilization of the temporal infrastructure and recultivation works following the completion of the works.		
		Safety risks for local people and personnel	- Use of non-faulty construction techniques and vehicles; - Fencing the camp territories right at the initial stage of the construction; - Installing the safety signs along the perimeter of the camps. - Protecting the perimeter of territory and controlling the movement of foreign people in the area. - Equipping the personnel with PPE and providing permanent control over their use; - Equipping the camps with the first aid kits	Construction Contractor	Roads Department

			- Ensuring electrical safety. - Keeping an incident registration log. - Personnel training at the initial stages; - The Construction Contractor will appoint H&S manager, who will permanently control observance of the safety standards by the prsonnel;		
Cleaning the corridor off the vegetation cover and accomplishing the earth works. The topsoil stripping is meant. Ensuring the right topography of the area (terracing, making cuts and fills) making foundations for bridges, etc.	Design road corridor	Cutting down the vegetation cover, habitat loss/fragmentation.	- Protecting the project perimeter to prevent excess harm to the plants. - Delisting the protected species from the environment will be done in line with the requirements of sub-clause f) of clause 1 of article 24 of Georgian Law “On the Red list and Red book of Georgia”, in agreement with the Ministry of Environment Protection and Agriculture of Georgia; - The expected impact will be partially compensated at the expense of recultivation and landscaping works. - Observing the borders of the working area; - Bordering the ditches to prevent the animals from falling into them and getting harmed; - Efficient use of the mitigation measures for the pollution of the environment (air, water, soil); - Thoroughly examining the affected areas in advance in order to identify the places of concentration/habitats of the animals these sites; - Accomplishing earthworks in limited terms; - Giving the explanation to the personnel regarding the importance of species and sanctions in case of unfair behavior.	Construction Contractor	Roads Department
		Damage or harm to animals, disturbance and migration from the territory, damage of their habitats (holes, nests, etc.) *(For further details See the table given in Para 7.6.4.2.1. of the present EIA Report)*		Construction Contractor	Roads Department, Ministry of Environment and Agriculture of Georgia

		Noise propagation, emissions of dust and combustion products	- Use of non-faulty construction techniques and vehicles; - Accomplishing the noisy works during the day as far as possible - Loading and unloading heights of the materials in the vehicles will be minimized to the extent possible; - Running the vehicle drives at minimal speed; - Accomplishing the intense construction works during the day as far as possible; - Prior to commencement of the intense construction works near the settled zone, temporary noise barriers may become necessary to provide towards the residential houses and other sensitive objects; - The state of the buildings and premises adjacent to the main working sites will be examined periodically and the impact of vibration on cracks and damages will b determined by means of observation and relevant mitigation measures will be taken as necessary.	Construction Contractor	Roads Department
		Loss of topsoil and degradation of sites	- Topsoil stripping and piling separately from the lower soil layer and other materials. - Water-diversion channels will be made along the perimeter of the topsoil fill and will be protected against scattering by the wind blow;	Construction Contractor	Roads Department, Ministry of Environment and Agriculture of Georgia.

			- In case of long-term storage of the topsoil, the measures must be taken to maintain its qualitative properties. Periodic loosening or grass sowing is meant under this clause. - Following the completion of the construction works, the territory will be recultivated and sanitary conditions will be restored what will reduce the probability of impact on soil quality and stability. The recultivation works will be done mainly in the roadside zone (embankments and cutting slopes) and spoil grounds.		
		Development of hazardous geo-dynamic processes	– Diverting the rain- and spring waters by bypassing highly sloped and other sensitive sites by using relevant water diversion techniques (channels, pipelines, temporal berms, settling basins); – Compacting the ground fill properly to avoid slope collapse. – Limiting or stopping the works with the slopes during the wet weather. – When providing the embankments, the bearing capacity of the grounds will be considered. On the sites where the ground is not sufficiently stable, additional reinforcement (rabbets, stone columns, rigid insertions or preliminary load + drainage pipes) under the embankment will be used; – Geosynthetic materials will be used on the slopes of cuts and embankments as per the recommendations provided by the engineering-geological conclusion (See paragraph 5.2.2.7);	Construction Contractor	Roads Department, Ministry of Environment and Agriculture of Georgia

			- Large-scale earthworks on more complex sites, on Iagluja Plateau, will be accomplished under the supervision of the geological engineer; - When founding the engineering structures, the engineering-geological properties of the existing grounds will be considered. Bridge piers will be founded below the scouring depth; - The structures crossing the surface waters are designed to release peak discharges as per the effective standards; - In order to prevent bogging of local sites, it is necessary to provide temporary drainage system and to place of the fills and materials in the manner as to avoid the bogging of the adjoining areas; - Recultivating the damaged areas after the completion of the works.		
		Erosion and deterioration of esthetic view	- The topsoil and subsoil must be placedfar from the surface water objects. - The sites will be immediately filled and compacted and the surfaces and slopes will be graded. If needed, the slope stabilization techniques will be used. - Site restoration by scattering the topsoil from above and creating the conditions favorable to restore the vegetation cover.	Construction Contractor	Roads Department

		Risks of pollution of surface and ground waters	- Use of non-faulty construction techniques and vehicles; - In case of spills of oil/lubricants, the spilled product will be localized/cleaned in the shortest possible time. - The appliances creating the risk of ground water pollution when in operation will be equipped with drip pans; - The vehicles must be preferably washed at private car washing areas; - Using temporal water diversion channels; - Filling the holes in a timely manner. - The impermeability of industrial-fecal waters cesspits will be ensured; the cesspits will be emptied before they are full.	Construction Contractor	Roads Department, Ministry of Environment and Agriculture of Georgia
		Damage or harm to animals, disturbance and migration from the territory, damage of their habitats (holes, nests, etc.) *(For further details See the table given in Para 7.6.4.2.1. of the given EIA Report)*	- Observing the borders of the working area; - Bordering the ditches to prevent the animals from falling into them and getting harmed; - Efficient use of the mitigation measures for the pollution of the environment (air, water, soil); - Thoroughly examining the affected areas in advance in order to identify the places of concentration/habitats of the animals these sites; - Accomplishing the ground works in limited terms. - Giving the explanation to the personnel regarding the importance of species and sanction sin case of unfair behavior.	Construction Contractor	Roads Department, Ministry of Environment and Agriculture of Georgia

		Waste origination	- Waste management must be done under the Waste Management Plan agreed with the Ministry in advance; - If necessary, an additional document must be developed or the main document must incorporate asbestos-containing waste management plan; - The hazardous waste must be handed to the contractors with relevant permits for the given type of activity; - The relevant waste storage sites must be provided on the construction camps, which will be protected against wind and rain.	Construction Contractor	Roads Department, Ministry of Environment and Agriculture of Georgia
		Accidental damage to the archeological monuments	- In case of finding any strange item, stopping the works immediately and informing the technical supervisor or the Client; - Renewing the works only after the formal instruction is received from the technical supervisor or the Client. -	Construction Contractor	Roads Department, National Agency for Cultural Heritage Preservation of Georgia
Building bridge piers and other works in / near the riverbed	Construction grounds near the riverbeds	Pollution of surface waters and impact on current integrity	- Use of non-faulty construction techniques and vehicles; - Equipping oil equipment with dripping systems; - The works to be accomplished in active riverbeds must be done within the limited time; - Prohibiting car wash in the riverbeds; - During the construction of bridge piers, the construction ground will be isolated from the water current in the rivers with temporary embankments so that the continuous river flow is maintained as far as possible and to avoid its fragmentation;	Construction Contractor	Roads Department, Ministry of Environment and Agriculture of Georgia

			- After the construction is complete, the tmporraily used areas will be recultivated and the sanitary conditions will be restored, and attention will be paid to prodiving the stability of sides of slopes and embankments to avoid the washdown of the loose material into the rivers together with the rainwater;		
Transportation	Construction grounds near the riverbeds Corridors of the roads used to transport necessary materials, temporal structures, labor and waste. The routes running near the settled areas are also significant. The transport operations will continue for the whole construction period	Noise propagation, emissions of dust and combustion products	- Use of non-faulty construction techniques and vehicles; - Limiting the driving speeds; - Maximally limiting the use of public roads and identifying and using alternative routes. - Watering the surfaces of operation routes in dry weather. - Duly covering the vehicle body during the transportation of dusty materials; - The state of the buildings and premises adjacent to the main working sites will be examined periodically and the impact of vibration on cracks and damages will be determined by means of observation and relevant mitigation measures will be taken as necessary; - Informing the population about the forthcoming intense vehicle movement.	Construction Contractor	Roads Department
			- temporary noise barriers may become necessary to provide in the direction of the residential houses and other sensitive objects.		
		Damage to the local road pavements	- Limiting the movement of heavy techniques along the public road to the extent possible; - Restoring all damaged road sections to the extent possible to make the roads accessible to the people;	Construction Contractor	Roads Department, local authorities
		Overloaded transport flows,	- Selecting an optimal bypass to the working area;	Construction	Roads Department,

		limited movement	- Installing road signs and barriers at necessary locations; - Limiting the movement of heavy techniques along the public road as much as possible; - Using flagmen for intense traffic; - Making temporal bypasses; - Informing the population about the time and periods of intense transport operations.	Contractor	local authorities
		Risks of safety of local people and personnel	- Use of non-faulty construction techniques and vehicles; - Driving the vehicles with admissible speeds. - Minimizing the use of the roads crossing the settled areas; - Limiting the traffic during the holidays	Construction Contractor	Roads Department
Paving the road surface and facing works	Design corridor	Pollution of soil and surface waters	- Laying the road surface only in dry weather; - The road surface must be laid only by taking the relevant safety measures: the materials or waste must not dissipate over the site, etc.	Construction Contractor	Roads Department, Ministry of Environment and Agriculture of Georgia
Waste management	Temporal waste storage areas, transport corridors and final storage areas	Irregular propagation of waste, environmental pollution	- Delivering the construction and other necessary materials only in needed quantities. - Re-using the waste as much as possible, including the use of inert materials for making the roadbed. - Arranging the temporal waste storage areas and equipping them with relevant signs. - Assigning the duly qualified personnel for waste management. - Instructing the personnel.	Construction Contractor	Roads Department, Ministry of Environment and Agriculture of Georgia

8.6 Environmental management plan (EMP) - Exploitation phase

Type of work	Location	Expected negative impact	Mitigation measure	Responsible entity	Controlled by
Exploiting the road in a common mode	Along the road	Noise propagation	- Making noise barriers in the sensitive areas; (if needed).	Construction Contractor	Roads Department
		Waste propagation; propagation of oil products.	- Regular cleaning of the roadside zone; - Regular cleaning and repairing of water channels and pipes	Construction Contractor	
		Development of hazardous geo-dynamic processes Emergency risks of erosion processes, emergency risks	- Monitoring the trouble-free performance of the protective engineering facilities for slopes and riverside zone and regular repairs. - Regular cleaning and repairing of water channels and drain systems as necessary. - Equipping the road with relevant road signs; - Equipping the road with the night illumination system; - Permanent control of the technical state of the road cover and other road infrastructure (road signs, crossings, etc.), and accomplishing the relevant rehabilitation measures immediately after any damage.	Construction Contractor Construction Contractor	
		Visual-landscape impact	- Landscaping along the corridor; - Recultivation of the adjoining areas.	Construction Contractor	
		Habitat fragmentation	- Providing overpasses for wild animals at relevant locations.	Construction Contractor	

		Impact on cattle-breeding – fragmentation of the driving corridor	- Providing overpasses for domestic animals at relevant locations.	Construction Contractor	
			-		
Planned repairs and preventive works	Along the road	Propagation of polluting substances (water, soil pollution) during the repairs and replacement	- The road surface must be repaired in dry weather to avoid the pollution of the surface flow; - In order to avoid the dissipation of the materials used to repair the damaged road sections, the relevant works must be planned in an expedient manner.	Construction Contractor	

9. ENVIRONMENTAL MONITORING PLAN

9.1 Introduction

One of the preconditions for reducing the negative nature and value is the correct management of the strict and well-planned activity under strict supervision (environmental monitoring).

The monitoring methods incorporate visual observation and measurements (if needed). The monitoring program describes the monitoring parameters, time and frequency of monitoring, and collection and analysis of monitoring data. The size of monitoring depends on the value of the expected impact/risk.

The environmental monitoring plan in the project base must cover the issues, such as:

- Assessment of the state of environment.
- Identification of the reasons for changes in the environment and evaluation of the outcomes.
- Identification of the correction measures when the target values cannot be reached.
- Regular supervision over the degree and dynamics of the impact of the activity on the environment.
- Compliance with the legal requirements for impact intensity.
- Control over the set parameters associated with significant ecological aspects.
- Prevention and timely identification of the possible violations related to ecological aspects or emergencies during the activity.

The following are subject to the regular observation and evaluation in the course of environmental monitoring:

- Atmospheric air and noise;
- Water;
- Geology;
- Soil;
- Biologocal environment;
- Labor conditions and meeting the safety standards, etc.

9.2 Environmental monitoring plan in the construction phase

What? (Is the parameter to monitor)?	**Where?** (Is the parameter to monitor)?	**How?** (Must the parameter be monitored)?	**When?** (frequency or duration of monitoring)	**Who** (Is responsible for monitoring)?
1	**2**	**3**	**4**	**5**
Dust propagation, exhaust fumes	• Construction camps; • Construction corridors; • Transportation routes; • At the nearest Buildings	• Visual observation: • No significant dust propagation is fixed; • The machines and technique are non-faulty without significant exhaust fume;	• Checking dust propagation – during the intense operations and vehicle movement, particularly in dry and windy weather. • Checking the technical state - at the start of the working day;	Roads Department. Construction Contractor under its supervision
	• At the nearest settled areas and other sensitive objects, at the following presumable points: 1-x497507; y4600493 (from the city of Rustavi) 2-x497861; y4599824 (from the city of Rustavi) 3-x498426; y4590932 (near village Algeti) 4-x497043; y4585582 (near village Azizkendi) 5-x502102; y4581094 (near village Meore Kesalo); The existing ground road sections, which will run close the settled areas and will be intensely used for construction purposes.	Measuring dust concentration with a portable device.	• During the intense works on a relevant site, in dry, particularly windy weathers twice a day • In case of complaints	Roads Department. Construction Contractor under its supervision
	• At the border of the stationery sources of dust propagation	Measuring dust concentration with a portable device.	• Once a week in dry and particulaly windy weather	Roads Department. Construction Contractor under its supervision.
Noise propagation	• Construction camps; • Construction corridors; • Transportation routes; • At the nearest Buildings	Control of the technical state of machines and equipment;	• Checking the technical state - at the beginning of the working day;	Roads Department. Construction Contractor under its supervision Roads Department and Supervision company for

				construction works

	• At the nearest settled areas and other sensitive objects, at the following presumable points: 1-x497507; y4600493 (near Rustavi) 2-x497861; y4599824 (near Rustavi) 3-x498426; y4590932 (near village Algeti) 4-x497043; y4585582 (near village Azizkendi) 5-x502102; y4581094 (near village Meore Kesalo); The existing road sections, which will run close the settled areas and will be intensely used for construction purposes.	• Measuring noisi propagation with a portable device.	During the intense works on relevant site, on a daily basis; • in case of complaints	Roads Department. Construction Contractor under its supervision
	• At the border of the stationery sources of noise propagation	• Measuring noisi propagation with a portable device.	• Once a month	Roads Department. Construction Contractor under its supervision
Vibration propagation	Nearest houses and other objects.	• Visual observation of the stability of the residential houses (no cracks identified)	• Visual observation of the stability of the residential houses before and after the intense works causing vibration	Roads Department. Construction Contractor under its supervision
	At the nearest settled areas and other sensitive objects, at the following presumable points: 1-x497507; y4600493 (near Rustavi) 2-x497861; y4599824 (near Rustavi) 3-x498426; y4590932 (near village Algeti) 4-x497043; y4585582 (near village Azizkendi) 5-x502102; y4581094 (near village Meore Kesalo); The existing road sections, which will run close the settled areas and will be intensely used for	• Measuring vibration levels with a portable device.	During the intense works on relevant site, on a daily basi;	Roads Department. Construction Contractor under its supervision

	construction purposes.			

	• At the border of the stationery sources of vibration propagation.	• Measuring vibration levels with a portable device.	• Once a month	Roads Department. Construction Contractor under its supervision
Engineering-geological stability	• Sensitive sections and inclined slopes identified in the project corridor, particularly within the corridor running across Iagluja Plateau; • Crossing points of rivers and gullies, erosion-sensitive sites.	• Visual observation; • Controlling the efficiency of the protective buildings; • Periodic examinations by the geological engineer; • Sloepes are stable and no erosion is fixed.	Before the onset of works on relevant site; Every day, during the works; Particularly after the periods with precipitations	Roads Department. Construction Contractor under its supervision
Soil and ground quality	• Areas adjacent to the construction camps; • Project corridor; • Materials and waste storage areas; • Corridor of the access road	Visual observation: No significant oil products spills are identified • Laboratory control	Visual observation -at the end of the working day; • Laboratory examination - in case of large oil spills	Roads department • Visual observation - by an environmental manager; • Laboratory control - with the help of the Contractor.

Temporal storage of the removed ground and topsoil	• Construction corridor; • Ground storage areas.	Visual observation: • The lower soil layer and topsoil are piled separately; • The height of the topsoil pile does not exceed 2 m; • The inclination of piles does not exceed 45°; • The stored soil is distanced from the water objects; • Soil is temporarily stored at locations preliminarily agreed with the technical supervisor; • No erosion or ther hazardosu processes are observed.	Every day following the completion of ground works.	Roads Department. Construction Contractor under its supervision

	• Construction Contractor's office	Examining the documented agreement about the temporal use of soil.	Shortly after the ground works are complete	
Vegetation cover	• Construction corridor, particularly the section running across Iagluja Plateau, where there are wind-breaking belts and artificial plantings	Visual observation: • **The works are accomplished within the limits of the designated zone and** no additional damage to plants or illegal cutting take splace.	• Visual observation – at the end of the working day;	Roads Department. Construction Contractor under its supervision
Wildlife, including:	• Construction corridor, particularly the section running across Iagluja Plateau,	Visual observation: • There are no animal habitats (nest, holes, burrows, etc.) fixed in within the designed working zone; • No harm or death of animals is fixed.. Inspection: No illegal hunting takes place.	• Visual observation – daily on every site at the preparatory stage and during the construction works; • Inspection – unscheduled.	Roads Department. Construction Contractor under its supervision
• Traces and signs of vital activity of relatively large mammals – jackal, fox, etc.	• Construction areas, all along the project road, particularly along the section running across Iagluja Plateau	Visual observation: If there are signs of the presence of wild animals in the project affected areas;	• On every construction ground before starting the work	Roads Department. Construction Contractor under its supervision
• Nests of small birds	Construction areas, all along the project road, particularly the areas covered with trees and vegetation, buhses and tall hervaceous cover.	Visual observation: if there are functioning nests in the trees or other sites under the project impact	• On the construction ground before starting the work	Roads Department. Construction Contractor under its supervision

Reptiles and their habitation sites, including Mediterranean tortoise, Caspian Turtle and European pond turtle	• Construction areas, all along the project road, particularly the araes with high herbaceous cover; • River bank area; • Agricultural plots	Visual observation: if there are sites of concentration of reptiles in the areas under the project impact	On the construction ground before starting the work	Roads Department. Construction Contractor under its supervision

• Holes, trenches and other hazardous places for animals	• Consruction sites,	Visual observation: If such sits are duly fenced and how great the animal harm risks are; if there are planks inserted in the holes	• At the end of each working day	Roads Department. Construction Contractor under its supervision
• Efficiency of impact prevention and compensation measures	• Consruction sites, All along the project road;	The environmental manager will supervise the observance of the safety and environmental rotection standards by the personnel and efficiency of such measures. If necessary, he will apply to the high management to plan and realize additional measures.	• During the intense construction works; • Inspection - periodically.	Roads Department. Construction Contractor under its supervision
Management of industrial and fecal waters	• Construction camps	• Discarging the industrial and fecal waters into the assenization pools; • The assenization pools are cleaned and their technical state is satisfactory; • No untreated wastewater is discharged into the rivers;	• Visual observation – during each working day	Roads Department. Construction Contractor under its supervision
Waste management	• Construction camps; • Construction corridor; • Temporal storage sites of waste	Visual observation: • The sites of temporal waste disposal are assigned in the construction area and are duly marked. • The storage areas for hazardous waste are protected against the penetration of strangers and against	• Visual observation - at the end of each working day;	Roads Department. Construction Contractor under its supervision

		the weather impact; • On the territory, at due locations, there are marked containers to collect domestic waste. • The sanitary condition of the territory is satisfactory - no dissipated waste is observed. • The waste is not stored on the territory for long.		

	• Construction Contractor's office	• Checking the waste registration log; • Checking the documented agreement about waste disposal	Document check - once a month	Roads Department. Construction Contractor under its supervision
Oil and oil products management	• Construction camps; • Storage sites	Visual observation: • Protected sites are allotted for oil, oil products and other liquid substances and are marked; • The perimeter of the reservoirs is duly bordered, what in case of emergencies, will retain spilled mass.	• Visual observation - at the end of each working day;	Roads Department. Construction Contractor under its supervision
Technical state of the access road, possibility of free movement	• Corridors of the transportation roads	Visual observation: • The vehicles move along the routes specified in advance, bypassing the settled areas as far as possible. • The state of the driving routes is satisfactory. • Free movement is not limited. • Driving speeds are observed.	During the intense transportation operations	Roads Department. Construction Contractor under its supervision
Kabor safety	• Working area	Visual observation: • The territory is fenced and protected against the illegal penetration of strangers, • The personnel are equipped with	• Visual observation- before the onset of each working;	Roads Department. Construction Contractor under its supervision

		PPE. • The technical state of the exploited equipment and mechanisms is satisfactory. • Electrical and fire safety is ensured. • The safety, prohibiting and information signs are installed on the territory and along its perimeter. • There is a banner on the territory with the basic safety rules. • Smoking areas are specially assigned.		

		• Unscheduled control (Inspection): • The personnel observe the safety rules and use the PPE.	• Inspection - regularly.	• Roads Department. Construction Contractor under its supervision

9.3 Environmental Monitoring Plan – Operation Phase

What? (Is the parameter to monitor)?	**Where?** (Is the parameter to monitor)?	**How?** (Must the parameter be monitored)?	**When?** (Frequency or duration of monitoring)	**Who?** (Is responsible for monitoring)?
1	2	3	4	5
Hazardous geological processes	• Sensitive sections in the main road corridor; • Sites of the protective buildings • Bridge piers locations	• Visual observation; • Controlling the efficiency of the protective buildings.	• Twice a year, at the end of winter and in autumn	Roads Department
Vegetation cover	• Vegetation in the RoW.	• Visual observation	• Several times a year;	Roads Department
Safe drive	• In the road corridor	Visual observation: • Checking the presence of the relevant road signs; • Examining the technical state of the road cover.	• Several times a year;	Roads Department
Proper operation ofdrainage systems	• In the road corridor	• Examining the technical state of the drainage system.	• Several times a year;	Roads Department
Proper operation of the underpasses for people and animals under the road	• In the road corridor	• Examining the technical state of the viaducts	• Several times a year	Roads Department
Waste	• In the road corridor	Visual observation:	• On a periodic basis	Roads Department

10. PUBLIC CONSULTATION AND GRIEVANCE REDRESS MECHANISM

10.1 Public awareness and public meetings

Aiming at organizing an information campaign within the scope of Rustavi-Red Bridge Road Construction/Improvement Project, the Consultant's social group prepared an information leaflet, which was agreed with the Environmental Protection Team of the Roads Department of Georgia. Following the fact that most of the population of the project zone is Azerbaijani, the leaflet was developed in the Georgian and Azerbaijani languages.

Prior to the onset of the information campaign, the concerned parties and legal and private entities were identified on whom project implementation would or could have a positive or negative impact. The concerned parties were represented by the representatives of the local authorities, non-governmental sector and local population, who live or run business in the project zone or adjacent to it. The project implementation will also have an impact on the population living along the sections of the existing road to be bypassed by the designed highway after the project is implemented. The local population along the given road section ran both, legal and illegal businesses receiving certain profits. This population mostly used to trade with their own harvest and other essential commodities, or ran small catering objects.

On May 3-4 of 2018, the Consultant's social group met with the representatives of both, non-governmental and governmental local self-government authorities. The goal of the meeting was to communicate the details, goals and objectives of the planned project to the representatives of the local authorities and learn about their views and expectations in respect of the project.

On May 3, meetings were held with Mr. Zaur Tabatadze, the First Deputy of the Mayor of the city of Marneuli (See Figure 10.1.1.), and Mr. Anzor Abashidze, acting as a Gamgebeli (superior) in village Shulaveri (Figure 10.1.2.)

Figure 10.1.1: A meeting with Mr. Zaur Tabatadze, the First deputy of the Mayor of the city of Marneuli

Figure 10.1.2. A meeting with Anzor Abashidze, acting as a Gamgebeli (superior) of village Shulaveri

At the meetings, the representatives of the local self-governing bodies showed a full support of the project. In their opinion, this project will promote the development of the region, will support agriculture, which is one of the leading branches in the region and will help increase the budget consequently. All these benefits will have a positive impact on the youth of the region and will reduce the immigration, which is one of the major problems of Marneuli municipality today. In addition, the representatives of the self-governing bodies stated about their wish to engage the local population in the construction works to the extent possible.

Within the scope of the construction campaign, a meeting was also held with the representatives of the local non-governmental sector, who work on the severe problems in the region, gender issues and migration of the young people in particular. The meetings were held with Rena Nurmamedova, one of the leaders of the “Marneuli Youth Center” (See Figure 10.1.3.) and Olga Endeladze, the head of “Democrat Women of Marneuli” (Figure10.1.4.).

Figure 10.1.3. A meeting with non-governmental organization “Marneuli Youth center”

Figure 10.1.4 A meeting with the head of “Democrat Women of Marneuli”

As it became clear at the meetings, both problems - the migration of the young people and gender issues - are quite severe in the region and need urgent response. At the meetings, the representatives of the non-governmental sectors stated about some of their wishes and opinions regarding the solution of the problems. At the project planning and implementation stages, in their opinion, the major attention must be paid to the following issues:

a. The expected negative project impact on the population must be studied in details and a fair compensation plan must be developed.
b. To the extent possible, the population must be informed about the current project and the population must be given a clear understanding of the advantages of the project.
c. The local workers must be employed to the extent possible at the project implementation stage.
d. The women’s wishes and expectations are desirable to study on their own at the project implementation stage.

As Ms. Rena Nurmamedova explained, a gender problem is one of the major issues in Marneuli municipality, particularly, among the Azerbaijani population. Following the century-long traditions, it is very difficult not only to protect the women’s rights, but also to obtain the information.

As per the primary plan developed by the Consultant during the implementation of the information campaign, the meetings were to be held in the villages, which were to be crossed by the Highway or where the Highway ran near a village or a settled area. After the meetings, it was decided that the information campaign would be given larger scales and the information would be disseminated among more people, particularly among the women living in the region. It was also decided to try and find additional ways to receive information from them.

With the aim to discuss the given project, on May 18, 2018, an hour-long transmission was broadcasted from “Radio Marneuli” station (Figure 10.1.6.),where Mr. Z. Revazishvili, a company representative, was invited in the name of the consultation company “Eco-Spectri” Ltd. The broadcast was totally dedicated to the project discussion. The radio listeners were given thorough information about the essence and goals of the project. Both, the technical and environmental and social aspects of the project were considered thoroughly both, at the regional and country levels. During the broadcast, all the questions were answered in details. The radio broadcast was possible to listen to beyond the borders of the region as well.

Figure 10.1.5: Negotiation at Marneuli radio broadcasting office

Figure 10.1.6: On the air

Within the prepared information campaign, the Consultation Company held some additional meetings in the villages and settled areas adjacent o the project zone. Within the scope of the said campaign, not only the population was informed about the planned activities, but the information about the population's opinions and wishes were gathered as well. show the photos depicting the meetings with the local population of the villages and settled areas adjacent to the project zone and the process of distributing the information leaflets.

Figure 10.1.7: Meeting with the population

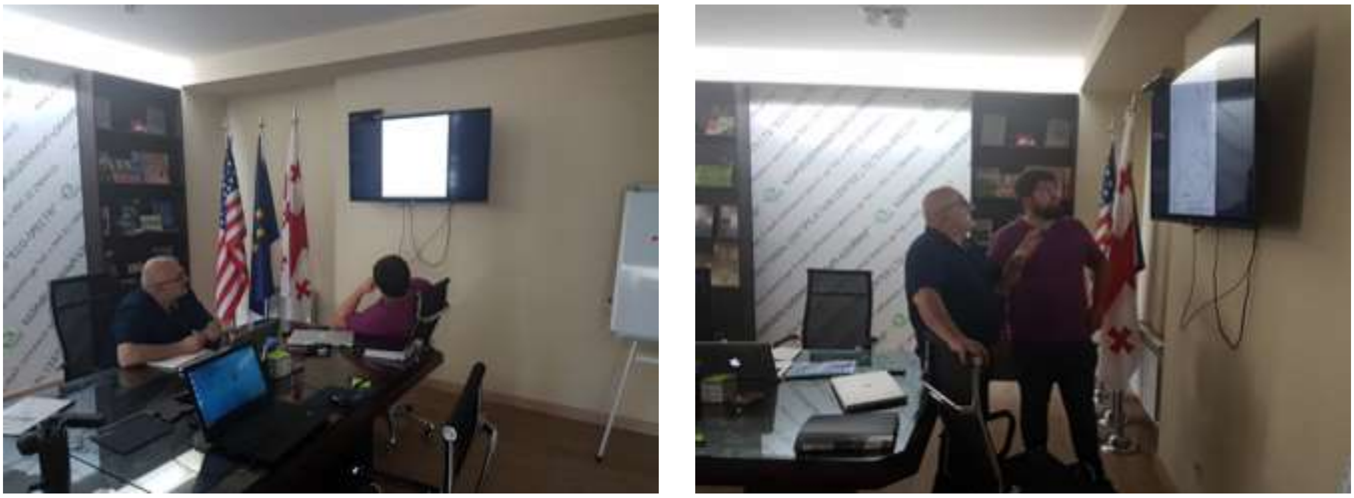
Figure 10.1.8. Meeting with the population

Figure 10.1.9: A meeting with small business representatives

Figure 10.1.10: Meeting with the population

One of the economic branches in Marneuli Municipality is sheep-breeding. Following the branch specifics, the sheep is driven to and from the summer pastures twice a year. The route of the sheep drive is developed by the state and is used by all private business representatives. The route of driving the sheep, as the preliminary data suggest, is located adjacent to the project zone and consequently, there was a risk of the project road to cross the sheep driving route. In order to clarify this issue better, the Consultant met with Mr. Beka Gonashvili, the President of the Sheep's Association of Georgia. The meeting was held on May 15, 2018 at the Consultant's office (Figure 10.1.11). As it was clarified during the meeting, the given route of the sheep driving did not cross the project zone, but was distanced from it by 1-1,5 km.

Figure 10.1.11: A meeting with Mr. Beka Gonashvili, the President of the Sheep's Association of Georgia



Within the scope of the project, as per the requirements of Georgia, a scoping report was developed and submitted to the Ministry of Environment Protection and Agriculture of Georgia. Public hearing was held organized by the Ministry:

October 16, 2018, 14:00, Administrative Building of Marneuli Municipality, Rustaveli Street, #73

The Scoping Report and relevant detailed information regarding the planned activity was available at the following address:

- Ministry of Environment Protection and Agriculture of Georgia, address; #6, Marshal Gelovani Avenue, Tbilisi.
- Marneuli Municipality, address: Rustaveli Street, #73; Tel: (0357) 22 33 21, e-mail: municipaliteti@marneuli.gov.ge

The responses to the issues presented by the Ministry of Environment Protection and Agriculture of Georgia are given in Annex 1.

As per the information gathered as a result of the held information campaign, the following mitigation measures and recommendations were developed related to the social issues within the scope of the project:

1. Regarding the employment of the local staff, the following requirements are to be envisaged in the contract to be concluded with the construction Contractor: (i) in case of equal qualification, advantage should be given to the local staff for the employment purposes within the scope of the project, and (ii) 70% of the non-qualified labor should be the local staff.
2. At the stage of developing the Resettlement Action Plan, a particular attention should be paid to the current business along the section of the Highway where the traffic flow is expected to decrease. The business incomes are expected to reduce along these sections for the business owners.
3. As regards the gender problems, the Construction Contractor and/or Consultant must develop a gender plan within the scope of the project both, in the project implementation and operation phases. The local non-governmental organizations are to be engaged in the plan development process.
4. Following the safety and technical standards requirements, trading with agricultural products by the local people is prohibited adjacent to the Highway. Consequently, the population, who gains certain benefit through such a business, will lose their incomes. Within the scope of the project, it is necessary to plan the construction of the organized trade center(s) adjacent to the project Highway so that the population should not lose sources of income. The compensation for the business suspension will be given out as the last alternative and this decision must be clearly grounded in the Resettlement Action Plan.

10.2 Grievance Redress Mechanism

During implementation of the Project, there might be several issues related to environmental and social hazards and disputes on entitlement processes occurred due to the Project activities. A Grievance Redress Mechanism will be set up for the Project to deal with both the environmental and social issues of the Project.

The present chapter specifies the procedures of establishing Grievance Reddress Mechanism (GRM) and its structure and composition. The Safeguard Units of the IA has important role for establishing the GRM.

The GRM consists of temporary, project-specific units established at the municipal level in project affected municipalities and regular system established at IA. ***Grievance Reddress Committee (GRCE)*** established at a municipal level as a project-specific instrument, which is functional only for the period of the project implementation.***Grievance Redress Commission (GRCN)*** is formed as permanently functional informal structure within the IA to ensure grievance review, resolution and record.

Grievance Redress Committees at implementing organizations/agencies

Grievance Redress Commission (GRCN) is formed by the order of the Head of RDMRDI as a permanently functional informal structure, engaging personnel of RDMRDI from all departments having regard to the environmental and resettlement issues and complaint resolution. This includes top management, Environmental and Social Safeguards Units, Legal Departments, PR department and other relevant departments (depending on specific structure of the IA). The GRCN is involved at the Stage 2 of grievance resolution process. The Order shall also state that if necessary representative of local authorities, NGOs, auditors, representatives of APs and any other persons or entities can be engaged in a work of GRCN.

The following members are proposed for GRCN (Table 10.2.1):

Table 10.2.1: Membership of the Grievance Redress Committee

(i) Management of the implementing organization/agency	:	Member
(ii)Head of the environmental and social security department	:	Member
iii)Legal department of the implementing organization/agency	:	Member
(iv) PR Department of the implementing organization/agency	:	Member
(v) Relevant ddepartments of the implementing organization/agency	:	Member

Project-specific Grievance Redress Committees at a municipal level

Grievance Redress Committee (GRCE) is an informal, project-specific grievance redress mechanism, established to administer the grievances at Stage 1. This informal body will be established at community level in affected Municipality (village/community authority). The GRCE shall include representatives of Municipal LAR Teams and local communities. The RD representative in the Municipal LAR Team shall coordinate the GRCE formation. He/she will then be responsible for the coordination of GRC activities and organizing meetings (Convener).

Thereafter, the contact person will be responsible for the activity of the **Grievance Redress Committee** (GRCE) and organizing the meetings. Besides, the **Grievance Redress Committee** (GRCE) must have a representative of Sakrebulo as its member (Secretary) and representatives of project affected persons (AP), project affected women (if any) and relevant local NGOs so that the project affected people are allowed to voice their opinions and participate in the decision-making process.

A **Grievance Redress Committee** (GRCE) is formed at the level of the local people (official representative's office in the Municipality and head of the Municipality Sakrebulo[11]). The formation of the **Grievance Redress Committee** (GRCE) is officially registered by the first session protocol by mentioning the Land Acquisition and Resettlement Frame document (LARF) and Environmental Assessment Frame document (EARF), as an inseparable part of the agreement concluded between the government and the ADB. The following membership of the **Grievance Redress Committee** (GRCE) is proposed (Table 10.2.2):

Table 10.2.2: Membership of the Grievance Redress Committee (GRCE)

(i) Representative(s) of the environmental protection and resettlement department of the implementing organization/agency	:	Meeting convener; contact person(s)
(ii) Sakrebulo representative	:	Member, secretary

[11] Sakrebulo is a local elected self-governing body (local parliament) and the representative of Gamgebeli in the Municipality is the Executive Authorit.

(iii) Representative of Gamgebeli of the region to relevant Municipality (village/Municipality level)	:	Chairman
(iv) Representative of the project affected people (AP)	:	Member
(v) Representative of an NGO[12]	:	Member
(vi) Construction works implementing contractor's representative	:	Member
(vii) Environmental and resettlement/social security specialists of the Supervisory Consultant	:	Member

Representative of the Resettlement and Environment Division of RD (Convener, contact person) is coordinating the work of the Committee and at the same time he/she is nominated as a contact person for collecting the grievances and handling grievance log. The local authorities at the municipal level, civil works Contractor, Supervising Company (Engineer), as well as APs (through informal meetings) will be informed about the contact person and his contact details are available in offices of all mentioned stakeholders.

The APs should be informed about the available GRM. This could be achieved through implementing information campaigns, distributing brochures (e.g. Communication Plan), keeping all focal points up-to-date & maintaining regular communication with them, allowing multiple entry points for complaints, introducing forms for ease of reporting complaints.

10.3 Grievance Redress Procedures

Brief description of all stages of Grievance Resolution Process are given in the **Table** 10.3.1.

Table 10.3.1: Grievance Resolution Process

Steps	Action level	Process
Stage 1 (GRCE Level)	**Step 1:** Informal negotiations with APs	The complaint is informally reviewed by the GRCE Contact Person – Representative of Environmental and Resettlement Unit of IA/PIU, which takes all necessary measures to resolve the dispute amicably. At this stage, Contact Person engages in discussions with AP only those members of the GRCE, who have direct relation to the issue.
	Step 2: Formal negotiations with APs GRCE levelresolution of grievance	If the oral grievance is not solved during the negotiations, the GRCE will assist the aggrieved APs to formally lodge the grievances to the GRCE. The aggrieved APs shall submit their complaints to the GRCE within 1 week after completion of the negotiations at the village level or later, as he wishes. The aggrieved AP shall produce documents supporting his/her claim. The GRCE Contact Person will review the complaint and prepare a Case File for GRCE

[12] In case of AP's wish and presence of such NGOs in the region.

		hearing and resolution. A formal hearing will be held with the GRCE at a date fixed by the GRCE Contact Person. On the date of hearing, the aggrieved AP will appear before the GRCE at the Municipality office for consideration of grievance. The member secretary will note down the statements of the complainant and document all details of the claim. The decisions from majority of the members will be considered final from the GRCEat Stage 1 and will be issued by the Contact Person/Convenor and signed by other members of the GRCE. The case record will be updated and the decision will be communicated to the complainant AP

Steps	Action level	Process
Stage 2	**Step 3** Decision from central IA/PIU GRCN	If any aggrieved AP is unsatisfied with the GRCE decision, the next option will be to lodge grievances to the IA/PIU at the national level. GRCE should assist the plaintiff in lodging an official compalint to GRCN (the plaintiff should be informed of his/her rights and obligations, rules and procedures of making a complaint, format of complaint, terms of complaint submission, etc). The aggrieved AP shall produce documents supporting his/her claim, in accordance with the legal requirements (Administrative Code of Georgia). The GRCN of the IA shall review the complaint in compliance with the procedures specified in the Administrative Code of Georgia. If needed, a formal hearing will be held with the GRCN at a date fixed by the GRCN member secretary. On the date of hearing, the aggrieved AP will appear before the GRCN at the IA office for consideration of grievance. The Contact pperson will note down the statements of the complainant and document all details of the claim. The plaintiff shall be informed of the decision.

Stage 3	**Step 4** Court decision	If the IA/PIU decision fails to satisfy the aggrieved APs, they can pursue further action by submitting their case to the appropriate court of law (Rayon Court). The aggrieved AP can take a legal action not only about the amount of compensation but also any other issues, e.g. occupation of their land by the contractor without their consent, damage or loss of their property, restrictions on the use of land/assets, etc.

10.4 Grievance Log

The Grievance Logs will be developed at both – GRCE and GRCN levels.

The Grievance Logs will be developed and managed by the RD representative at site (Convenor of the GRCE/Contact Person) and will be kept at site (in the IA/PIU office or Engineer's office).

The records in Grievance logs include the following information:

- Name and contact details of the claimant
- Date of receiving claim
- Form of claim – (oral or written)
- To whom the claim has been addressed initially (entry point)
- The brief description of the essence of claim
- the stages, dates and participants of negotiations with the AP with GRCE (stage 1)
- Minnutes of meetings
- Final decision of the GRCE (in case of the dispute is resolved, the decision is about closure of the issue. In case if the dispute remains unresolved, the decision is about passing to the stage 2 of the grievance redress process)
- Date of decision of GRCE
- Documents prepared by AP with the help of GRCE for passing to GRCN

The copies of the records/documents may be also kept in the municipal office.

11. CONCLUSIONS AND RECOMMENDATIONS

The following principal conclusions were made in the EIA process:

1. The activity considered by the EIA report envisages modernization of Rustavi-Red Bridge Highway (E-60). The implementing agency is the Roads Department of the Ministry of Regional Development and Infrastructure of Georgia.

2. The EIA report was developed by considering the requirements of the national legislation and environmental policy of the International financing organizations.

3. The EIA report will consider several alternative options of the project implementation, incuding no-action option and 3 alternative options of the alignment. and the option best in an environmental respect was selected;

4. The project highway meets the internationals standards. It is designed for 120 km/h design speed;

5. The corridor of the considered section of the highway is distinguished for the morphological and geological diversity and has some sensitive sites, which are less hazardous in a geodynamic respect. There are several sensitive sites respect of hazardous geodynamic processes in the corridor. However, the project envisages the realization of relevant preventive measures in the construction and exploitation phases.

6. During the construction works, there will be stationery and mobile sources of atmospheric emissions of harmful substances and noise propagation in the project corridor. By considering the relevant mitigation measures, the impact on the natural environment and population will not be significant. In the exploitation phase, it may become necessary to make noise barriers along some sections.

7. The biological environment of the project corridor is not distinguished for sensitivity. The degree of naturalness of the vegetation cover and habitats is low. Therefore, the expected impact on the biological environment must be assessed as low or average. Despite this, relevant mitigation and compensation measures will be considered.

8. Impact on visible historical-cultural monuments will be insignificant. Therefore, in the construction stage, there are certain risks of impact on the quality of surface waters. For the prevention of risks, the proper waste and wastewater management is needed.

9. Impact on visible historical-cultural monuments will be insignificant.

10. The project implementation will be associated with the need for the physical and economic resettlement, and a Resettlement Action Plan (RAP) will be developed in this connection;

11. Before the onset of the construction works, particularly at the sections where the project road coincides with the existing road, it will be necessary to properly organize the construction. Before the onset of the construction works on each site, traffic flows management plan must be developed and agreed with all interested parties;

12. The project corridor will not cross and will not run near the protected areas

13. As a result of the highway modernization, a high positive social and economic impact is expected. The project will be a factor significantly promoting the sustainable economic development of the country, and the number of car accidents and risks of traffic limitation will be reduced a lot.

14. The EIA report gives the Environmental Management Plan and Environmental Monitoring Plan. In terms of realizing the measures envisaged by the given plans, the expected impacts will be reduced significantly.

Simultaneously with the activities, the environmental protection measures envisaged by the Georgian legislation and given in the EIA report will be accomplished, with the following basic measures:

- The obligations envisaged by the terms of the Permit and mitigation measures envisaged by the EIA report will be realized.
- The measures envisaged by the Waste Management Plan will be realized. The question of arranging the landfills will be agreed with the local authorities
- Delisting of timber plants in the project corridor will be agreed with a duly authorized body. Particular attention will be made on protecting the Red-Listed species and the process of their removal from the environment will be done with special supervision;
- The compensation measures for the damage inflicted to trees and plants will be identified as per the rule to calculate the compensation for using the forest fund with a special designation developed within the scope of Georgian Government Resolution No. 242 of August 20, 2010 “On the Rules of Forest Use”. The compensation measures to remove the Red-Listed tree and plant species from the environment will be determined as per Georgian Government Resolution No. 242 of August 20, 2010 “On the Rules of Forest Use”.
- Significant attention will be paid to ensuring the engineering-geological stability. If necessary, additional protection facilities will be used; the relevant monitoring will be implemented.
- In case of the population’s claims, all possible measures to meet their complaints will be realized.
- The safety of people’s movement along the highway will be ensured.
- After the construction works are over, the improved areas will be cleaned, the materials and waste will be removed and the damaged sites will be restored and cultivated.
- The information about the occurrence of any significant unforeseen environmental problems will be communicated to the Ministry of Environmental Protection and Agriculture of Georgia (MoEPA).

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13. ANNEXES

Annex 1. Responses to the questions specified by scoping opinion N13 of the Ministry of Environment Protection and Agriculture of Georgia

1.	The EIA Report must incorporate: the information established under Part 3 of Article 10 of the Environment Assessment Code of Georgia	The EIA Report incorporates the information established under Part 3 of Article 10 of the Environment Assessment Code of Georgia. The Report is enclosed by the relevant documentation.
2.	The EIA Report must be enclosed by: the documentation specified by Part 4 of Article 10 of the Environment Assessment Code of Georgia	The EIA Report incorporates the information established under Part 3 of Article 10 of the Environment Assessment Code of Georgia. The Report is enclosed by the relevant documentation.
3.	The EIA Report must present the results of the studies (specified, obligatory) under the Scoping Report, obtained and studied information, impacts studied thoroughly during the EIA process and relevant reduction/mitigation measures	Individual paragraphs of the EIA Report incorporate the said information.
4.	Substantiation of the project need	This issue is given in Paragraph 3.1.1 of the EIA Report
5.	Project description	This issue is given in Paragraph 4 of the EIA Report
6.	Description of the project road infrastructural objects	This issue is given in Paragraph 4 of the EIA Report
7.	Principal technical parameters of the project road	This issue is given in Paragraph 4.2 of the EIA Report
8.	Shp files of the objects of the project road, spoil grounds/temporary spoil grounds (if any) and construction camp	The information is provided in Annex on CD
9.	Distance of the axis of the project road from the settled areas by specifying concrete distances	The required issue is given on Drawing 4.1.3. of the EIA Report
10.	Issue related to the construction of bridges and auxiliary buildings	This issue is given in Paragraph 4.5 of the EIA Report
11.	Information about providing concrete works, foundations and bridge structures	This issue is given in Paragraph 4.5 of the EIA Report
12.	Number of road interchanges	This issue is given in Paragraph 4.4 of the EIA Report

13.	Information about the providing passages, drainage channels, profiling and lateral drainage pipelines/ditches	This issue is given in Paragraphs 4.6 and 4.8 of the EIA Report
14.	Construction of the pedestrian passages	This issue is given in Paragraph 4.6 of the EIA Report
15.	Information about the geometrical parameters, road pavement and cross sections	This issue is given in Paragraphs 4.2 and 4.7 of the EIA Report
16.	Project alternatives in details: with relevant substantiation, including No-Action alternative, alternative locations of the project road infrastructural objects and detailed description of the alternative selected and substantiated in an environmental respect	This issue is given in Paragraph 3 of the EIA Report
17.	Issues related to the need and construction of the access road	This issue is given in Paragraph 4.10.8 of the EIA Report
18.	Detailed information about stripping the vegetation and soil cover, ground works and recultivation works (by meeting the requirements of Technical Regulation “On topsoil stripping, storage, use and recultivation”);	Paragraph 4.10.9 of the EIA Report states that Decree №424 of the Government of Georgia Technical Regulation – on "Topsoil Removal, Storage, Use and Cultivation was used as the guiding document for recultivation was works
19.	The sequence of the construction of the project road, as well as their infrastructure (by showing the terms);	This issue is given in Paragraph 4.10 of the EIA Report
20.	Total number of people employed for the construction of the project road, including the percentage ration of the locals	This issue is given in Paragraph 4.10 of the EIA Report
21.	The list and quantities of the techniques to use in the construction	This issue is given in Paragraph 4.10.13 of the EIA Report
22.	The sites where the temporary and final disposal of spoil ground useless for construction is planned, in particular, the coordinates of the locations of spoil ground disposal (spoil grounds) and relevant design documentation	This issue is given in Paragraph 4.10.2 of the EIA Report and in annex, on CD
23.	The sites where the inert materials needed for the construction of the road will be extracted	This issue is given in Paragraph 4.10.4. of the EIA Report

24.	Information about the objects manufacturing construction materials	This issue is given in Paragraph 4.10.4. of the EIA Report
25.	Issues related to the extraction of the inert materials needed for construction	This issue is given in Paragraph 4.10.4. of the EIA Report
26.	The issues the manufacturing of raw materials (asphalt, cement, etc.) are planned	This issue is given in Paragraph 4.10.4. of the EIA Report
27.	General layout of the construction camp	The General layout of the construction camp is given on Drawing 4.10.1.1. of the EIA Report
28.	Coordinates and area of the camp site	The information about the construction camps is provided in Para 4.10.1 of the EIA Report
29.	Description of the water supply project with relevant drawings showing the way the construction camp supply with drinking and economic water (individually or from the water supply system)	The information about the construction camps is provided in Para 4.10.1 of the EIA Report
30.	The way the issue of discharge waters originated at the camp will be solved; capacity of the cesspit planned on the territory; if there are sedimentation ponds for the industrial discharge waters; type and capacity of the fuel reservoir to be installed on the main construction camp	The information about the construction camps is provided in Para 4.10.1 of the EIA Report
31.	Geology of the project site	The required information is given in Paragraph 5.2.2.1 of the EIA Report
32.	General geological map of the Region	The General geological map of the Region is given on Drawing 5.2.2.1.1. of the EIA Report
33.	Relief (geomorphology)	The required information is given in Paragraph 5.2.2.2. of the EIA Report
34.	Engineering-geological map, engineering-geological sections of the project corridor	The required information is given in Paragraph 5.2.2.3 of the EIA Report
35.	Description of geomorphologic, geological, hydrogeological, hydrological, climate-meteorological, seismic and tectonic conditions of the project area	The required information is given in Paragraphs 5.2.2.1 through 5.2.2.5. of the EIA Report
36.	The results of the engineering-geological studies accomplished in the project corridor.	

	Attention must be paid to the locations of sites complex in respect of development of hazardous geodynamic processes (landslides, erosion, rock fall) in the project corridor. The necessary preventive measures must be listed (protective structures, slope terracing, etc.)	The given issue is discussed in clause 5.2.2.6 of EIA Report
37.	Plan of the pre-construction detailed engineering-geological studies (number of boreholes, their location, laboratory studies, results of the ground laboratory study, etc.)	The given information is provided in Paragraph 5.2.2.6 of the EIA Report
38.	Conclusions and recommendations developed by considering the results of the geological studies	The given information is provided in Paragraph 5.2.2.7 of the EIA Report
39.	As the project area is in immediate vicinity of the Emerald Candidate Site, the EIA Report must examine the impact on the Emerald Candidate Site. The assessment of expected impact of the planned activity on the Emerald Candidate Site is to be provided. Based on defining imperative reasons of over-riding public interest (IROPI), the assessment must give the expected impact with relevant substantiation, mitigation, impact prevention and compensation measures, conservation plan developed based on the study results.	During the preparation of the EIA Report, the impact expected on the Emerald Candidate Site was provided. The results of the assessment are given in Paragraphs 5.3.3. and 7.6.4 of the EIA Report. Paragraph 7.6.4.1 gives the expected impact of the construction and operation of the highway on the Emerald Candidate Site and relevant mitigation measures are given in Table 7.6.4.2.1.
40.	Hydrology of rivers Mtkvari, Khrami and Debeda	The required information is given in clause 5.2.4 of the EIA Report
41.	Detailed information about peak discharge, low-water discharge, solid drift	The required information is given in clauses 5.2.4. and 5.2.4.1. of the EIA Report
42.	Information about erosive processes and as necessary, about the anti-erosive measures, bed processes andbank reinforcement works	The required information is given in clause 4.8 of the EIA Report
43.	**Biological environment**: Detailed description of flora and fauna in the project area; Georgian Rare and Red-Listed species occurring in the planned project corridor; land fauna; Georgian Red-Listed animal species common in the project corridor; study area and field study methods, sensitive sites, field study results	The required information is given in clause of the EIA Report5.3.ში

44.	Impact on atmospheric air in the construction and operation phases, emissions from the operation of the construction techniques, calculation of emissions from the constructon materials production plants	The required information is given in Paragraph 7.1 of the EIA Report.
45.	Noise propagation and expected impact in the construction and operation phases and relevant mitigation measures	This issue is discussed in Paragraph 7.2. of the EIA Report and Annex 7
46.	Impact on geological environment in the construction and operation phases and relevant mitigation measures	This issue is discussed in Paragraph 7.3 of the EIA Report
47.	Impact on underground/ground waters and mitigation measures	This issue is discussed in Paragraph 7.4 of the EIA Report
48.	Impact on surface waters in the construction and operation phases, risks of surface water pollutio	This issue is discussed in Paragraph 7.4 of the EIA Report
49.	Impact on biological environment and impact assessment in the construction and operation phases	This issue is discussed in Paragraph of the EIA Report 7.6. ში
50.	Impact on the integrity of the vegetation cover and habitats; impact on fauna, including fish fauna (including Red-Listed species) and results of relevant studies. Relevant mitigation measures and compensation measures if necessary	Para 7.6.1.-of the EIA Report decsribes the impact on habitat integrity; the impact on the vegetation cover is decsribed in Para 7.6.2; as for the impact on fauna, including fish fauna, it is described in Para 7.6.3. Relevant mitigation measures are given under each paragraph.
51.	In case of impact on the plants in the project area, the information about them, trees and vegetation to cut down and their species and numbers, detailed study of their properties, impact on species protected by the legislation of Georgia ad international covenants, as well as prevention and compensation measures for such impacts, including habitat restoration measures as necessary	Timber resources registration sheet is given in Annex 4 and on the enclosed CD. The impact on timber plants is described in Para 7.6.2.

52.	Based on the results of the above-listed studies, the Monitoring Plan must show the impacts on individual components of biodiversity	Paragraph 9 of the EIA Report gives the Environmental Monitoring Plan giving the issues of observation over the components of biodiversity.
53.	Waste management issues, including Waste Management Plan and impact expected by waste origination	Annex 3 of the EIA Report gives the Waste Management Plan for the waste expected in the road construction and operation phases
54.	Impact and impact assessment on the social-economic environment, land ownership and use, limitation of natural resources, health- and safety-related risks and relevant mitigation measures	This issue is discussed in Paragraph of the EIA Report 7.9. ში
55.	Information about the historical-cultural and archeological monuments in the project area and issues of impact on them	The required information is given in Paragraph 7.10 of the EIA Report
56.	Summary of the impacts expected as a result of the project implementation	The necessary mitigation measures to realize during the project implementation are given in paragraph 8 (Environmental Management Plan) of the EIA Report
57.	Monitoring Plan to realize in the construction and operation phase	The required information is given in Para 9 of the EIA Report
58.	Detailed Emergency Response Plan	The required information is given in details in Annex 2 of the EIA Report
59.	Assessment of public awareness in the scoping phase and public opinions and remark	The given information is given in Annex 1 of the EIA Report
60.	Principal conclusions developed during the EIA process and principal measures to realize during the activity	The required information is given in clause of the EIA Report11 ში
61.	General location plan of the project area (with relevant markings)	The general layout of the project road is given on Paragraph 4.2.3 of the EIA Report
62.	Main technical parameters of the project road as a single table	The required information is given in Table 4.2.1 of the EIA Report
63.	A single schematic map of the project area, depicted on aerial photograph (high resolution) should be presented in printed and electronic form (A3 format, Shape File WGS_1984_37N (38N) projection) showing all necessary infrastructural facilities, existing and project roads,construction camp, construction grounds, territory of the spoil ground (as necessary)	The given information is given on drawing 4.1.3 of the EIA Report and enclosed CD -ROM

64.	Detailed designs of the irrigation channels crossing the dry gullies	The given information is given on Paragraph 4.6 of the EIA Report
65.	The EIA Report must give the information about the protective zones of the operating and project road in details	
66.	The project area of construction covers the contours of ore extraction licenses : #100129 (“Kvisha” Ltd. 2013”), #10019903 (“Sinohydro Corporation Branch in Georgia” Ltd.”), #1003208 (“New Quality” Ltd.), #10017726 (Physical Entity Elmadin Mamedov). Under clause 1 of article 8 of the law of Georgia “On Subsoil”, “It shall be prohibited to allocate lands of the subsoil fund with the right of ownership, lease or in any other form without the consent of the Legal Entity under Public Law called the National Agency of Mines under the Ministry of Economy and Sustainable Development of Georgia ('the Ministry'), and in the case of a licensed object, without the consent of the license holder as well.	Was taken into account
67.	The project territory partially covers the contour of Mziuri clay and gypsum deposit. The area of the territory envisaged by the specified project is 0,14 ha with 1702 tons of lay-gypsum (plaster) reserve. Under sub-clause 1, clause 1, article 5 of the LAW OF GEORGIA ON FEES FOR THE USE OF NATURAL RESOURCES, The amount of fee for extracting clay ad gypsum is 1 GEL.	Was taken into account
68.	Under clause 1 of article 39 of the Law of Georgia “On Subsoil”, Build-up in areas of mineral resource deposits shall be permitted, if an initiator of the build-up process pays to the owner of mineral resources compensation that is equal to the price (in the amount of a fee for the use of relevant natural resource as provided for by the Law of Georgia On Fees for the Use of Natural Resources) of the type of mineral resource, the use of which is limited or delayed by the scheduled build-up	Was taken into account

69.	By considering the listed circumstances, it is necessary to obtain consent of the owners of subsoil use licenses, pay the compensation fee by observing relevant procedures and correct the project territory (section) according to the ongoing application (45098-ID2018) within the scope of the administration proceedings.	Was taken into account

13.1 Annex 2 Emergency Response Plan

Goals and Objectives of the Plan

Goal of the emergency response plan is to determine and establish guidelines for workers employed for the road construction works in order to ensure rational and coordinated actions of personal during techno genic accidents or incidents, as well as protection of personnel, population and environment.

Objectives of this plan are:

- Determination of possible emergency situations during the road construction;
- Determination of groups responsible for response to each type of emergency situation, their equipment, emergency action plans and responsibilities;
- Determination of internal and external alarm systems;
- Immediate activation of internal resources and, if necessary, mobilization of additional resources and relevant procedures;
- Provision of emergency management system;
- Ensure compliance with legislative, regulatory and safety requirements during emergency situations.

Expected emergency response plan envisages the requirements of Georgian laws and legislative acts.

Types of Emergency Situations

Considering specificities of planned activities, following types of emergency situations are expected:

- Traffic accidents;
- Accidental spills of pollutants;
- Fire;
- Personnel traumatism and incidents related to their health safety.

It is noteworthy, that emergency situations, listed above, may be subsequent and development of one emergency situation may initialize another one.

<u>Traffic Accidents</u>

Trucks and heavy machinery will be used during construction works. During their movement on public and access roads, following are expected:

- Collision with transport means, real estate or livestock of local population;
- Collision with local population;
- Collision with project personnel;
- Collision with other project machinery;
- Collision with local infrastructure facilities;

High risk of traffic accidents will be related to relatively intensified traffic. A number of preventive measures should be taken in order to minimize the risks of traffic accidents, including: limitation of traffic speed, arrangement of warning signs, selection of optimal routes for vehicles, regulation of traffic by standard-bearer, etc.

Machinery must be accompanied with specially equipped techniques and trained personnel; this will dramatically reduce risks of collisions or digress from the road.

Accidental Spills of Pollutants

Oil spill risk may be related to a violation of the conditions of their storage, fuel or oil leakage from vehicles and equipment and so forth.

Fire

The main factor of accident may be anthropogenic, namely: indifference of personnel and violation of safety norms, violation of storage rules for fuels, oils and other explosive substances and etc. in order to prevent fire eruption, strict supervision over fuel and lubricants storage rules, provision of fire fighting means on the construction site, periodic training of personnel on fire prevention and elimination of its consequences will be required.

Personnel Traumatism

Except incidents related to other emergency situations, personnel traumatism may also be related to:

- Incidents related to heavy machinery/equipment used for project implementation;
- Fall from large heights;
- Poisoning with used chemical substances;
- Electric shock, during working near aggregates under high voltage.

General Preventive Measures

Preventive measures for traffic accidents:

- Selection of optimal transport movement routes and speed restrictions;
- Installation of warning, prohibiting and pointing road signs at access roads and construction camps;
- During movement of special and oversized machinery they should be escorted by specially equipped machinery and trained experienced personnel.

Preventive measures for hazardous substance spill:

- Strict supervision over implementation of fuel and chemicals' storage and use terms. Fitness of storage vessel must be checked before storing;
- The technical functionality of oil containing equipment should be periodically monitored;
- Termination of works / suspension of equipment and machinery operation and implementation of maintenance work after detection of minor spill, so that incident would not become large-scale.

Preventive measures for fire/explosion:

- Periodical training and testing of personnel on fire prevention issues;
- Storage of easily flammable and explosive substances at safe places. Installation of corresponding warning signs at their warehouses;
- Implementation of fire safety rules and arrangement of functional fire fighting equipment at the territory;

Preventive measures for personnel traumatism/injury:

- Periodical training and testing of personnel on labour safety issues;
- Provision of personnel with individual protection means;
- Warning signs should be arranged within the dangerous zones;
- Preparation of special staff, which will control implementation of safety norms at construction sites and will register facts of violation.

Approximate Scale of Accidents

By considering the expected emergencies, incidents, liquidation resources and legislative requirements, accidents and emergency situations are sorted in 3 levels of response. Table 14.2.1. provides description of emergency situations according to their levels, indicating relevant responses.

Table 13.1.1. Description of Different-Level Emergencies

Accidents	Level		
	I Level	II Level	III Level
General	The internal resources are sufficient for emergency liquidation	External resources and workforce are needed for emergency liquidation	Involvement of regional and country resources for emergency liquidation
Road accidents	The damage of equipment, vehicles, infrastructure and non-valuable items takes place. Human health is not in danger.	The damage of the equipment, vehicles, infrastructure and valuable objects takes place. There is the threat to human health	The damage of the equipment, vehicles, infrastructure and valuable objects takes place. There is the high risk of development of other emergencies.
Hazardous substance spillage	Local spillage, which does not need external interference and can be eliminated with internal resources. The risks of spreading of the substance on large areas do not exist.	Large spills (spills of hazardous substances 0.3 tons to 200 tons). There are risk of substance spreading in the area and the risk of the river pollution.	Large spills (more than 200 tons) does not expected
Fire	Local fire, which does not need any external interference and is easily controlled. The meteorological conditions are not conductive to the rapid spread of the fire. There are no inflammable and explosive sections/ warehouses and materials.	Large fires, which spread quickly due to the weather conditions. There are inflammable/explosive areas/ warehouses and materials. It is necessary to call the local fire squad.	A large fire, which spread rapidly. The ignition risk of surrounding neighbourhoods and provocation of other emergencies is high. The approach to the territory is complicated. The inclusion of the regional fire service for the liquidation of the incident is necessary.
Personnel injury / Traumatism	• One incident of traumatism; • • One incident of traumatism; • Light fracture, bruises; • I degree burns (skin surface layer damage); Assistance to injured personnel and the liquidation of the incident is possible by local medical service.	• Individual cases of accidents; • Severe fracture - a fracture of the joints of the middle; • II degree burns (deep layer of the skin lesions); There is the need to move injured personnel to the local medical facility.	• Several traumatic accidents; • Severe fracture - Articular fracture etc.; • III and IV degree burns (skin, hypodermic tissues and muscle lesions); There is the need to move injured personnel to the regional or Tbilisi medical service centres with relevant profile.

Emergency Response

The plan identifies authorized and responsible persons for emergency response, as well as power delegation and granting methods. After arrangement of the area responsible persons and their position must be established; this is considered by the operation sequence plan. This information must be provided to the management of the construction contractor.

During the accident of road transport, it is necessary to implement the following strategic actions:

- A unit whose task and objective will be defined beforehand must be established in case of emergency;
- Objectives for firefighting operations must be established beforehand. Monitoring of the measures conducted must be carried out weekly;
- Procedures to be carried out during emergency and people responsible for them must be also determined;
- Measures to avoid environmental pollution in case of accidental spill of oil products and other substances must be defined. Hazardous materials must be recorded and this information must be available for every staff member.

<u>Response During Traffic Accidents</u>

During the accident of road transport, it is necessary to implement the following strategic actions:

- To stop vehicles/equipment;
- Transmission of information in accordance with the emergency report scheme;
- In case if there is no danger for human health and there are no risks of provoking other emergency situations (for example: collision of other vehicles, explosion, fire, oil spill, hydrodynamic accident or others), then:
  - Get out of the vehicle/equipment or get away from the accident place and stand on a safe distance;
  - Wait for the police/rescue team to come.
- In case of further threats, act as follows:
  - Get out of the vehicle/equipment or get away from the accident place and stand on a safe distance;
  - If the vehicle accident has occurred on the dangerous section of the road of public use (for example: in the turning, there visual field on the road is limited), then ask to the accident witness to stop the cars moving in direction of an accident location;
  - If you are alone on the accident place, place the warning signs or sharp colour safe signs on the road away from the place of an accident, so that those signs will be visible for the drivers moving in direction of an accident place and will ensure the car stop;
  - In case of explosion, fire, oil spill, hydraulic accident and others, ac in accordance with the strategy given in the relevant paragraphs;
  - In case if there is a threat on the health of a person, do not try to move the body;
  - If the injured person is lying in the middle of the street, cover him with something and confine the accident location, so that it will be seen from a distance;
  - Remove everything from him, which might be making asphyxia (belt, scarf);
  - First aid to the injured in accordance with the first aid strategy given in the relevant paragraphs (but remember, by extra movement of the injured person, you might create additional risks to his health).

Response During Fire

The strategic actions of the person and the personnel working in the vicinity, who detected fire or smoke, are as follows:

- Termination of works on every site, except for safety measures;
- Assessment of the situation, reconnaissance of fire hearth and adjacent territories;
- Withdrawal of the equipment-devices from the areas, where the fire spreading is possible;
- Electrical equipment should be turned out from the circuit;
- In case if fire is strong and it is hard to approach the fire hearth, some kind of fire or explosive hazardous sites/substances are located adjacently, then:
  - Get away from the danger zone:
  - Inform senior manager/operator about the accident;
  - Wait for rescue team and when they appear, inform them about the fire reasons and the situation in the vicinity of fire hearth;
- In case if the fire is not strong, the fire hearth is easily approachable and getting near to it is not dangerous for your health. At the same time, there are certain risks of fire distribution on adjacent territories, then, act as follows:
  - Inform senior manager/operator about the accident;
  - Search for the nearest fire stand and supply yourself with necessary fire inventory (fire extinguisher, axe, crowbar, bucket and etc.);
  - Try to liquidate fire hearth with fire extinguisher, in accordance with the instruction shown on the fire extinguisher;
  - In case if there is no fire stand on the site, use sand or water for fire hearth liquidation or cover it with less flammable thick cloth;
  - In case if the electrical equipment turned into the circuit are near the fire hearth, it is prohibited to use water;
  - In case of fire in the closed space, do not window the room (except for special needs), because the fresh air supports fire and fire scale growth.

Strategic actions of site manager/chief operator in case of fire:

- Gathering detailed information on fire hearth location, existing/stored devices-equipment in the vicinity and substances;
- Information transfer in accordance with the notification scheme;
- Visiting the accident place and reconnaissance of the situation, risks analysis and assessment of expected fire scales (I, II or III scale);
- Ask whole personnel to use vehicles and fire extinguishing equipment;
- Controlling and managing the personnel actions.
- Support of fire-fighting team actions (need of certain equipment may occur);
- Implementation of liquidation measures after the end of the accident –monitoring of the burnt-down territoryto identify any remained fire hearths;
- Preparation of a report and submission to the Construction Contractor’s management.

<u>Response during Accidents Related to Human Injuries and Incidents Related to Their Health and Safety</u>

The person, who is taking care of injured person, must notify ambulance about an accident as a first action. Before the rescue will appear, injured person must receive first aid service in accordance with the tactics given below in following chapters. Before carrying out medical service, it is necessary to assess the situation and determine if approaching and helping an injured person might create some threat.

Open bone fractures:

- Promptly call helper, so that helper will immobilize the damaged area of the injured person, while you will process the wound;
- Cover the wound with clean cloth and directly press on it to stop the bleeding. Do not press directly on broken bone fragments;
- Without touching the wound with fingers, surround the damaged area with a clean cloth and fit ix;
- If the broken bone fragment is seen in the wound, place the soft cloth around the bone fragment in such way, that the cloth will not be removed and the bandage would not impact on bone fragments. Fix the bandage I such way, that it will not disrupt the blood circulation below the wrapped place;
- Carry out a broken bone immobilization, in the same way as during covered fracture;
- Check pulse, capillary filling and sensitivity below the wrapped place once in every 10 minutes.

• In case of closed fracture:

- Ask injured person to stay still and fix the damaged part of the fracture above and below it by hand, before it will be immobilized (fixed);
- For a good fixation, fix the injured part of the body on uninjured part. If the fracture is on the hand, fix it on the body with triangle bandage. If the fracture is on the leg, fix the damaged leg on another leg;
- Check pulse, sensitivity and capillary filling below the wrapped place once in every 10 minutes. If the blood circulation or sensitivity is reduced, make a less tight bandage.

There are three types of bleeding:

• There is a little blood. In this case is risk of infection:
  - Clean the wound of injured person with any colourless liquid suitable for drinking;
  - Wrap the wound with clean cloth.
• There is a lot of blood. In this case there is a risk of blood loss:
  - Cover the wound with several layers of cloth and make press bandage;
  - If the blood is still leaking, tight the cloth to the wound again (do not take of the blood-drenched cloth) and strongly press on blood source area.
• The blood is pouring like a fountain from the wound. In this case the blood loss is very fast. In this case you must push finger (or fingers) on the artery projection area to avoid this and then put a bandage.

The areas of load on the artery are: the lower third of an arm and upper third of the thigh. The bandage should be fixed like this:

- The bandage is fixed only in extreme case, because often it leads to irreversible damage;
- The bandage is fixed above wound;
- The location where the bandage will be fixed must be covered with cloths. If the wound area is bare, we should place clean cloth under the bandage;

- First bandage must be tight (fixed as possible), then the bandage is getting tight and in addition placed 3-4 times (rope, belt and etc. can be used instead of bandage);
- The bandage should be fixed for 1 hour in the winter and for 2 hours in summer. Then we should release and after 5-10 minutes fix it slightly above from the original location;
- Check if the bandage is properly fixed – if it is properly fixed, there should be no pulse on limb;
- What we should not do;
- Do not put a hand in the wound;
- Do not take anything from the wound. If some foreign body is seen in the wound, we should try to maximally fix it (put a bandage around this body).

• Internal bleeding is hardly determinable damage. Suspect internal bleeding, when the shock signs are observed after getting injured, but there is no significant blood loss. In case of internal bleeding:
  - Lay injured person on his back and rise his legs up;
  - Remind tight clothes on neck, chest, waist;
  - Do not give food, medicine or drinks to injured person. If injured person is conscious and is very thirsty, just wet his lips;
  - Warm injured person – cover with blanket or cloth;
  - Check the pulse in every 10 minutes, as well as breathing and consciousness. If the person is losing mind, place him in safe location.

First Aid in Case of Burnts

The burn might be developed by hot objects and steam impact (thermal burn), by chemical substances impact on the skin (chemical burn), electricity impact (electrical burn). In order to properly carry out first aid, you must determine the degree of burn, which depends on damage depth and damage area (on what part is the burn distributed).

• The first aid measures during the burn are:
  - It is dangerous to breath in the smoke, so if there is a smoke in the room and it is not available to window fast, remove the injured person on a safe place, on a fresh air;
  - If the clothes are burning on the person, do not start to roll his body, pour the water on the body (in case of electrical burning, usage of water next to the equipment in the circuit, is prohibited);
  - If there is no possibility to use water, cover the body with non-synthetic cloth;
  - It is necessary to start cooling the burnt area in time with cold water (in case of I and II scale burn, water it for 10-15 minutes, in case of III and IV scale burn wrap it with clean wet cloth and then cool it in the water in such wrapped conditions);
  - Remove the cloth and other objects, from the damaged area, which may interrupt blood flow. Do not remove cloth pieces, which are stick to the damaged area;
  - Cover the damaged area with sterile wrapping. This would reduce the likelihood of infection;
  - Breathing in a hot air is possible when burnt, which leads to the burning of respiratory tracts. If the victim has hard noisy breathing, facial or neck burn, singed hair cover of face and nose, swelled mouth and lips, swallowing difficulty, cough, hoarseness voice – suspect the respiratory tracts burn and wait for the medical service;

- Constantly check breathing and pulse before the medical service will come, be ready to carry out reanimation measures;
- It is not allowed to take off the clothes particles from the burnt skin, cause this may lead to the deepening of the damage;
- It is not allowed to destroy the integrity of blebs, because the skin cover is damaged and it makes a favourable conditions for the invasion of infection in the body;
- Do not use ointments, lotions or oils for processing the damaged parts;
- It is prohibited to process the chemical burn areas with neutralizing solutions/ For example, alkaline caused burn treatment with acid.

First Aid in Case of Electrical Trauma

There are three types of electrical trauma:

- The trauma caused by high-voltage electricity. The damage developed as a result of high voltage traumas, are fatal in most cases. Severe burns are being developed at this time. Due to the strong muscle compression the injured person is often threw away on a significant distance, which leads to serious injuries. In case of high-voltage power trauma:
  - It is prohibited to get close to the injured person, before the electricity will be turned off and if necessary, the isolation will be made. Remain 18 m radius safe distance. Do not let other witnesses to approach the injured person;
  - After receiving electric trauma, as soon as approaching the injured person, open the breathing ways without moving head back, by moving the lower jaw in front;
  - Check breathing and circulation signs. Be prepared to make reanimation measures;
  - If the injured person is unconscious but is breathing, place him in a safe location;
  - Carry out first aid in case of burns and other injuries.
- The electrical trauma caused by low-voltage electricity. Low-voltage electricity trauma may turn into serious damages and even death reason. Often, this kind of electrical trauma is caused by damaged plugs, wiring and equipment. When standing on a wet floor or touching undamaged electrical wiring with wet hands, the risks of getting the electrical trauma are sharply increasing. In case of low-voltage power caused trauma:
  - Do not touch the injured person, if he is touching the power source;
  - Do not use metal object for removing the power source;
  - If you are able, stop power supply (turn off the power switch). If it is not available, turn off the electrical equipment from the power source;
  - If you are not able to switch off the electricity, then stand on dry insulation thing (for example: a plank of wood, on rubber or plastic pad, on book or pile of newspapers);
  - Remove the victim's body from the power source by broom, stick, and chair. You can move the victim's body away from the power source, or vice versa, the power source away from the body, if it is more convenient;
  - Without touching the body of injured person, tie a rope around his foot and shoulders and move away from the power source;
  - At least, grab the injured person in dry not-tight cloth and move him away from the power source;
  - If the victim is unconscious, open the airways, check the breathing and pulse;

- If the victim is unconscious, is breathing and has a pulse, place in a safe location. Cool the burned areas and wrap it;
- If the visible injuries are not seen on the victim and feels good, advice to take a rest.

- The electrical trauma caused by lightning/thunder:
  - Various traumas, burns, face and eyes damage is often by the electrical trauma. Sometimes the lightning may cause a sudden death.

Quickly move damaged person form the place of the accident and serve with first aid as in case of different type of the electrical trauma.

Emergency response equipment

The following emergency response equipment must be available on the construction base:
Personal protection means are:

- Helmets;
- Safety glasses;
- Uniforms with reflective stripes;
- Waterproof boots;
- Gloves.

Fire extinguishing equipment:

- Standard fire extinguisher: on every site, as well as on every special machines and equipment;
- Buckets, sand, shovels and etc.;
- Properly equipped fire stands;
- Fire truck – the nearest fire fighters team truck will be used.

Emergency medical service equipment:

- Standard medical boxes: Standard medical boxes for vehicles: on every project vehicle and equipment;
- Ambulance car

Spill response equipment:

- Heavy duty plastic bags;
- Absorbent pads;
- Gloves;
- Drip trays;
- Buckets;
- Polyethylene film.

Necessary Qualification and Personnel Training

Testing of each system of emergency response must be periodically implemented, obtained experience must be documented and weak spots should be improved (the same should take place in case of accident realization).

The whole staff, employed on treatment facility construction and operation, must undergo introductory training, which includes emergency response course. Personnel additional training registration system should exist and be kept at offices of customer or contractors.

13.2 Annex 3 Waste management plan for the waste generated during the construction and operation of the highway

Introduction

The present document is the waste management plan for the waste generated during the construction and operation of Rustavi-Red Bridge Road of East-West Highway (E-60). The Plan is a live document and may be corrceted as necessary.

During the planned activity, non-hazardous and inert materials are expected to originate, as well as hazardous materials. Consequently, a plan to manage the waste originated during the project construction and operation phases is developed. The plan has the following sections:

- Goals, objectives and ways of achievement.
- Waste management hierarchy and approaches;
- Institutional plan in Georgia, which is responsible for waste management and monitoring;
- Information about the originated waste;
- Information about the waste prevention and remediation measures;
- Methods of separation of the originated waste;
- Temporary storage of waste;
- Waste transportation;
- Waste resource-use and/or methods of waste treatment;
- Information about potential sub-contractors;
- Waste handling;
- Waste management monitoring.

Goals, objectives and ways to achieve them

The objective of the present waste management plan is to protect environmental and human health what is achieved:

1. By preventing or reducing waste generation and its negative impact;
2. By designing efficient waste management mechanisms;
3. By reducing the harm caused by using resources at the expense of more efficient resource use.

These objectives can be achieved by full mobilization of the resources available to the construction contractor and project owner (infrastructural, human), who have the capability to accomplish the following tasks:

- All actions in waste management are realized in line with the requirements of the waste management policy and waste management legislation of Georgia;
- Avoiding and/or reducing waste generation to the extent possible both, in the construction and operation phases;
- Identifying waste originated in the construction and operation phases according to the types, properties and content of waste (the waste, which cannot be identified will be considered hazardous waste);
- Waste collection;
- During the transportation and processing, environmental pollution, debris accumulation and harmful impact on human health must be excluded to the extent possible;
- Undertaking obligation to take care and realize cleaning measures in case of environmental pollution or debris accumulation during the waste transportation;

- Handing over the waste to the relevant object for treatment, which has relevant certificate and registration;
- Undertaking responsibility and controlling the management process of the waste handed over to the contractor through total remediation.

If the construction contractor and/or project owner lacks resources to meet the requirements above, it is obliged to attract additional human resources and/or update the information.

Institutional plan in Georgia responsible for waste management and monitoring

Responsibility of state structures

The Ministry of Environmental Protection and Natural Resources of Georgia is the principal body charged with developing and realizing the state policy in the field of waste management. The competence of the Ministry of Environmental protection and Agriculture of Georgia is as follows:

a) Developing and realizing a single state policy in the field of waste management;

b) State registration of waste and keeping database;

c) Developing the waste management national strategy and biodegradable municipal waste strategy;

d) Developing waste management national action plan, coordinating its realization and reporting;

e) Issuing permit for activities related to waste management and registration;

f) Supporting the waste prevention, separation, reuse and recycling measures;

g) Realizing state control of waste management.

The Ministry of Labor, Health and Social Affairs of Georgia together with the Ministry of Environmental protection and Agriculture of Georgia, regulates and controls medical waste management under the established rule.

The Ministry of Environmental protection and Agriculture of Georgia regulates and supervises animal waste under the rule established by the legislation.

The agency within the system of the Ministry of Economics and Sustainable Development of Georgia issues the permits for vehicles to be used to transport waste.

The Ministry of Environmental protection and Agriculture of Georgia, together with the Ministry of Finance of Georgia, regulates cross-border transportation of waste.

“Solid Waste Management Company of Georgia” Ltd.

Management of solid domestic waste is a question of national, regional and local important for Georgia. The Government of Georgia has defined the management of solid domestic waste polygons as one of the severest problems and with this purpose started reforming the existing system. Within the limits of the reform, on April 24, 2012, “Solid Waste Management Company of Georgia” Ltd. was established within the system of the Ministry of Regional Development of Information of Georgia. The company is 100% state-owned. The company manages solid domestic waste polygons all over Georgia, except Tbilisi and autonomous Republic of Ajara.

The goal of the company is:

- Reducing negative impact of waste disposal and processing on the environment;
- Avoiding and minimizing waste origination;
- Reducing the number of existing polygons and gradually closing of all polygons inconsistent with the EU Directives;
- Providing relevant information on the polygon for separation and processing;
- Providing safe conditions and modern working environment for the employees;
- Supporting the better living standards of the population by accenting orienting on the aspects of sustainable management of solid waste;
- Providing a efficient system to share cooperation and experience between the company and the municipalities.
- Close cooperation with all interested parties, including ministries, local municipalities and other bodies responsible for various aspects of waste management system;
- Observing EC Directives in the field of solid waste management.

The mission of the company is:

- Improving the receipt of waste on the polygons;
- Putting the polygons owned by the company to order and to trouble-free mode of operation;
- Improving the registration system of waste on polygons;
- Considering environmental impact, labor safety and human health, including technical and infrastructural measures in managing the polygons;
- Specifying the number of new regional sanitary polygons and reloading stations;
- Remediation and closure of highly risky polygons;
- Professional development of the company employees regarding different issues of waste management, including technical, economic, administrative and legal issues;
- Developing an efficient system to compensate costs.
- Introducing mechanisms of separation, treatment and recycling at the source by cooperating with the municipalities.

Participation of private sector in waste management

In the field of waste management, in line with the state strategy, the funds of the state budget must be mainly used for the rehabilitation/conservation of the existing landfills, while the establishment of waste processing plants on the new polygons must be a concern for the private sector. Since the enforcement of the Waste management Code of Georgia, the number of private companies owning a license to manage various types of waste has drastically increased.

Waste management hierarchy and principles

In Georgia, the waste management policy and Georgian legislation in waste management field are based on the following hierarchy[13]:

- Prevention;
- Preparation for reusing;
- Recycling;
- Other recovery types, including energy recovery;
- Disposal.

When defining certain responsibilities regarding the waste management hierarchy, the following should be considered:

- Environmental benefits;
- Technical feasibility by using the best available equipment
- Economic practicability.

The waste management should be implemented by avoiding threats to environment and human health, namely, so that the waste management[14]:

- Should not pose threats to water, air, soil, flora and fauna;
- Should not cause noise and odor;
- Should not have a negative impact on the entire territory of the country, especially on the protected areas and cultural heritage;

Waste management procedures are is carried out by considering the following principles:

- **„The principle of taking preliminary security measure":** the measures should be taken in order to prevent threats to the environment posed by wastes, even when there is no scientifically approved data;
- **"Polluter pays" principle:** the waste generator or waste holder is obliged to cover waste management expenses;
- **„Proximity principle":** wastes should be treated on the nearest waste treatment facility, considering environmental and economic efficiency;
- **The principle of self-dependence":** an integrated and adequate network of municipal waste disposal and recovery facilities should be set up and operate.

Types and approximate amounts of waste generated during the work implementation

The expected types and approximate volumes of the waste to originate during the implementation of the planned activity are given in Table below. It should be noted that the given amount of waste is approximate. The given amount of waste in the operation phase is mostly closely associated with the intensity of various types of repairs, preventive and cleaning works.

[13]Waste Management Code – Article 4. Waste management Hierarchy
[14]Waste Management Code – Article 5. Waste management Principles

Table 13.3.1 Types and amounts of expected waste during the project implementation

Waste Code	Waste Description	Hazardous (Yes/No)	Index of hazard	Approximate amount of waste originated during the construction	Approximate amount of waste originated during the during the technical maintenance in the operation phase (annually)	Disposal/recovery operations	Basel Convention Code
08 01 11*	waste paint and varnish containing organic solvents or other hazardous substances.	Yes	H 6	100-200 kg	<10 kg	**1. Best practice:** The waste will be returned to the producer by based on an agreement. 2. The waste will be handed over to the company with relevant license for further management	Y9
16 06 01*	Lead batteries	Yes	H 15	20-30 pcs.	-	The waste will be handed over to the company with relevant license for further management	Y31
16 01 03	end-of-life tyres	No	-	40-50 pcs.	-	The waste will be handed over to the company with relevant license for further management	
16 01 07*	oil filters	Yes	H 15	50-60 pcs.	-	The waste will be handed over to the company with relevant license for further management	Y31
16 01 17 16 01 18	ferrous metal non-ferrous metal	No	-	3-4 t	-	The waste will be scrapped	Y17
20 03 01	mixed municipal waste	No	-	200 m^3	-	The domestic waste will be collected in special containers bearing special marking. The domestic waste accumulated on the construction grounds will be taken to the local landfill.	

17 05 05*	dredging spoil containing dangerous substances (soil and ground polluted with oil hydrocarbons)	Yes	H 15	Impossible to specify in advance. Depends on the scales of spills.		The waste will be handed over to the company with relevant license for further management	Y9
11 01 13*	degreasing wastes containing dangerous substances	Yes	H 6	30-50 l	-	The waste will be handed over to the company with relevant license for further management	Y9
17 02 01	wood	No		>1000 m^3	-	The waste will be disposed to the site specified by LEPL „National Forest Agency“ and will be handed over to the Agency for further management	
15 02 02*	oily cloths (cleaning rugs and protective clothes)	Yes	H 15	60-70 kg	-	The waste will be handed over to the company with relevant license for further management	Y9
16 01 19	plastic	No		100 kg		The waste will be handed over to the company with relevant license for further re-processing	Y17
08 03 17*	waste printing toner containing dangerous substances	Yes	H 6	40-50 pcs.	-	The waste will be handed over to the supplied for further processing/recovery	Y31

Waste management procedures

General requirements for safe waste handling

1. The personnel engaged in the waste management (collection, storage, transportation, receipt/delivery) would have undergone appropriate training on health and safety issues;
2. Staff will be provided with special uniforms, footwear and personal protective equipment. If necessary, staff clothing are subject to special treatment, especially after performing works related to hazardous waste;
3. Personnel should be able to render first aid in case of poisoning or trauma during working with waste;
4. A person who has not taken the proper training, has no special clothing or has signs of sickness, will not be allowed to the working area;
5. On the site of waste generation, the disposal of waste, more than allowable rate, is prohibited. The waste disposal is not allowed near the igneous and sparking sources.
6. In case of disposing several types of waste together, their compatibility will be considered;
7. Storing of strange objects, personnel clothing, uniforms, individual protection means, as well as eating on waste accumulation area is prohibited;
8. During working with waste, personal hygiene norms should be protected; after finishing the work it is necessary to wash hands with soap and warm water;
9. In case there are some signs of poisoning, a person should stop working and must apply to the nearest medical center and notify the authorities of the structural unit;
10. Firefighting equipment will be provided on fire hazardous waste collection sites. In such areas, smoking and using open fire is strictly forbidden;
11. Personnel should be aware of the waste properties and firefighting rules. Extinguishing of burning easily inflammable or combustible liquids is possible through fire-extinguishers, sand or asbestos tissues;
12. Extinguishing burning solvents with water is prohibited.

Waste management procedures and rules

The given section describes the measures and rules, which must be observed (prior to processing and/or destruction) for the waste management purposes. The management measures are considered according to the following priorities.

Waste classification

Further waste management greatly depends on the waste classification at the place of origin. Depending on the types of waste, segregation, meeting the requirements for their storage and processing/destruction finally – all these procedures need due waste classification.

It is necessary to identify waste categories, take samples, examine or test them or subject them to laboratory analysis in order to classify them in line with the EU standards and to specify the following issues:

- The category to which the given waste belongs to – hazardous, non-hazardous or inert;
- The way the waste must be managed.

The person charged with waste management and responsible for waste classification:

- Will use temporary waste inventory list, which describes a wide range of expected waste types;
- If the given type of waste is not incorporated in the inventory list, other auxiliary methods will be used to classify the waste.
- If the general methods to classify the waste are not thorough, the waste samples will be taken and tested at the laboratory in order to classify the waste in line with the given Table.

The data in the table below are given according to the I and II annexes to the Waste management Code.

Table: Recovery and disposal operations Codes

Waste Code	Waste description	Hazardous (Yes/No)	Recovery operation code	Disposal operation code
08 01 11*	waste paint and varnish containing organic solvents or other hazardous substances.	Yes	R2	-
16 06 01*	lead batteries	Yes	R4	
16 01 03	end-of-life tyres	No	R5	
16 01 07*	Oil filters	Yes		D10
16 01 17 16 01 18	ferrous metal non-ferrous materials	No	R4	
20 03 01	mixed municipal waste	No	-	D1
17 05 05*	dredging spoil containing dangerous substances (soil and ground polluted with oil hydrocarbons)	Yes	R9	D2
11 01 13*	degreasing wastes containing dangerous substances	Yes	R9	
17 02 01	Wood	No	R13	

08 03 17*	Printer toners/ink remains containing hazardous substances	Yes	-	D9
15 02 02*	Oily cloths (cleaning rugs and protective clothes)	Yes	-	D10
16 01 19	Plastic	No	-	D1
17 05 06	Ground not included in clause 17 05 05 (ground stripped during the earthworks)	No	R10	D5

Inventory:

Following the waste classification, which must determine any potential threat of waste, the person responsible for waste management, will draft the waste inventory list, which incorporates the following information:

- Waste flows and sources;
- Description and classification of waste flows and; e.g. if the waste is hazardous or not;
- Rules of storage as necessary;
- Quantitative indicators of waste – annual, quarterly or monthly, as necessary.

The inventory records are kept by the persons responsible for waste management either annually, or at making relevant a change. The copies of the waste inventory lists will be presented to the enterprise management. The records are updated only the persons specially trained in using the waste inventory list.

The waste inventory sample forms are given in the Table below

Table: Waste inventory sample

			Part 1
Information about the waste originator			
Company:			
Name, Registration no.			
Representative:			
Name, position, contact information			
Legal address:			
region, municipality, city, street			
telephone number, fax number, e-mail			
Location of waste origination:			
region, municipality, city, street			
Contact person at the waste origination facility:			
Name, position, contact information			

					Part 2
List of waste originated at the facility					
Waste Code	Waste description	Hazardous (Yes/No)	Degree of hazard	Disposal/recovery operations	Code of Basel Convention

The right waste inventory is necessary to solve the following issues:

- What type of treatment (if any) does the given waste need?
- What kind of handling (if any) does the given waste need (e.g. PPE or other)?
- How must the given waste be stored (if any)?
- What is the rule of final processing/destruction?

The goal of inventory and following measures, including labeling, is to provide the information and therefore, to destruct the waste in a safe manner.

Waste segregation and collection:

Special containers must be placed near the waste origination site.

Waste must be segregated on the waste origination site and placed in relevant containers.

As a result of the activity, waste is originated and accumulated at different sites, which are subject to inventory/registration, collection, temporary storage, removal, neutralization, recycling and or disposal.

A method of collecting industrial and domestic waste must be organized at the facility depending the categories and class of hazard of the waste.

The following types of waste are subject to collection and segregation:

- Domestic waste;
- Industrial waste, which is not forbidden to dispose to the polygon of solid domestic waste e.g. paronite, rubber waste, domestic plastic items, wooden and paper tare, timber and sawdust waste, polyethylene pipes, sandpaper leftovers, etc.)
- Mercury-containing substances and materials;
- Lead-containing waste;
- Oily cleaning cloths, used respiratory filters;
- Oil products leftovers, including the waste accumulated in settling tanks;
- Used industrial oils, lubricants;
- Materials used in liquidation works in case of oil spills;
- Polluted soil and sand;
- Metal scrap, leftovers of welding electrodes;
- Used rubber pipes, used tires;
- Remains of used lead batteries;

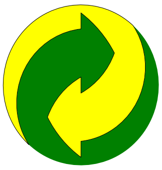
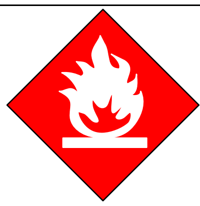
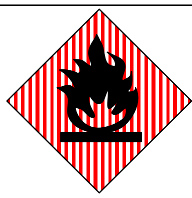
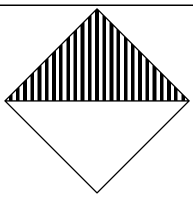
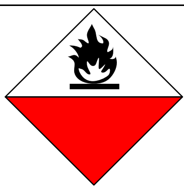
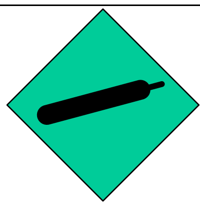
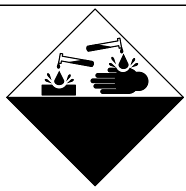
- Paint and paint can waste;
- Medical waste.

Labeling:

The persons responsible for waste management are obliged for labeling waste containers to allow identifying and specifying describing precisely their content. This is necessary for the outsider personnel would be able to observe safety rules. The waste, whose types are not specified are considered hazardous waste and will be subject to the above-given classification.

All containers on site (jugs, roller boxes, barrels, etc.) must have relevant labels to make it clear what kind of waste is to be put in some or other container. In order to avoid misunderstanding, old labels must be removed.

The informative warning signs under the legislation of Georgia are given below.

 No Smoking	 Subject to recycling	 For domestic waste	 Fire-hazardous
 Explosive substance and make	 Toxic gas and substance	 Inflammable gas and liquid	 Inflammable solid substance
 Other hazardous substance and make	 Self-ignition substance	 Non-toxic gas	 Hazardous under water action
 Infection danger	 Oxidizing substance	 Corrosive substance	 Radioactive substance

Storage of waste:

The waste must remain on site for the least possible time and must be removed for processing or destruction as soon as possible.

The waste storage sites must be shown on the relevant facility plan. The waste must be stored in the manner as to exclude:

- Accidental leakage and spills, pollution of ground or underground waters, breaking of containers due to accidental crash, contact with air during secondary packing and/or using the caps;
- Container corrosion or ware under the action of environment or remains in them. For this reason, the containers resistant to concrete waste must be selected, e.g. car batteries must be placed on the plastic boards resistant to corrosion;
- Theft due to unsafe storage of waste within the protected perimeter of the object.

The waste containers must comply with the sizes, shape, content and class of hazard of the waste to store in them. Only good containers must be used, with well their caps locked trouble-free. The containers which may react with its content, or from which hazardous substance may leak out, are inadmissible to us. Only one type of hazardous waste can be placed in one container. It is inadmissible to mix solid and liquid wastes.

Accumulation or storage the waste for long on the territory of the enterprise is inadmissible. It is admissible to accumulate or store the waste for a short term, if:

- The waste is used in the following technological cycle with total utilization;
- There is no user present, etc.
- Following the toxicological and physical-chemical properties of the waste and its components, their temporary storage is inadmissible;
- Temporary storage is admissible in a non-stationary warehouse;
- On the open ground;
- The places of temporary storage on the territory of the object are specified during the inventory of the waste and must comply with the following requirements;
- The ground cover must be hard (concrete, reinforced concrete or concrete slabs);
- Fencing or embankment must be provided along the whole perimeter of the ground to prevent the harmful substances from getting in the sewerage or soil;
- The ground must have a suitable access road;
- The waste must be efficiently protected against atmospheric precipitations and wind (by using a shed, placing waste in tare, containers, etc.).

In case of temporary storage of w n non-stationary warehouses or on the grounds the following conditions must be observed: the possibility of the waste to get in the effluent waters or on the soil must be exclude.

Hazardous waste can be stored temporarily in a stationary warehouse and a special warehouse is to be assigned on the territory for this purpose, by observing the environmental requirements, in particular:

- The floor and walls of the warehouse must be faced with ceramic tiles;
- The warehouse ceiling must be painted with a wet-resistant paint;
- The warehouse must be equipped with the following appliances:
- Exhaust ventilation system;
- Wash-bowl and tap to water and wash the territory;
- Floor drain;
- There must be gratings on the door and windows;
- Shelves must be provided for the waste;
- The waste is admissible to store only in hermetic tare, packed, with relevant labeling.

Removal of hazardous waste from the territory of the enterprise and its further management must be provided by the company duly licensed for this activity.

The rule to hand over the waste

Waste must be handed over by filling in the relevant waste handing form. In all cases, the following information is required:

- Date of handing over, by indicating the waste amount;
- Information about the waste producer;
- Information about the waste transportation company;
- Information about the waste receiving company;
- Signatures of the producing, transportation and receiving companies.

The filled-in form of waste handing over must be enclosed to all waybills from the waste origination place to the object treatment or destruction point, i.e. to the wastewater treatment plant, crematorium, landfill, etc.

Each waste hand over form must give a full description of waste, its content, production process, packing rule, total amount of the handed-over waste and other relevant information.

The waste and over form must be filled in 3 copies. A formal procedure of waste hand over is as follows:

- The waste hand over form is signed by duly authorized persons and sub-contractor, who is charged with waste disposal and transportation;
- The first copy remains with the facility and is kept with the achieves;
- The other two copies accompany the waste on their way to processing, neutralizing or place of disposal.
- At the waste receiving object, the transportation company is obliged to have the duly authorized person sign the form, where it must be indicated that the waste was received at the designation point;
- Thereafter, the second copy remains with the receiving object;

- The third copy remains with the transportation company, who takes it to its office;
- By the following term of waste disposal, the transportation company must return the third copy of the form to the waste origination site;
- The third copy will remain with the waste origination site and is kept together with the first copy;
- A photo-copy of the third copy of the form is provided by the waste origination site and is forwarded to the environmental protection department for reporting purposes.

The filled-in forms of waste hand-over are kept for the whole contract period.

The responsible person is obliged not to hand over the waste or sign the waste hand-over form if he has a firm basis to think that the waste did not reach the place of designation in a due manner. A sample of the waste hand-over form is given below.

The waste must remain on the site of accumulation for the least possible time and must be removed for processing or destruction as soon as possible.

The waste storage sites must be shown on the facility plan. The waste must be stored in the manner as to exclude:

- Accidental leakage and spills, pollution of ground or underground waters, breaking of containers due to accidental crash, contact with air during secondary packing and/or using the caps;
- Container corrosion or ware under the action of environment or remains in them. For this reason, the containers resistant to concrete waste must be selected, e.g. car batteries must be placed on the plastic boards resistant to corrosion;
- Theft due to unsafe storage of waste within the protected perimeter of the object.

The waste containers must comply with the sizes, shape, content and class of hazard of the waste to store in them. Only good containers must be used, with well their caps locked trouble-free. The containers which may react with its content, or from which hazardous substance may leak out, are inadmissible to us. Only one type of hazardous waste can be placed in one container. It is inadmissible to mix solid and liquid wastes.

Accumulation or storage the waste for long on the territory of the enterprise is inadmissible. It is admissible to accumulate or store the waste for a short term, if:

- The waste is used in the following technological cycle with total utilization;
- There is no user present, etc.
- Following the toxicological and physical-chemical properties of the waste and its components, their temporary storage is inadmissible;
- Temporary storage is admissible in a non-stationary warehouse;
- On the open ground.

The places of temporary storage on the territory of the object are specified during the inventory of the waste and must comply with the following requirements:

- The ground cover must be hard (concrete, reinforced concrete or concrete slabs);
- Fencing or embankment must be provided along the whole perimeter of the ground to prevent the harmful substances from getting in the sewerage or soil;
- The ground must have a suitable access road;
- The waste must be efficiently protected against atmospheric precipitations and wind (by using a shed, placing waste in tare, containers, etc.).

In case of temporary storage of w n non-stationary warehouses or on the grounds the following conditions must be observed: the possibility of the waste to get in the effluent waters or on the soil must be exclude.

Hazardous waste can be stored temporarily in a stationary warehouse and a special warehouse is to be assigned on the territory for this purpose, by observing the environmental requirements, in particular:

- The floor and walls of the warehouse must be faced with ceramic tiles;
- The warehouse ceiling must be painted with a wet-resistant paint;
- The warehouse must be equipped with the following appliances:
  - Exhaust ventilation system;
  - Wash-bowl and tap to water and wash the territory;
  - Floor drain;
  - There must be gratings on the door and windows;
  - Shelves must be provided for the waste;

The waste is admissible to store only in hermetic tare, packed, with relevant labeling.

Removal of hazardous waste from the territory of the enterprise and its further management must be provided by the company duly licensed for this activity.

The rule to hand over the waste:

Waste must be handed over by filling in the relevant waste handing form. In all cases, the following information is required:

- Date of handing over, by indicating the waste amount;
- Information about the waste producer;
- Information about the waste transportation company;
- Information about the waste receiving company;
- Signatures of the producing, transportation and receiving companies.

The filled-in form of waste handing over must be enclosed to all waybills from the waste origination place to the object treatment or destruction point, i.e. to the wastewater treatment plant, crematorium, landfill, etc.

- Each waste hand over form must given the full description of waste, its content, production process, packing rule, total amount of the handed-over waste and other relevant information.

- The waste and over form must be filled in 3 copies. A formal procedure of waste hand over is as follows:
- The waste hand over form is signed by duly authorized persons and sub-contractor, who is charged with waste disposal and transportation;
- The first copy remains with the facility and is kept with the achieves;
- The other two copies accompany the waste on their way to processing, neutralizing or place of disposal.
- At the waste receiving object, the transportation company is obliged to have the duly authorized person sign the form, where it must be indicated that the waste was received at the designation point;
- Thereafter, the second copy remains with the receiving object;
- The third copy remains with the transportation company, who takes it to its office;
- By the following term of waste disposal, the transportation company must return the third copy of the form to the waste origination site;
- The third copy will remain with the waste origination site and is kept together with the first copy;
- A photo-copy of the third copy of the form is provided by the waste origination site and is forwarded to the environmental protection department for reporting purposes.

The filed-in forms of waste hand-over are kept for the whole contract period.

The responsible person is obliged not to hand over the waste or sign the waste hand-over form if he has a firm basis to think that the waste did not reach the place of designation in a due manner. A sample of the waste hand-over form is given below.

Table. Waste hand-over form

№	Information about the waste originator	Information about the waste carrier	Information about the waste receiver	Waste content	Rule/place of origin	Kind of package

№	Type of waste	Amount of waste	Duration of waste origination	Number and name of the vehicle used to transport waste	Driver's signature	Time of removal of the waste from the place of origin	Time of receiving the waste at the receiving point	Waste originator's signature	Waste receiver's dignature

Waste originating organization ______________________________ Seal

Waste receiving organization ______________________________ Seal

(to be filled in 3 copies, with one copy remaining with the waste originator, the second copy is remained with the driver and the third copy is remained with the waste receiver. After transporting the waste, the driver returns his copy to the waste originator).

Transportation of waste:

The waste will be transported with a full compliance with the sanitary and environmental rules and by observing the safety rules to transport hazardous shipments. All operations of waste loading/unloading must be mechanized to the extent possible and must be hermetic.

Loss or scattering of waste must be excluded during the transportation. When transporting hazardous waste to a temporary warehouse, the accompanying person must have a request for hazardous waste certified by the plant manager. The waste carrier ensures the relevant vehicle, loading and transportation of hazardous waste to the relevant location by full observance of sanitary, environmental and safety rules.

As soon as the operation is complete, the vehicle must be duly cleaned, washed and sterilized. The vehicle used to transport the waste must bear relevant warning sign. The waste subject to secondary treatment (recycling) must be taken from the plant territory by a duly licensed contracting company based on the agreement concluded in advance.

Domestic waste is gathered in special containers on the territory of the facility and is disposed by the municipal cleaning company under the schedule envisaged by the relevant agreement.

The personnel (drivers and workers) engaged in the waste transportation must be trained. The following types of risks are associated with the transportation of waste:

- Car accidents;
- Scattering or spill of waste;
- Undue loading of the vehicle.

In order to avoid the above-listed risks, it is necessary:

1. To check if the vehicle operates trouble-free and observe the speed limits;
2. To check how hermetically the containers are closed;
3. To consider the carriage capacity of the vehicles when loading them to avoid vehicle overloading;
4. To place a liquid-impermeable membrane on the vehicle body to maintain the waste on the vehicle body in case of emergency spills or scattering.

Despite the safety measures listed above, if the environmental pollution occurs as a result of an accident, the driver must contact the management of the facility, which must take relevant measures envisaged by the ERP by the emergency response team.

Monitoring of waste management:

During the collection, transportation, utilization, neutralization and disposal of waste effective environmental, sanitary-epidemiological and safety standards must be observed.

The registration of waste origination, neutralization and disposal is provided in a special log. The volume of the disposed or utilized waste must be confirmed in writing.

The entity responsible for waste management is obliged to regularly control the following issues:

- Suitability of the tare consequently collect the waste in it.
- Labeling on the tare;
- State of the temporary storage grounds for waste;
- Amount of accumulated waste and compliance with the standards (visual control);
- Observing the regularity of waste disposal from the territory;
- Observing the requirements of environmental safety and safety techniques.

See the information about the monitoring of the waste originated in the facility operation phase in the table above.

The management of the waste originated at the object (classification, inventory, segregation, collection, storage, handing over, transportation and monitoring) will be done in line with the principles and procedures given above.

13.4 Annex 4. Taxation list of timber resources

Territorial body with land management authority: City Hall of Marneuli Municiplaity

Territory adjacent to village Kapanakhchi -100 559 sq.m

Slope inclination (degree): 5

Number of timber resources with the diameter of 8 cm and more subject to taxation (pcs.), volume (cub.m) according to diameters and species of timber resources

#	Species	Species (Latin name)	Diameter (D)	Number of trees	Volume (V)	Note
1	2	3	4	5	6	7
1	Caspian locust	*Gleditsia caspia*	8	124	2.728	**III-Degree**
			10	85	3.06	
			12	146	7.884	
			14	123	9.348	
			16	110	10.78	
			18	80	10.4	
			20	82	12.3	
			24	56	1.344	
			28	53	15.37	
			32	30	10.5	
			36	17	6.97	
			40	7	3.29	
			44	4	2.2	
			48	1	0.63	
			56	1	0.79	
			60	2	1.78	
Total of Caspian locust				**921**	**99.374**	
2	Silver wattle	*Acacia dealbata*	8	3	0.066	
			10	1	0.036	
			12	5	0.27	
			14	2	0.152	
			16	2	0.196	
			18	1	0.13	
			20	4	0.6	

Total of Silver wattle				**18**	**1.45**		
3	Willow	*Salix magnifica*	16	1	0.11	**V-Degree**	
			18	1	0.14		
			20	3	0.54		
			24	3	0.84		
			28	1	0.4		
			32	1	0.56		
			36	2	1.44		
			40	1	0.93		
Total of Willow				**13**	**4.96**		
4	White poplar	*Populus alba*	16	1	0.131	**III-Degree**	
			32	2	1.34		
			36	1	0.88		
			40	3	3.63		
			44	4	5.64		
			52	1	2.06		
			56	1	2.43		
			68	1	3.74		
			88	1	6.46		
			148	1	16.22		
Total of White poplar				**16**	**42.531**		
5	Silver poplar	*Populus pyramidalis*	8	1	0.027	**III-Degree**	
			12	1	0.67		
			16	1	0.131		
			18	2	0.35		
			28	5	2.445		
			32	5	3.35		
			36	21	18.48		
			40	31	37.51		
			44	4	5.64		
			48	4	6.88		
Total of Silver poplar				**75**	**75.483**		
6	Mulberry	*Morus alba*	8	8	0.176	**V-Degree**	
			10	8	0.304		

			12	10	0.57	
			14	4	0.332	
			16	7	0.77	
			18	3	0.42	
			20	5	0.9	
			24	2	0.56	
			28	1	0.4	
			32	2	1.12	
			36	1	0.72	
Total of Mulberry				**51**	**6.272**	
7	Cherry plum	*Prunus insititia*	8	12	0.216	VII-Degree
			10	3	0.093	
			12	7	0.329	
			14	3	0.201	
			16	1	0.09	
			20	1	0.145	
Total of Cherry plum				**27**	**1.074**	
8	Wallnut	*Juglans regia*	20	3	0.435	V-Degree
			28	3	0.999	Red List
			32	4	1.864	
			52	1	1.41	
Total of Wallnut				11	**4.708**	
9	Mediterranean cypress	*Cupressus sempervirens*	14	1	0.106	III-Degree
			20	2	0.5	
			24	2	0.8	
			28	21	12.18	
			32	40	32.4	
			36	43	46.44	
			40	42	59.22	
			44	38	67.26	
			48	5	10.9	
Total of Mediterranean cypress				**194**	**229.806**	
Total:				**1326**	**465.658**	

Besides, the timber resources with the diameter of <8 cm was registered in the following number					Note
Caspian locust	1125	pcs.	0.1	cub.m	
Silver poplar	11	pcs.	0.002	cub.m	
Silver wattle	72	pcs.	0.05	cub.m	
Mulberry	121	pcs.	0.05	cub.m	
Cherry plum	301	pcs.	0.05	cub.m	
Dog-rose	82	pcs.	0.001	cub.m	
Christ's thorn	250	pcs.	0.002	cub.m	
Blackberry	1290	pcs.	0.001	cub.m	
Total:	**3252**	**pcs.**	**0.256**	**cub.m**	
Sum:	**4578**	**pcs.**	**465.914**	**cub.m**	

Date of the List compilation: 25.04.2019

General Location Plan

Adjacent to village Kapanakhchi of the City Hall of Marneuli Municipality

Area to cut down

Area: 10.0559 Ha

N	X	Y
1	498105	4591277
2	498619	4590302

Territorial body with land management authority: City Hall of Marneuli Municiplaity

Territory adjacent to village Kapanakhchi - 232 687sq.m

Slope inclination (degree): 5.

Number of timber resources with the diameter of 8 cm and more subject to taxation (pcs.), volume (cub.m) according to diameters and species of timber resources

#	Species	Species (Latin name)	Diameter (D)	Number of trees	Volume (V)	Note
1	2	3	4	5	6	7
1	Caspian locust	*Gleditsia caspia*	8	3	0.066	III-Degree
Total of Caspian Locust				**3**	**0.066**	
2	Silver wattle	*Acacia dealbata*	12	1	0.054	III-Degree
			14	2	0.152	
			16	3	0.294	
			18	1	0.13	
			24	3	0.72	
			28	1	0.29	
			32	3	1.05	
Total of Silver wattle				**14**	**2.69**	
3	Plane tree	*Platanus*	16	1	0.131	III-Degree
			32	1	0.67	
			40	2	2.42	
			44	3	4.23	
			48	4	6.88	
			60	1	2.84	
Total of Plane tree				**12**	**17.171**	
4	White poplar	*pul us alb*	84	1	5.87	III-Degree

			200	1	22.01	
	Total of White poplar			**2**	**27.88**	
5	Silver poplar	*Populus pyramidalis*	68	1	3.74	**III-Degree**
	Total of Silver poplar			**1**	**3.74**	
6	Mulberry	*Morus alba*	8	2	0.044	**V-Degree**
			10	1	0.038	
			12	7	0.399	
			14	4	0.332	
			16	9	0.99	
			18	7	0.98	
			20	16	2.88	
			24	25	7	
			28	8	3.2	
			32	17	9.52	
			36	4	2.88	
			40	10	9.3	
			44	3	3.48	
			48	2	2.84	
			52	1	1.71	
			64	1	2.72	
			148	1	14.11	
	Total of Mulberry			**118**	**62.423**	
7	Cherry plum	*Prunus insititia*	8	1	0.018	**VII-Degree**
			18	1	0.12	
			20	1	0.145	
			24	1	0.233	
	Total of Cherry plum			**4**	**0.516**	
8	Wallnut	*Juglans regia*	16	1	0.11	**V-Degree**
			20	4	0.72	**Red List**
			24	3	0.84	

			28	2	0.8	
			32	1	0.56	
			36	1	0.72	
			44	1	1.16	
	Total of Wallnut			**13**	**4.91**	
9	Mediterranean cypress	*Cupressus sempervirens*	8	33	0.759	**V-Degree**
			10	22	0.858	
			12	19	1.14	
			14	51	4.539	
			16	52	6.5	
			18	40	6.6	
			20	38	7.98	
			24	6	2.04	
			28	4	1.96	
			32	1	3.68	
	Total of Mediterranean cypress			**266**	**36.056**	
10	Pine	*Pinus nigra*	12	1	0.065	**V-Degree**
			14	1	0.091	
			16	6	0.78	
			18	11	1.815	
			20	26	5.2	
			24	18	5.76	
			28	18	7.92	
			32	13	7.93	
			36	18	14.58	
			40	16	16.64	
			44	3	3.84	
	Total of Pine			**131**	**64.621**	
11	Deodar cedar	*Cedrus deodara*	28	2	0.98	**V-Degree**
			32	1	3.68	
	Total of Deodar cedar			**3**	**4.66**	
		ce				
12	Box elder	*nu s ex*	10	1	0.023	**VI-Degree**

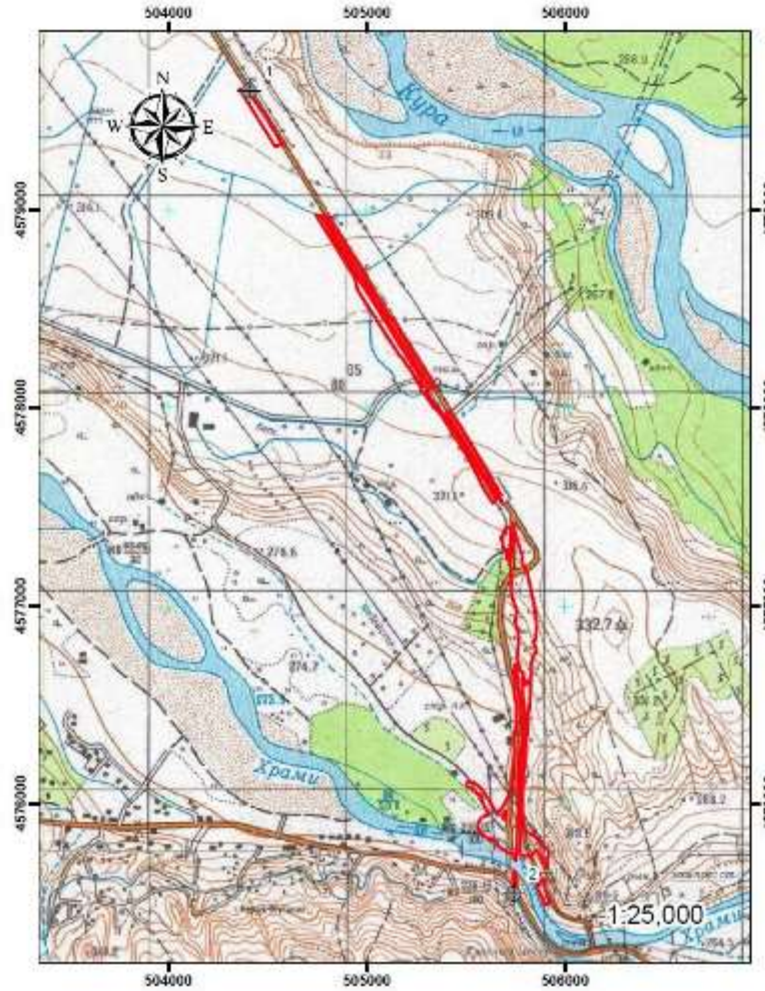
			12	4	0.18	
			14	1	0.065	
			20	3	0.471	
			24	1	0.256	
			28	1	0.356	
Total of Box elder				**11**	**1.351**	
13	Oak	*Quercus iberica*	16	1	0.09	**VI-Degree**
			20	1	0.157	
Total of oak				**2**	**0.247**	
14	Field maple	*Acer campestre*	28	1	0.356	**VI-Degree**
Total of Field maple				**1**	**0.356**	
15	Lime	*Tilia caucasica*	12	2	0.09	**VI-Degree**
			14	3	0.195	
			16	2	0.18	
			18	5	0.61	
			20	9	1.413	
			24	9	2.304	
			28	7	2.492	
			32	3	1.5	
			36	1	0.623	
Total of Lime				**41**	**9.407**	
16	Shamrock	*Malus sylvestris*	20	1	0.145	**VII-Degree**
Total of Shamrock				**1**	**0.145**	
17	Wild apricots	*Prunu s armen a ac*	12	1	0.047	**VII-Degree**
			18	5	0.6	

			20	1	0.145	
			24	3	0.699	
			32	1	0.466	
	Total of Wild apricots			**11**	**1.957**	
18	Elm tree	*Ulmus foliacea*	8	1	0.018	**VII-Degree**
			16	5	0.45	
			28	2	0.666	
			32	2	0.932	
			36	1	0.61	
			44	1	0.965	
	Total of Elm trees			**12**	**3.641**	
19	Hawthorn	*Crataegus microphylla*	8	1	0.018	**VII-Degree**
			10	1	0.031	
			14	2	0.134	
			24	1	0.233	
	Total of Hawthorn			**5**	**0.416**	
20	Hackberries	*Celtis dlabrata*	16	1	0.09	**VII-Degree**
						Red List
	Total of Hackberries			1	**0.09**	
	Sum:			**652**	**242.343**	

Besides, the timber resources with the diameter of <8 cm was registered in the following number					**Note**
Box elder	27	pcs.	0.002	cub.m	
Lime	30	pcs.	0.003	cub.m	
Hawthorn	140	pcs.	0.05	cub.m	
Syringa	300	pcs.	0.01	cub.m	
Pomegranate	40	pcs.	0.005	cub.m	
Hackberries	10	pcs.	0.002	cub.m	Red List
Cherry plum	50	pcs.	0.005	cub.m	
Dog-rose	155	pcs.	0.001	cub.m	
Christ's thorn	23	pcs.	0.001	cub.m	
Blackberry	850	pcs.	0.001	cub.m	

Total		1625	pcs.	0.08	cub.m	
Sum		2277	pcs.	242.423	cub.m	

Date of the List compilation: 25.04.2019



General Location Plan

Adjacent to village Kapanakhchi

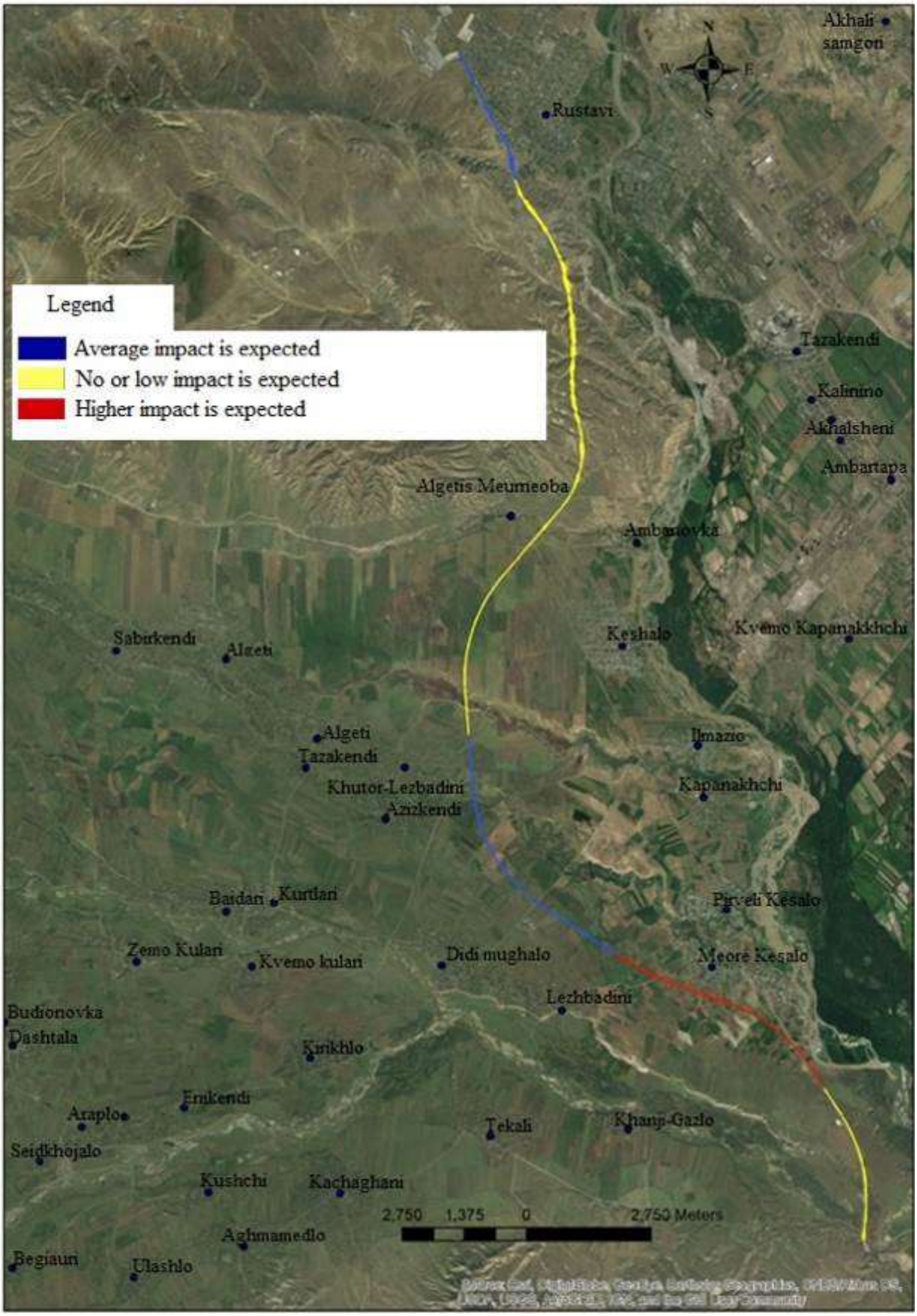
of the City Hall of Marneuli Municipality

Area to cut down

Area: 23.2687 Ha

N	X	Y
1	504406	4579602
2	505738	4575545

13.5 Appendix 5. Comparative values of expected impacts along different sections of the project corridor

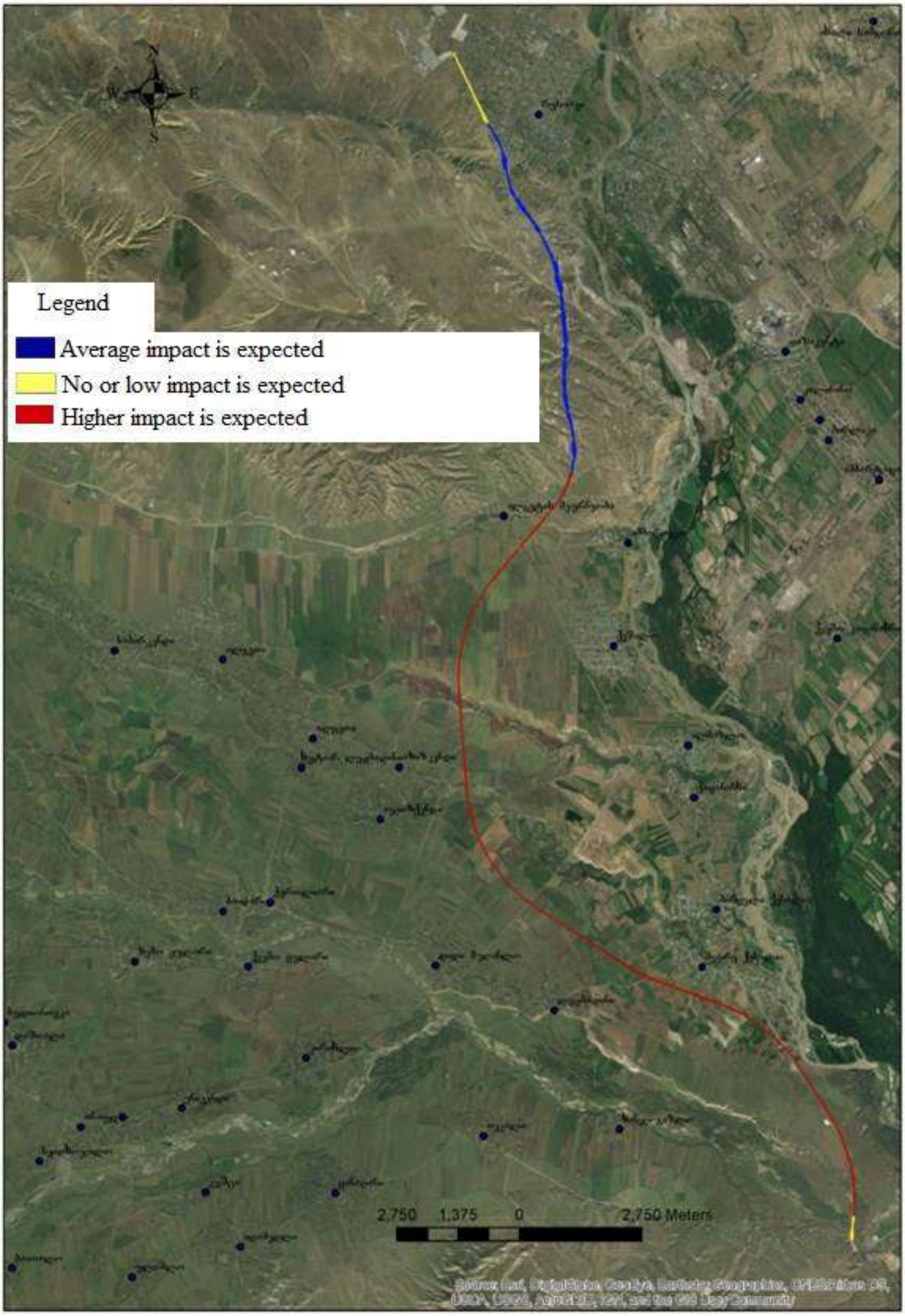


Co

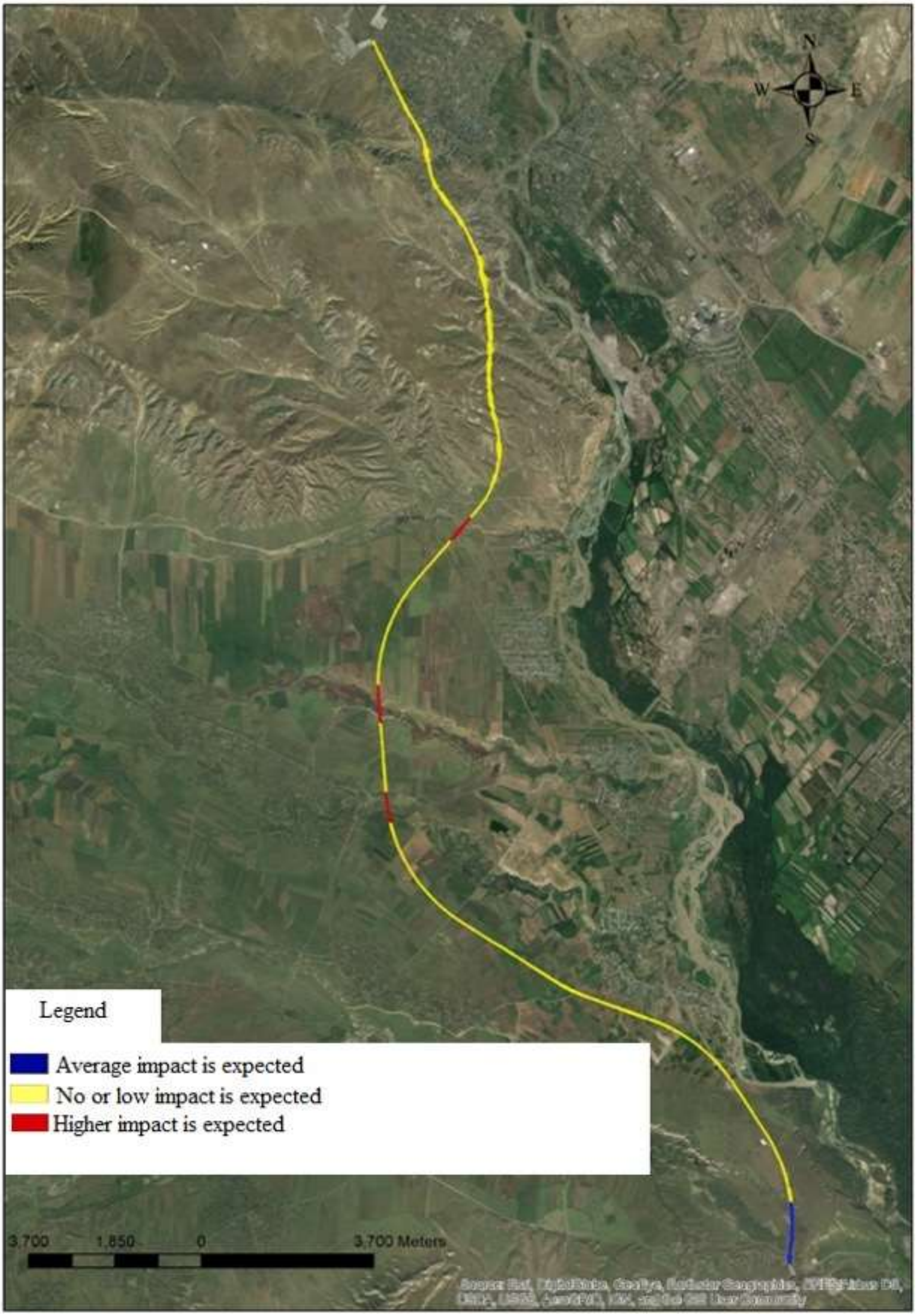
The value of impact on the geological environment along different sections of the Highway

Relative value of the impact on surface water quality along different sections of the Highway

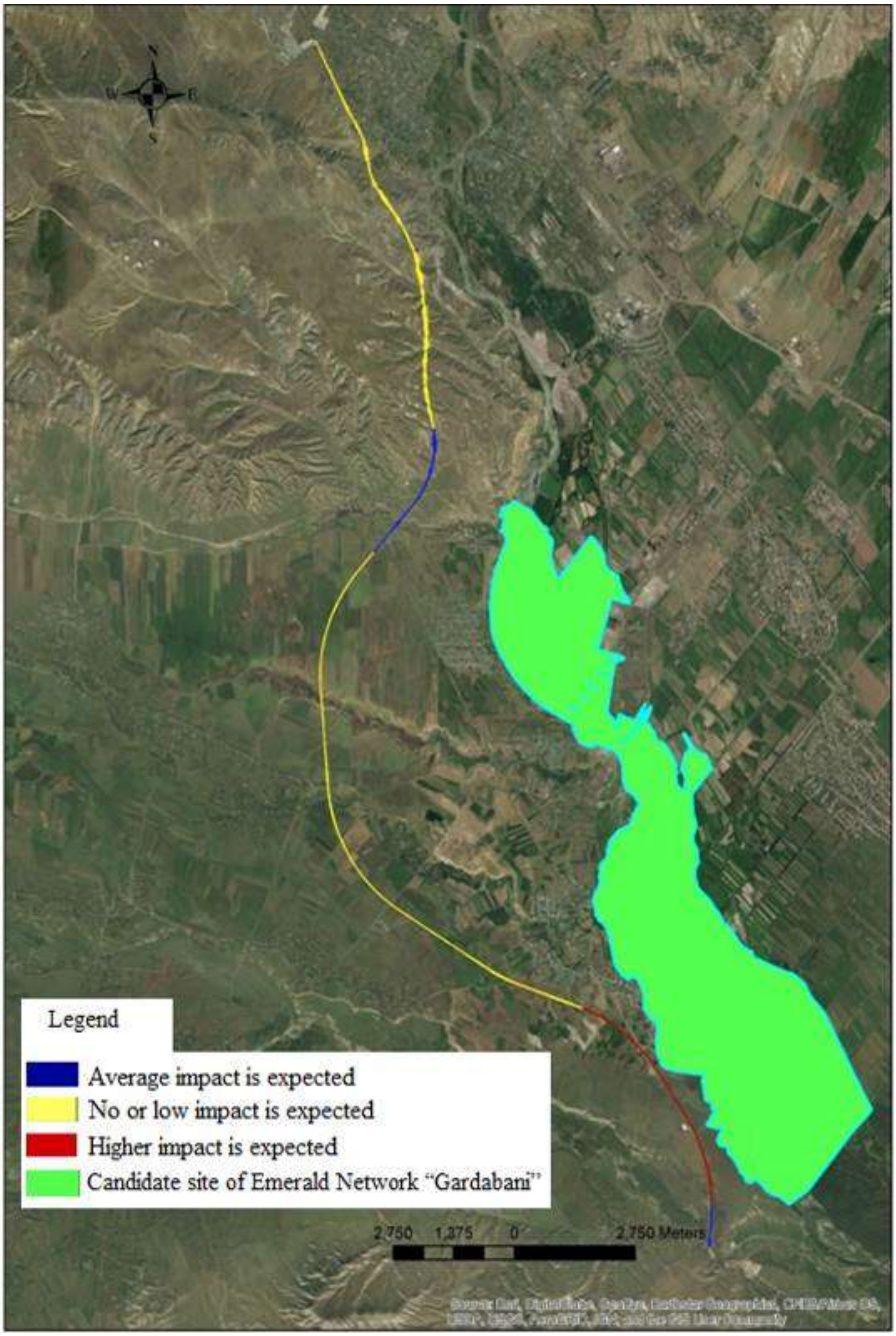
Relative value of impact on soil along the different sections of the design corridor



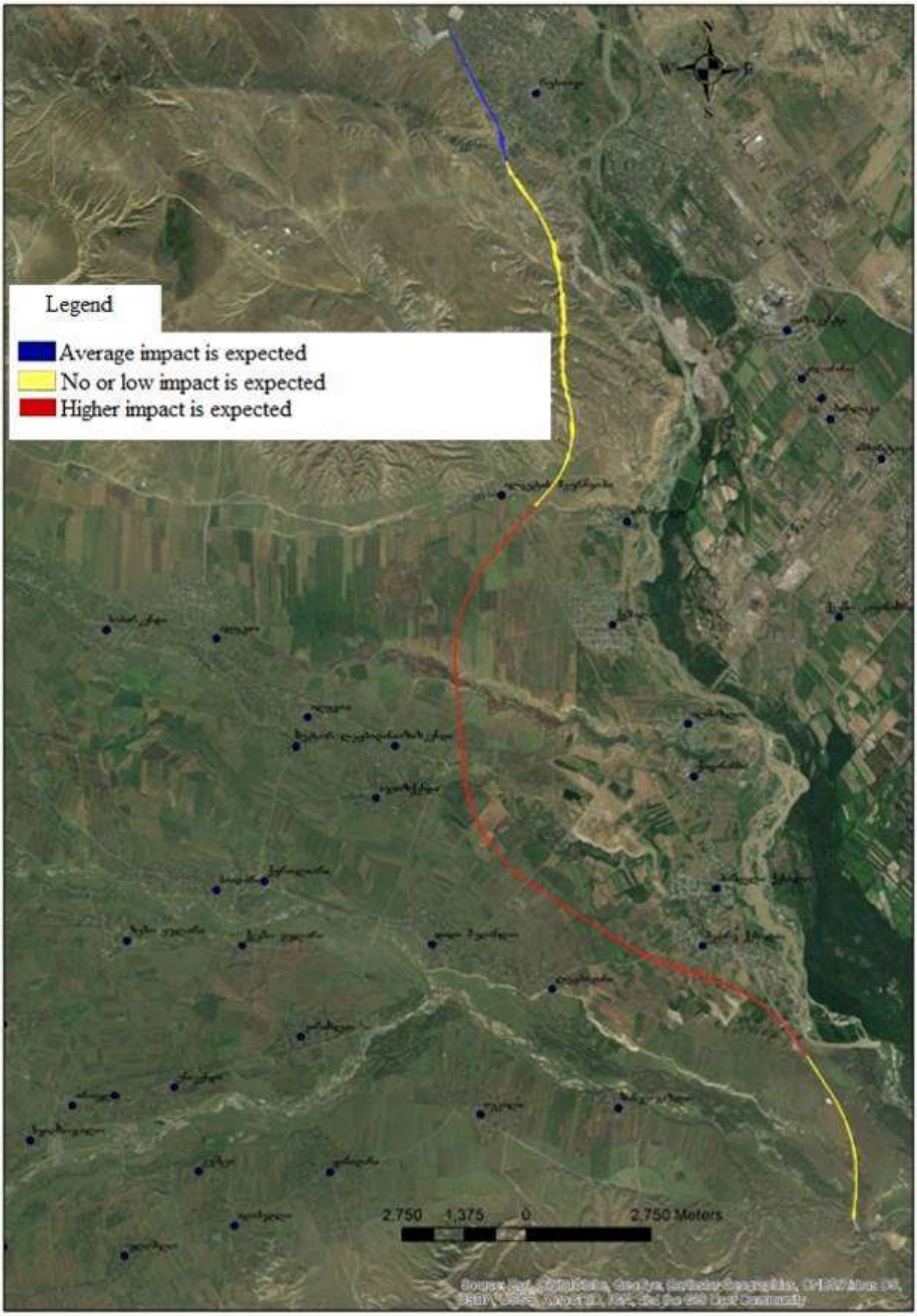
Relative value of the impact on biodiversity along the different sections of the design corridor



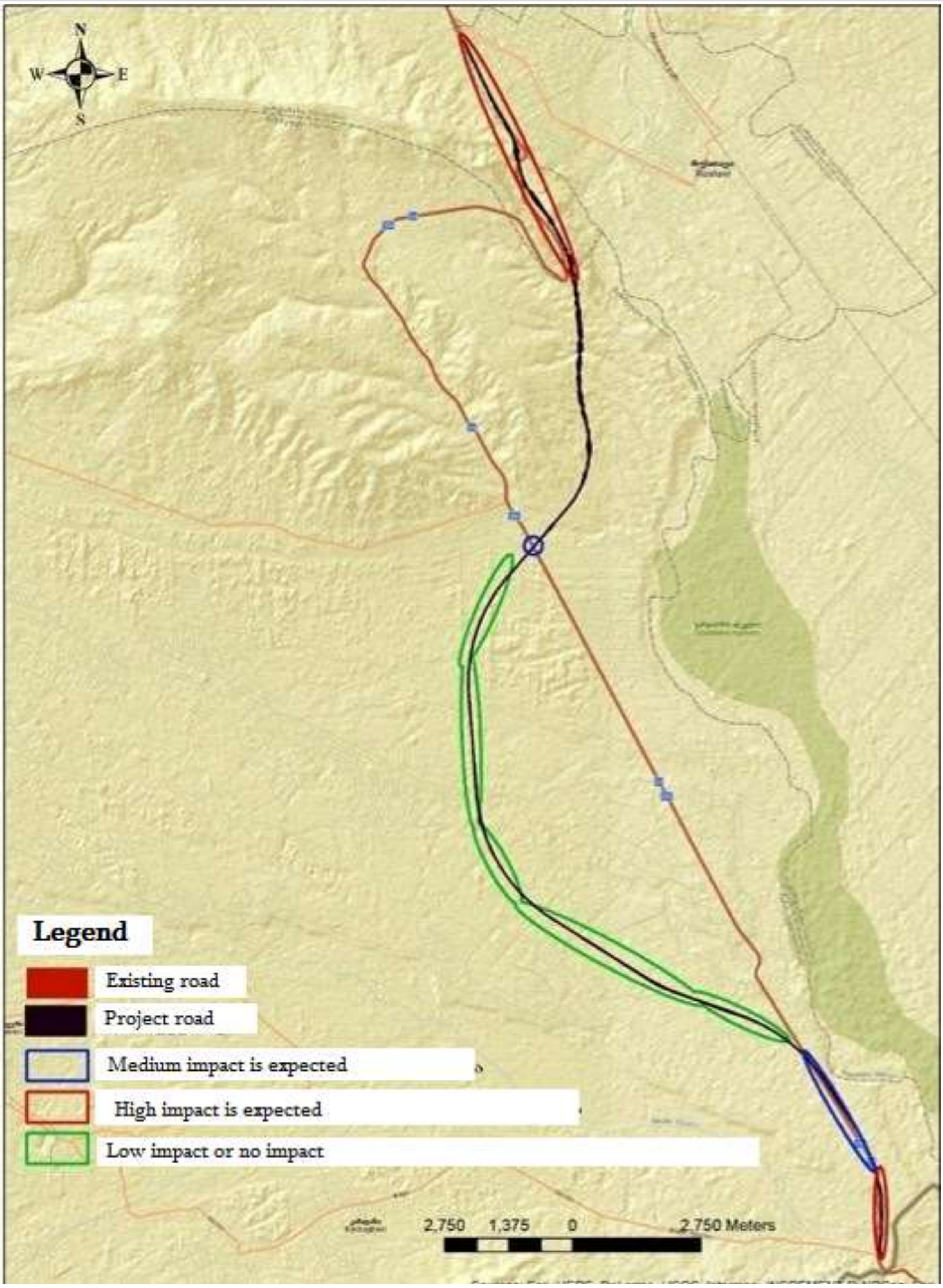
Locations of the design corridor and the protected areas in relation to one another, comparative value of the expected impact along different road sections



Relative value of social impacts along the different sections of the design road



Relative value of the impact on traffic flows along the different sections of the design corridor



13.6 Annex 6

УПРЗА ЭКОЛОГ, V. 3.1

Enterprise #12609 Construction camp

Option of the initial data: 1, new option of the initial data
Calculation option: New calculation option
Calculation provided: for summer
Calculation module: "ОНД-86"
Calculation constants: E1= 0.01, E2=0.01, E3=0.01, S=999999.99 sq.km

Meteorological parameters

Average temperature of the hottest month	31.9° C
Average temperature of the coldest month	0.3° C
Coefficient dependant on the atmospheric air stratification temperature	200
Maximum wind velocity for specific location (reoccurrence of excession within 5% limits)	12,5 m/sec

Structure of thr enterprise (grounds, shop)

Number	Description of the ground (shop)

Parameters of Emission Sources

Registration:

Considered issues:
"%" – The source is considered excluding the background;
"+" - The source is considered without excluding the background;
"-"The source is not considered and its contribution is not included in the background.
In case of absence of marking, no emission source is considered.

Types of sources:
1 – Point;
2 – Linear;
3 – Unorganized;
4 – A set of point sources combined as a single plane source for calculation purposes;
5 – Unorganized, with emissions variable in time;
6 – Point, with umbrella-like or horizontal emission;
7 – A set of point sources with umbrella-like or horizontal emission;
8 – Motorway.

Registration during calculation	Ground #	Shop . #	Source #	Source	Option	Type	Source height (m)	Diameter (m)	Gas-air mixture volume (m3)	Gas-air mixture velocity(m/sec)	Gas-air mixture temperat. (°C)	Relief coefficient	Coordinate. X1 axis (m)	Coordinate. Y1 Axis (m)	Coordinate. X2 axis (m)	Coordinate. Y2 axis (m)	Source Width (m))
%	0	0	1	Cement silo 1								1,0	0,0	0,0	0,0	0,0	0,00

Subst. code	Substance	Emission (gr/sec)	Emission (t/year)	F	summer.: Cm/MAC	Xm	Um	wint.: Cm/MAC	Xm	Um
2908	Inorganic dust: 70-20% SiO2	0.0140000	0,0000000	1	0,039	57	0,5	0,141	28,3	0,5

Subst. code	Substance	Emission (gr/sec)	Emission (t/year)	F	summer.: Cm/MAC	Xm	Um	wint.: Cm/MAC	Xm	Um
0301	Nitrogen dioxide (Nitrogen (IV) oxide)	0.0220090	0,0000000	1	0,463	28,5	0,5	0,463	28,5	0,5
0304	Nitrogen (II) oxide (Nitrogen oxide)	0.0035760	0,0000000	1	0,038	28,5	0,5	0,038	28,5	0,5
0328	Carbon (Soot)	0.0024220	0,0000000	1	0,068	28,5	0,5	0,068	28,5	0,5
0330	Sulphur dioxide	0.0032660	0,0000000	1	0,039	28,5	0,5	0,039	28,5	0,5
0337	Carbon oxide	0.0625330	0,0000000	1	0,053	28,5	0,5	0,053	28,5	0,5
2732	Oil fraction	0.0096920	0,0000000	1	0,034	28,5	0,5	0,034	28,5	0,5

Registration during calculation	Ground #	Shop . #	Source #	Source	Option	Type	Source height (m)	Diameter (m)	Gas-air mixture volume (m3)	Gas-air mixture velocity(m/sec)	Gas-air mixture temperat. (°C)	Relief coefficient	Coordinate. X1 axis (m)	Coordinate. Y1 Axis (m)	Coordinate. X2 axis (m)	Coordinate. Y2 axis (m)	Source Width (m))
%	0	0	4	Grinding complex	1	3	5,0	0,00	0	0,00000	0	1,0	108,0	-187,0	136,0	-211,0	5,00

Subst. code	Substance	Emission (gr/sec)	Emission (t/year)	F	summer.: Cm/MAC	Xm	Um	wint.: Cm/MAC	Xm	Um
0333	Hydrogen sulphide	0.0000549	0,0000000	1	0,095	17,1	0,5	0,425	7,7	0,5
2754	Saturated hydrogens C12-C19	0.0195451	0,0000000	1	0,271	17,1	0,5	1,210	7,7	0,5

Subst. code	Substance	Emission (gr/sec)	Emission (t/year)	F	summer.: Cm/MAC	Xm	Um	wint.: Cm/MAC	Xm	Um
2908	Inorganic dust: 70-20% SiO2	0.1050000	0,0000000	3	4,421	14,3	0,5	4,421	14,3	0,5

Subst. code	Substance	Emission (gr/sec)	Emission (t/year)	F	summer.: Cm/MAC	Xm	Um	wint.: Cm/MAC	Xm	Um
2908	Inorganic dust: 70-20% SiO2	0.0032507	0,0000000	3	0,137	14,3	0,5	0,137	14,3	0,5

Registration during calculation	Ground #	Shop . #	Source #	Source	Option	Type	Source height (m)	Diameter (m)	Gas-air mixture volume (m3)	Gas-air mixture velocity(m/sec)	Gas-air mixture temperat. (°C)	Relief coefficient	Coordinate. X1 axis (m)	Coordinate. Y1 Axis (m)	Coordinate. X2 axis (m)	Coordinate. Y2 axis (m)	Source Width (m))
%	0	0	6	Receiving and storing inert materials	1	3	5,0	0,00	0	0,00000	0	1,0	95,0	-370,0	197,0	-253,0	80,00

Subst. code	Substance	Emission (gr/sec)	Emission (t/year)	F	summer.: Cm/MAC	Xm	Um	wint.: Cm/MAC	Xm	Um
2908	Inorganic dust: 70-20% SiO2	0.0316746	0,0000000	3	1,334	14,3	0,5	1,334	14,3	0,5

%	0	0	7	Receiving and storing fractioned grit	1	3	5,0	0,00	0	0,00000	0	1,0	18,0	-151,0	165,0	-118,0	50,00

Subst. code	Substance	Emission (gr/sec)	Emission (t/year)	F	summer.:	Cm/MAC	Xm	Um	wint.:	Cm/MAC	Xm	Um
2908	Inorganic dust: 70-20% SiO2	0.0550048	0,0000000	3		2,316	14,3	0,5		2,316	14,3	0,5

%	0	0	5	Band conveyor	1	3	5,0	0,00	0	0,00000	0	1,0	47,0	-56,0	4,0	-21,0	1,00

Emissions from sources for different substances

Registration:

Considered issues:
"%" – The source is considered excluding the background;
"+" - The source is considered without excluding the background;
"-"The source is not considered and its contribution is not included in the background.
In case of absence of marking, no emission source is considered.

Types of sources:
1 – Point;
2 – Linear;
3 – Unorganized;
4 – A set of point sources combined as a single plane source for calculation purposes;
5 – Unorganized, with emissions variable in time;
6 – Point, with umbrella-like or horizontal emission;
7 – A set of point sources with umbrella-like or horizontal emission;
8 – Motorway.

Substance: 0301 Nitrogen dioxide (Nitrogen (IV) oxide)

Ground #.	Shop #.	Source #	Type	Registration	Emission (gr/sec)	F	Summer			Winter		
							Cm/MAC	Xm	Um m/sec)	Cm/MAC	Xm	Um m/sec)
0	0	2	3	%	0.0220090	1	0,4634	28,50	0,5000	0,4634	28,50	0,5000
Total:					**0.0220090**		**0,4634**			**0,4634**		

Substance: 0304 Nitrogen (II) oxide (Nitrogen oxide)

Ground #.	Shop #.	Source #	Type	Registration	Emission (gr/sec)	F	Summer			Winter		
							Cm/MAC	Xm	Um m/sec)	Cm/MAC	Xm	Um m/sec)
0	0	2	3	%	0.0035760	1	0,0376	28,50	0,5000	0,0376	28,50	0,5000
Total:					**0.0035760**		**0,0376**			**0,0376**		

Substance: 0328 Carbon (Soot)

Ground #.	Shop #.	Source #	Type	Registration	Emission (gr/sec)	F	Summer			Winter		
							Cm/MAC	Xm	Um m/sec)	Cm/MAC	Xm	Um m/sec)
0	0	2	3	%	0.0024220	1	0,0680	28,50	0,5000	0,0680	28,50	0,5000
Total:					**0.0024220**		**0,0680**			**0,0680**		

Substance: 0330 Sulphur dioxide

Ground #.	Shop #.	Source #	Type	Registration	Emission (gr/sec)	F	Summer			Winter		
							Cm/MAC	Xm	Um m/sec)	Cm/MAC	Xm	Um m/sec)
0	0	2	3	%	0.0032660	1	0,0393	28,50	0,5000	0,0393	28,50	0,5000
Total:					**0.0032660**		**0,0393**			**0,0393**		

Substance: 0333 Hydrogen sulphide

Ground #.	Shop #.	Source #	Type	Registration	Emission (gr/sec)	F	Summer			Winter		
							Cm/MAC	Xm	Um m/sec)	Cm/MAC	Xm	Um m/sec)
0	0	3	1	%	0.0000549	1	0,0952	17,10	0,5000	0,4247	7,67	0,5000
Total:					0.0000549		0,0952			0,4247		

Substance: 0337 Carbon oxide

Ground #.	Shop #.	Source #	Type	Registration	Emission (gr/sec)	F	Summer			Winter		
							Cm/MAC	Xm	Um m/sec)	Cm/MAC	Xm	Um m/sec)
0	0	2	3	%	0.0625330	1	0,0527	28,50	0,5000	0,0527	28,50	0,5000
Total:					0.0625330		0,0527			0,0527		

Substance: 2732 Oil fraction

Ground #.	Shop #.	Source #	Type	Registration	Emission (gr/sec)	F	Summer			Winter		
							Cm/MAC	Xm	Um m/sec)	Cm/MAC	Xm	Um m/sec)
0	0	2	3	%	0.0096920	1	0,0340	28,50	0,5000	0,0340	28,50	0,5000
Total:					0.0096920		0,0340			0,0340		

Substance: 2754 Saturated hydrogensC12-C19

Ground #.	Shop #.	Source #	Type	Registration	Emission (gr/sec)	F	Summer			Winter		
							Cm/MAC	Xm	Um m/sec)	Cm/MAC	Xm	Um m/sec)
0	0	3	1	%	0.0195451	1	0,2710	17,10	0,5000	1,2095	7,67	0,5000
Total:					0.0195451		0,2710			1,2095		

Substance: 2908 Inorganic dust: 70-20%SiO2

Ground #.	Shop #.	Source #	Type	Registration	Emission (gr/sec)	F	Summer			Winter		
							Cm/MAC	Xm	Um m/sec)	Cm/MAC	Xm	Um m/sec)
0	0	1	1	%	0.0140000	1	0,0390	57,00	0,5000	0,1408	28,34	0,5000
0	0	4	3	%	0.1050000	3	4,4211	14,25	0,5000	4,4211	14,25	0,5000
0	0	5	3	%	0.0032507	3	0,1369	14,25	0,5000	0,1369	14,25	0,5000
0	0	6	3	%	0.0316746	3	1,3337	14,25	0,5000	1,3337	14,25	0,5000
0	0	7	3	%	0.0550048	3	2,3160	14,25	0,5000	2,3160	14,25	0,5000
Total:					0.2089301		8,2467			8,3485		

Source emissions for different total impact groups

Considered issues:
"%" – The source is considered excluding the background;
"+" - The source is considered without excluding the background;
"-"The source is not considered and its contribution is not included in the background.
In case of absence of marking, no emission source is considered.

Types of sources:
1 – Point;
2 – Linear;
3 – Unorganized;
4 – A set of point sources combined as a single plane source for calculation purposes;
5 – Unorganized, with emissions variable in time;
6 – Point, with umbrella-like or horizontal emission;
7 – A set of point sources with umbrella-like or horizontal emission;
8 – Motorway.

Total impact group: 6009

Ground #.	Shop #.	Source #	Type	Registration	Code в-ва	Emission (gr/sec)	F	Summer			Winter		
								Cm/MAC	Xm	Um m/sec)	Cm/MAC	Xm	Um m/sec)
0	0	2	3	%	0301	0.0220090	1	0,4634	28,50	0,5000	0,4634	28,50	0,5000
0	0	2	3	%	0330	0.0032660	1	0,0393	28,50	0,5000	0,0393	28,50	0,5000
Total:						**0.0252750**		**0,5026**			**0,5026**		

Total impact group:6043

Ground #.	Shop #.	Source #	Type	Registration	Code в-ва	Emission (gr/sec)	F	Summer			Winter		
								Cm/MAC	Xm	Um m/sec)	Cm/MAC	Xm	Um m/sec)
0	0	2	3	%	0330	0.0032660	1	0,0393	28,50	0,5000	0,0393	28,50	0,5000
0	0	3	1	%	0333	0.0000549	1	0,0952	17,10	0,5000	0,4247	7,67	0,5000
Total:						**0.0033209**		**0,1345**			**0,4640**		

Total impact group:6046

Ground #.	Shop #.	Source #	Type	Registration	Code в-ва	Emission (gr/sec)	F	Summer			Winter		
								Cm/MAC	Xm	Um m/sec)	Cm/MAC	Xm	Um m/sec)
0	0	1	1	%	2908	0.0140000	1	0,0390	57,00	0,5000	0,1408	28,34	0,5000
0	0	2	3	%	0337	0.0625330	1	0,0527	28,50	0,5000	0,0527	28,50	0,5000
0	0	4	3	%	2908	0.1050000	3	4,4211	14,25	0,5000	4,4211	14,25	0,5000
0	0	5	3	%	2908	0.0032507	3	0,1369	14,25	0,5000	0,1369	14,25	0,5000
0	0	6	3	%	2908	0.0316746	3	1,3337	14,25	0,5000	1,3337	14,25	0,5000
0	0	7	3	%	2908	0.0550048	3	2,3160	14,25	0,5000	2,3160	14,25	0,5000
Total:						**0.2714631**		**8,2993**			**8,4012**		

The calculation was made for different substances (total impact groups)

Code	Substance	MAC	*MAC Correction coefficient / Reference safe impact	Baseline concentration

					Level		
		Type	Reference value	Value used in calculations		Consideration	Interpolation
0301	Nitrogen dioxide (Nitrogen (IV) oxide)	max. amount	0.2000000	0.2000000	1	No	No
0304	Nitrogen (II) oxide (Nitrogen oxide)	max. amount	0.4000000	0.4000000	1	No	No
0328	Carbon (Soot)	max. amount	0.1500000	0.1500000	1	No	No
0330	Sulphur dioxide	max. amount	0.3500000	0.3500000	1	No	No
0333	Hydrogen sulphide	max. amount	0.0080000	0.0080000	1	No	No
0337	Carbon oxide	max. amount	5.0000000	5.0000000	1	No	No
2732	Oil fraction	Referenec safe impact level	1.2000000	1.2000000	1	No	No
2754	Saturated hydrogens C12-C19	max. amount	1.0000000	1.0000000	1	No	No
2908	Inorganic dust: 70-20% SiO2	max. amount	0.3000000	0.3000000	1	No	No
6009	Incomplete total impact group, coefficient "1.6": Total impact group (2) 301 330	Group	-	-	1	No	No
6043	Summarized impact group: Summarized impact group (2) 330 333	Group	-	-	1	No	No
6046	Summarized impact group: Summarized impact group (2) 337 2908	Group	-	-	1	No	No

*Is applied if the use of special normative requirements is absolutely necessary. In case the value of “MAC/SRLI correction coefficient” is changed, with its standard value equaling 1, the values of maximum concentration must be compared not to the coefficient value, but to 1.

Selection of design meteorological parameters during the calculation

Automated selection

Wind velocities are selected automatically

Wind direction

Sector start	Secttor end	Wind selection step
0	360	1

Reference area

Control Sites

№	Type	Full description of the site				Width (m)	Step (m)		Height (m)	Comment
		Middle point coordinates I side (m)		Middle point coordinates II side (m)						
		X	Y	X	Y		X	Y		
1	Given	-2000	-300	1000	-300	2000	100	100	2	

Control points

№	Point coordinates (m)		Height (m)	Type of point	Comment
	X	Y			
5	28,00	566,00	2	500 m zone	N
6	817,00	-206,00	2	500 m zone	E
7	117,00	-910,00	2	500 m zone	S
8	-673,00	-146,00	2	500 m zone	W
1	-1479,00	-393,00	2	Point at the border of the residential zone	The nearest settlement westwards (direct distance 1,33 km)
2	-1005,00	-747,00	2	Point at the border of the residential zone	The nearest settlement South-west (direct distance 1,00 km)
3	-312,00	-1108,00	2	Point at the border of the residential zone	The nearest settlement southwards (direct distance 0,83 km)
4	-149,00	-1267,00	2	Point at the border of the residential zone	The nearest settlement southwards (direct distance 0,89 km)

Calculation results for different substances (design grounds)

Types of points:
0 – User's design point; 1 – A point at the border of the protection zone; 2 - A point at the border of the production zone; 3 - A point at the border of the sanitary-protection zone; 4 - A point at the border of the residential zone; 5 - A point at the border of the accommodation zone.

№	Coordinate X(m)	Coordinate Y(m)	Height (m)	Concentration (MAC share)	Wind direction	Wind velocity	Background (MAC share)	Background before exclusion	Type of point

Substance: 0301 Nitrogen dioxide (Nitrogen (IV) oxide)

8	-673	-146	2	0.02	88	8,36	0.000	0.000	3
5	28	566	2	0.02	190	12,50	0.000	0.000	3
7	117	-910	2	0.01	345	12,50	0.000	0.000	3
6	817	-206	2	0.01	275	12,50	0.000	0.000	3
3	-312	-1108	2	9.9e-3	12	12,50	0.000	0.000	4
2	-1005	-747	2	8.7e-3	55	12,50	0.000	0.000	4
4	-149	-1267	2	8.3e-3	3	12,50	0.000	0.000	4
1	-1479	-393	2	6.1e-3	79	12,50	0.000	0.000	4

Substance: 0304 Nitrogen (II) oxide (Nitrogen oxide)

8	-673	-146	2	1.4e-3	88	8,36	0.000	0.000	3
5	28	566	2	1.2e-3	190	12,50	0.000	0.000	3
7	117	-910	2	1.0e-3	345	12,50	0.000	0.000	3
6	817	-206	2	8.9e-4	275	12,50	0.000	0.000	3
3	-312	-1108	2	8.1e-4	12	12,50	0.000	0.000	4

2	-1005	-747	2	7.1e-4	55	12,50	0.000	0.000	4
4	-149	-1267	2	6.8e-4	3	12,50	0.000	0.000	4
1	-1479	-393	2	5.0e-4	79	12,50	0.000	0.000	4

Substance: 0328 Carbon (Soot)

8	-673	-146	2	2.6e-3	88	8,36	0.000	0.000	3
5	28	566	2	2.2e-3	190	12,50	0.000	0.000	3
7	117	-910	2	1.8e-3	345	12,50	0.000	0.000	3
6	817	-206	2	1.6e-3	275	12,50	0.000	0.000	3
3	-312	-1108	2	1.5e-3	12	12,50	0.000	0.000	4
2	-1005	-747	2	1.3e-3	55	12,50	0.000	0.000	4
4	-149	-1267	2	1.2e-3	3	12,50	0.000	0.000	4
1	-1479	-393	2	8.9e-4	79	12,50	0.000	0.000	4

Substance: 0330 Sulphur dioxide

8	-673	-146	2	1.5e-3	88	8,36	0.000	0.000	3
5	28	566	2	1.3e-3	190	12,50	0.000	0.000	3
7	117	-910	2	1.0e-3	345	12,50	0.000	0.000	3
6	817	-206	2	9.2e-4	275	12,50	0.000	0.000	3
3	-312	-1108	2	8.4e-4	12	12,50	0.000	0.000	4
2	-1005	-747	2	7.4e-4	55	12,50	0.000	0.000	4
4	-149	-1267	2	7.1e-4	3	12,50	0.000	0.000	4
1	-1479	-393	2	5.2e-4	79	12,50	0.000	0.000	4

Substance: 0333 Hydrogen sulphide

6	817	-206	2	2.5e-3	272	12,50	0.000	0.000	3
7	117	-910	2	1.5e-3	13	12,50	0.000	0.000	3
5	28	566	2	1.4e-3	161	12,50	0.000	0.000	3
8	-673	-146	2	1.0e-3	92	12,50	0.000	0.000	3
3	-312	-1108	2	8.1e-4	33	12,50	0.000	0.000	4
4	-149	-1267	2	7.3e-4	22	12,50	0.000	0.000	4
2	-1005	-747	2	5.1e-4	67	12,50	0.000	0.000	4
1	-1479	-393	2	3.3e-4	83	12,50	0.000	0.000	4

Substance: 0337 Carbon oxide

8	-673	-146	2	2.0e-3	88	8,36	0.000	0.000	3
5	28	566	2	1.7e-3	190	12,50	0.000	0.000	3
7	117	-910	2	1.4e-3	345	12,50	0.000	0.000	3
6	817	-206	2	1.2e-3	275	12,50	0.000	0.000	3
3	-312	-1108	2	1.1e-3	12	12,50	0.000	0.000	4
2	-1005	-747	2	9.9e-4	55	12,50	0.000	0.000	4
4	-149	-1267	2	9.5e-4	3	12,50	0.000	0.000	4
1	-1479	-393	2	6.9e-4	79	12,50	0.000	0.000	4

Substance: 2732 Oil fraction

8	-673	-146	2	1.3e-3	88	8,36	0.000	0.000	3
5	28	566	2	1.1e-3	190	12,50	0.000	0.000	3
7	117	-910	2	9.1e-4	345	12,50	0.000	0.000	3
6	817	-206	2	8.0e-4	275	12,50	0.000	0.000	3

3	-312	-1108	2	7.3e-4	12	12,50	0.000	0.000	4
2	-1005	-747	2	6.4e-4	55	12,50	0.000	0.000	4
4	-149	-1267	2	6.1e-4	3	12,50	0.000	0.000	4
1	-1479	-393	2	4.5e-4	79	12,50	0.000	0.000	4

Substance: 2754 Saturated hydrogensC12-C19

6	817	-206	2	7.1e-3	272	12,50	0.000	0.000	3
7	117	-910	2	4.4e-3	13	12,50	0.000	0.000	3
5	28	566	2	3.9e-3	161	12,50	0.000	0.000	3
8	-673	-146	2	2.9e-3	92	12,50	0.000	0.000	3
3	-312	-1108	2	2.3e-3	33	12,50	0.000	0.000	4
4	-149	-1267	2	2.1e-3	22	12,50	0.000	0.000	4
2	-1005	-747	2	1.4e-3	67	12,50	0.000	0.000	4
1	-1479	-393	2	9.3e-4	83	12,50	0.000	0.000	4

Substance: 2908 Inorganic dust: 70-20%SiO2

7	117	-910	2	0.10	0	12,50	0.000	0.000	3
5	28	566	2	0.09	173	12,50	0.000	0.000	3
6	817	-206	2	0.09	271	12,50	0.000	0.000	3
8	-673	-146	2	0.07	93	12,50	0.000	0.000	3
3	-312	-1108	2	0.05	25	12,50	0.000	0.000	4
4	-149	-1267	2	0.04	14	12,50	0.000	0.000	4
2	-1005	-747	2	0.03	64	12,50	0.000	0.000	4
1	-1479	-393	2	0.02	83	12,50	0.000	0.000	4

Substance: 6009 Summarized impact group (2) 301330

8	-673	-146	2	0.01	88	8,36	0.000	0.000	3
5	28	566	2	0.01	190	12,50	0.000	0.000	3
7	117	-910	2	8.4e-3	345	12,50	0.000	0.000	3
6	817	-206	2	7.4e-3	275	12,50	0.000	0.000	3
3	-312	-1108	2	6.7e-3	12	12,50	0.000	0.000	4
2	-1005	-747	2	5.9e-3	55	12,50	0.000	0.000	4
4	-149	-1267	2	5.6e-3	3	12,50	0.000	0.000	4
1	-1479	-393	2	4.1e-3	79	12,50	0.000	0.000	4

Substance: 6043 Summarized impact group (2) 330333

6	817	-206	2	3.3e-3	273	12,50	0.000	0.000	3
8	-673	-146	2	2.3e-3	90	12,50	0.000	0.000	3
7	117	-910	2	1.5e-3	13	12,50	0.000	0.000	3
5	28	566	2	1.4e-3	161	12,50	0.000	0.000	3
3	-312	-1108	2	8.4e-4	12	12,50	0.000	0.000	4
2	-1005	-747	2	8.4e-4	57	12,50	0.000	0.000	4
1	-1479	-393	2	7.9e-4	81	12,50	0.000	0.000	4
4	-149	-1267	2	7.3e-4	22	12,50	0.000	0.000	4

Substance: 6046 Summarized impact group (2) 337 2908

7	117	-910	2	0.10	0	12,50	0.000	0.000	3
5	28	566	2	0.09	173	12,50	0.000	0.000	3
6	817	-206	2	0.09	272	12,50	0.000	0.000	3

8	-673	-146	2	0.07	93	12,50	0.000	0.000	3
3	-312	-1108	2	0.05	25	12,50	0.000	0.000	4
4	-149	-1267	2	0.04	14	12,50	0.000	0.000	4
2	-1005	-747	2	0.03	63	12,50	0.000	0.000	4
1	-1479	-393	2	0.02	82	12,50	0.000	0.000	4

13.7 Appendix 7 Results of Noise Modeling: Existing, Construction and Operation Stages (2020 and 2025)

Structure	
1	Picture of the village
2	Numbering of houses
3	Table of noise level excess
4	Information about barriers
5	Fully table of results

1 Rustavi

Location of Rustavi

on the map

Rustavi

Numbers of buildings adjacent to the project zone
The layout of the buildings in Rustavi

Table of excess values										
Rustavi										
	Current		Without Mitigation				With Wall Barriers			
			At present		2025		At present	2025		
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Sum of excess (number of Buildings)	18	24	0	0	10	4	0	0	1	1

Barriers		
Wall N	Length (m)	High (m)
1	50	4
2	50	4

Rustavi													
						No Mitigation				Wall Barriers			
Building N	Distance from the noise sources	current		Construction phase	Distance from the source of noises operation phase	Operation phase		2025 yewar		Operation phase		2025 year	
		day	night	day[13]		day	night	day	night	day	night	day	night
1	118	53.3	46.2	60.5	136	54.0	46.5	58.0	50.7	52.5	45.1	56.5	49.3
2	177	45.3	39.4	51.9	190	45.4	38.8	49.4	42.9	44.0	37.3	47.9	41.5
3	170	48.5	41.8	54.3	186	48.8	41.4	52.8	45.6	47.2	39.9	51.2	44.1
4	148	50.6	43.9	58.0	165	52.0	44.6	56.0	48.8	50.3	43.0	54.3	47.2
5	151	50.5	43.8	58.2	165	52.0	44.7	56.0	48.9	50.5	43.3	54.5	47.5
6	50	56.9	49.6	63.3	60	57.3	49.4	61.3	53.5	54.9	46.9	58.9	51.0
7	45	57.1	50.0	64.1	62	57.2	49.5	61.1	53.6	55.8	48.1	59.8	52.3
8	21	62.2	54.8	67.2	42	60.1	52.2	64.1	56.3	58.0	50.2	62.0	54.3
9	55	56.7	49.5	63.3	79	56.6	48.7	60.6	52.9	55.0	47.1	59.0	51.3
10	36	60.9	53.6	65.8	65	59.1	51.2	63.1	55.4	58.2	50.3	62.2	54.5
11	7	65.0	57.7	67.0	44	60.2	52.3	64.2	56.5	59.8	52.0	63.8	56.1
12	10	64.2	56.8	65.9	46	58.8	50.9	62.8	55.0	58.6	50.8	62.6	54.9
13	16	63.5	56.1	64.9	57	57.9	50.1	61.9	54.3	57.7	49.9	61.7	54.1
14	17	62.3	54.9	63.2	60	56.5	48.9	60.5	53.1	56.5	48.9	60.5	53.1
15	20	62.4	55.1	61.9	79	54.7	47.5	58.7	51.6	54.5	47.3	58.5	51.4
16	104	51.2	44.6	58.6	126	52.1	44.7	56.1	48.6	51.2	43.8	55.1	48.0
17	82	53.1	46.2	60.3	102	53.6	45.8	57.5	49.9	53.0	45.2	57.0	49.4
18	81	53.0	45.9	59.8	108	53.4	45.6	57.4	49.8	52.6	45.0	56.6	49.2
19	85	52.5	45.4	59.7	110	53.3	45.7	57.2	49.4	51.3	43.9	55.3	48.0
20	85	50.9	44.0	57.8	111	51.1	43.7	55.1	47.9	49.5	42.2	53.5	46.3
21	58	55.5	48.4	62.0	87	55.3	47.6	59.3	51.8	55.2	47.4	59.2	51.6
22	41	57.2	50.0	62.7	77	56.1	48.3	60.1	52.4	55.3	47.4	59.2	51.6
23	44	54.2	47.2	59.1	87	53.1	45.4	57.1	49.5	52.4	44.7	56.4	48.8
24	65	55.7	48.5	55.8	123	48.9	41.6	52.9	45.8	48.9	41.6	52.9	45.8
25	73	56.9	49.7	54.5	151	47.8	40.7	51.8	44.9	47.8	40.7	51.8	44.9

[13] No construction works will be accomplished at night.

26	41	60.0	52.9	54.5	154	48.4	41.3	52.4	45.5	48.3	41.2	52.3	45.4
27	43	60.1	52.9	51.5	181	45.3	38.5	49.3	42.7	45.2	38.3	49.2	42.5
28	43	54.4	48.0	52.4	200	43.7	36.6	47.7	40.8	43.7	36.6	47.7	40.8
29	54	56.2	49.7	55.9	130	47.3	40.1	51.3	44.2	47.3	40.1	51.3	44.2
30	36	58.2	51.7	63.3	79	55.5	47.9	59.5	52.0	55.5	47.9	59.5	52.0
31	190	48.8	42.5	59.8	99	51.6	44.5	55.6	48.6	51.6	44.5	55.6	48.6

	Noise level is within the admissible limits
	Noise level exceeds the admissible value by ≥4 dB
	Noise level exceeds the admissible value by 0-3 dB
	Noise level exceeds the admissible value by 3-4 dB

2. Algetis Meurneoba

Location of Algetis
Meurneoba on the map

Algetis meurneoba

Numbering of buildings adjacent to the project zone

Table of excess values										
Algetis meurneoba										
	Current		Without Mitigation				With Wall Barriers			
			current		2025		current	2025		
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Sum of excess (number of Buildings)	2	3	0	1	0	3	0	0	0	0

Locations and sizes of barriers Barriers		
Wall N	Length (m.)	High (m.)
1	100	4

Algetis meurneoba														
						No Mitigation				Wall Barriers				
Building N	Distance from the source of noise	Current		Construction	Distance from the source of noise	After construction		2025		After construction		2025		
		Day	Night			Day	Nigh	Day	Night	Day	Night	Day	Night	
32	370	43.5	38.0	55.8	227	52.1	45.8	53.1	46.7	51.3	44.1	52.3	45.0	
33	302	44.4	38.8	51.9	289	49.8	44.2	50.8	45.2	49.0	43.5	50.1	44.4	
34	390	39.6	34.8	55.0	240	51.6	45.0	52.6	46.0	50.4	44.0	51.4	44.9	
35	329	38.1	33.3	48.1	355	45.5	39.6	46.5	40.5	44.8	38.9	45.8	39.8	
36	187	47.3	42.0	48.5	451	45.8	40.2	46.8	41.1	45.3	39.6	46.3	40.5	
37	209	44.7	38.9	47.4	470	44.5	38.9	45.5	39.8	43.9	38.1	44.9	39.1	
38	170	44.0	37.8	45.0	481	42.8	37.4	43.8	38.3	42.5	37.1	43.5	38.0	
39	152	47.4	40.9	47.0	491	43.4	38.1	44.5	39.0	42.7	37.3	43.7	38.2	
40	135	46.6	40.1	46.4	483	42.4	37.1	43.5	38.0	41.7	36.2	42.7	37.1	
41	116	49.3	43.4	45.7	490	41.4	35.9	42.4	36.9	40.6	35.1	41.6	36.0	
42	79	51.9	46.2	44.3	500	42.3	36.9	43.3	37.8	42.3	36.9	43.3	37.8	
43	110	51.0	45.3	48.5	460	46.5	40.8	47.5	41.8	46.0	40.3	47.0	41.2	
44	43	55.6	49.7	43.0	540	43.6	38.4	44.6	39.3	43.4	38.2	44.4	39.1	
45	12	64.2	57.2	44.6	520	43.6	38.4	44.7	39.3	43.2	38.0	44.3	38.9	

	Noise level is within the admissible limits
	Noise level exceeds the admissible value by ≥4 dB
	Noise level exceeds the admissible value by 0-3 dB
	Noise level exceeds the admissible value by 3-4 dB

3. Azizkendi

Location of Azizkendi
on the map

Azizkendi

The layout of the buildings in Azizkendi

<table>
<tr><td colspan="7">Table of excess values</td></tr>
<tr><td colspan="7">Azizkendi</td></tr>
<tr><td rowspan="3"></td><td colspan="2" rowspan="2">Current</td><td colspan="4">Without Mitigation</td></tr>
<tr><td colspan="2">At present</td><td colspan="2">2025</td></tr>
<tr><td>Day</td><td>Night</td><td>Day</td><td>Night</td><td>Day</td><td>Night</td></tr>
<tr><td>Sum of excess (number of Buildings)</td><td></td><td></td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>

Azizkendi						
			No Mitigation			
Building N	Construction	Distance from the source of noise	After construct ion		2025	
			Day	Nigh	Day	Night
46	45.3	496	43.6	41.2	44.6	42.2
47	44.1	520	43.3	41.0	44.3	42.0
48	42.7	536	40.1	37.7	41.1	38.7
49	44.2	562	41.1	38.7	42.1	39.7
50	43.4	623	42.1	39.8	43.1	40.8
51	46.5	548	43.6	40.9	44.6	41.9
52	45.4	625	42.9	40.5	43.9	41.5
53	42.3	656	41.8	39.5	42.8	40.5
54	47.5	504	44.3	41.8	45.3	42.8
55	47.2	600	43.3	40.4	44.3	41.4
56	43.4	634	40.7	37.9	41.7	38.9
57	46.7	592	43.7	40.8	44.7	41.8
58	45.6	620	42.3	39.3	43.3	40.3
59	45.6	658	43.6	40.9	44.6	41.9
60	44.5	658	43.2	40.5	44.2	41.5
61	49.6	481	45.2	42.7	46.2	43.7
62	49.7	473	44.7	42.2	45.7	43.2
63	49.3	500	45.0	42.2	46.1	43.2
64	48.9	520	44.6	41.9	45.6	42.9
65	47.2	600	42.5	40.0	43.5	41.0

	Noise level is within the admissible limits
	Noise level exceeds the admissible value by ≥4 dB
	Noise level exceeds the admissible value by 0-3 dB
	Noise level exceeds the admissible value by 3-4 dB

4. Meore kesalo

Location of Meore kesalo on
the map

Meore kesalo

The layout of the buildings in Meore Kesalo

Table of excess values						
Meore Kesalo						
	Current		Without Mitigation			
			At present		2025	
	Day	Night	Day	Night	Day	Night
Sum of excess (number of Buildings)	0	6	0	0	0	0

Meore kesalo										
						No Mitigation				
Building N	Distance from the source of noise	Current		Construction	Distance from the source of noise	After construction		2025		
		Day	Night			Day	Nigh	Day	Night	
66	>500	25.3	20.7	47.8	471	39.8	36.0	43.4	38.0	
67	>500	26.0	21.3	47.7	484	39.8	36.0	43.5	38.1	
68	>500	24.8	20.0	47.6	481	40.1	36.3	43.8	38.3	
69	>500	28.6	23.9	48.3	514	41.8	38.1	45.5	40.2	

Meore kesalo										
						No Mitigation				
Building N	Distance from the source of noise	Current		Construction	Distance from the source of noise	After construction		2025		
		Day	Night			Day	Nigh	Day	Night	
70	>500	28.1	23.3	46.5	526	42.0	38.4	45.7	40.4	
71	>500	27.8	23.0	46.5	459	39.6	36.0	43.3	38.0	
72	>500	28.6	23.9	48.9	417	41.8	37.9	45.4	40.0	
73	>500	28.6	23.9	46.6	455	39.6	35.8	43.2	37.8	
74	>500	28.5	23.7	48.5	420	41.0	37.3	44.7	39.3	
75	>500	28.7	24.0	49.1	379	44.5	40.6	48.1	42.6	
76	>500	27.5	22.6	49.5	386	43.0	39.3	46.7	41.3	
77	>500	27.9	23.1	49.7	352	43.6	39.7	47.3	41.8	
78	>500	27.0	22.2	49.0	332	44.3	40.3	48.0	42.3	
79	>500	28.4	23.7	50.9	319	43.9	40.1	47.6	42.1	
80	>500	29.0	24.4	51.4	343	44.0	40.2	47.7	42.2	
81	>500	28.2	23.3	46.0	495	41.4	37.8	45.0	39.8	
82	>500	28.5	23.7	47.1	480	41.8	38.2	45.5	40.2	
83	>500	29.2	24.4	47.9	458	41.9	38.2	45.6	40.2	
84	>500	27.7	23.0	52.0	242	46.4	42.3	50.1	44.4	
85	>500	26.3	21.5	55.0	200	47.1	42.9	50.8	44.9	
86	>500	28.0	23.1	51.2	313	45.5	41.3	49.1	43.3	
87	>500	29.2	24.4	55.1	193	47.9	43.6	50.9	45.0	
88	>500	30.0	25.4	56.5	144	47.3	43.3	50.7	45.0	
89	>500	30.5	25.7	49.0	467	42.6	38.9	46.3	41.0	
90	>500	29.9	25.0	48.5	495	42.4	38.8	46.1	40.8	
91	>500	29.0	24.1	46.6	432	40.0	36.3	43.6	38.4	
92	>500	29.0	24.3	50.8	406	42.2	38.5	45.9	40.5	
93	>500	31.3	26.5	50.0	422	43.4	39.6	47.0	41.6	
94	>500	30.5	25.8	52.4	349	44.6	40.7	48.2	42.8	
95	>500	30.0	25.3	53.5	295	44.9	40.9	48.6	42.9	
96	>500	30.4	25.8	51.5	278	44.3	40.3	47.9	42.3	
97	>500	29.7	25.0	52.0	265	44.3	40.3	48.0	42.4	
98	>500	29.9	25.2	51.9	329	44.4	40.4	48.1	42.4	
99	>500	27.5	22.9	55.7	211	45.7	41.6	49.3	43.6	

Meore kesalo									
						No Mitigation			
Building N	Distance from the source of noise	Current		Construction	Distance from the source of noise	After construction		2025	
		Day	Night			Day	Nigh	Day	Night
100	>500	29.7	25.1	54.7	100	45.9	41.9	49.5	43.9
101	>500	28.2	23.3	57.1	211	47.2	43.1	50.9	45.0
102	>500	29.3	24.5	56.0	101	46.9	42.7	50.6	44.7
103	>500	31.4	26.6	55.8	169	47.8	43.4	51.4	45.0
104	>500	30.8	26.1	54.4	188	46.0	42.1	49.7	44.1
105	>500	32.2	27.5	53.4	221	44.3	40.1	47.9	42.1
106	>500	32.4	27.6	54.2	253	44.9	40.7	48.5	42.7
107	>500	32.5	27.8	51.9	276	44.3	40.4	47.9	42.4
108	>500	31.6	26.9	51.8	292	44.4	40.6	48.0	42.6
109	>500	32.2	27.5	48.2	353	41.9	38.1	45.5	40.1
110	>500	30.2	25.4	49.9	371	43.8	40.1	47.5	42.2
111	>500	31.9	27.1	49.2	389	43.9	40.3	47.6	42.3
112	>500	31.9	27.1	50.0	436	43.5	39.8	47.1	41.8
113	>500	32.5	27.8	52.1	436	44.8	40.8	48.4	42.8
114	>500	32.9	28.2	53.3	434	45.1	41.1	48.8	43.1
115	>500	32.8	28.1	52.8	370	44.9	40.7	48.5	42.7
116	>500	31.5	26.9	53.9	368	45.6	41.5	49.2	43.5
117	>500	32.7	28.0	55.4	353	46.8	42.4	50.4	44.4
118	>500	30.1	25.4	53.9	334	45.8	41.6	49.5	43.6
119	>500	31.3	26.5	53.7	271	46.1	41.7	49.8	43.7
120	>500	34.2	29.5	53.8	328	46.1	41.6	49.8	43.6
121	>500	34.1	29.3	50.9	352	42.9	38.7	46.6	40.8
122	>500	35.6	30.9	53.6	389	45.8	41.3	49.5	43.3
123	>500	34.2	29.4	52.4	410	43.3	39.1	47.0	41.1
124	>500	34.6	29.9	53.2	404	44.8	40.6	48.4	42.6
125	>500	35.5	30.7	53.4	410	45.1	40.8	48.8	42.8
126	>500	36.3	31.5	53.5	403	45.3	41.0	49.0	43.0
127	>500	36.9	32.1	53.7	406	45.2	41.0	48.9	43.0
128	>500	37.4	32.6	53.6	415	45.1	41.1	48.7	43.1
129	>500	36.7	31.9	54.9	366	45.4	41.4	49.1	43.4

Meore kesalo									
					No Mitigation				
Building N	Distance from the source of noise	Current		Construction	Distance from the source of noise	After construction		2025	
		Day	Night			Day	Nigh	Day	Night
130	>500	37.9	33.1	53.5	417	44.8	40.8	48.4	42.8
131	>500	38.2	33.4	53.9	414	44.7	40.6	48.4	42.7
132	>500	39.7	34.9	53.1	446	44.4	40.4	48.0	42.4
133	>500	40.8	35.8	53.1	444	43.9	39.8	47.6	41.8
134	>500	40.7	35.6	49.9	512	40.3	36.5	44.0	38.5
135	>500	53.9	47.8	50.3	578	40.1	36.2	43.7	38.2
136	81	49.2	43.5	49.7	605	39.5	35.6	43.1	37.6
137	85	47.4	42.0	48.8	619	39.3	35.5	42.9	37.5
138	82	48.2	42.9	49.3	597	40.2	36.4	43.9	38.4
139	110	47.0	41.8	49.2	608	40.2	36.4	43.8	38.4
140	73	51.7	46.0	50.1	534	40.5	36.6	44.2	38.6
141	167	45.4	40.2	49.6	643	40.0	36.2	43.6	38.2
142	212	42.3	37.2	49.3	677	39.2	35.5	42.9	37.5
143	120	41.9	36.9	47.9	670	39.2	35.5	42.9	37.5
144	222	44.0	39.1	48.1	636	40.5	36.8	44.1	38.8
145	230	43.3	38.4	47.6	640	40.4	36.7	44.1	38.8
146	238	41.8	36.9	47.3	625	40.8	37.1	44.4	39.2
147	208	44.7	39.7	49.9	594	40.5	36.7	44.2	38.8
148	94	50.6	45.1	51.2	510	41.4	37.6	45.1	39.6
149	215	44.9	39.8	50.0	583	39.9	36.0	43.5	38.0
150	214	45.8	40.4	50.6	571	40.4	36.6	44.1	38.6
151	222	46.1	40.7	50.0	590	41.1	37.3	44.8	39.3
152	185	47.1	41.6	51.9	550	42.0	38.0	45.7	40.1
153	221	46.4	41.0	52.3	577	42.9	39.0	46.5	41.0
154	219	45.7	40.5	52.2	552	42.6	38.8	46.3	40.8
155	189	52.4	46.8	52.6	441	41.9	37.9	45.5	39.9
156	74	51.1	45.6	53.2	445	42.5	38.5	46.1	40.5
157	219	49.9	44.4	54.0	449	44.1	40.3	47.8	42.3
158	258	47.2	41.7	52.8	460	44.0	40.2	47.7	42.2
159	265	46.4	41.2	54.3	320	43.6	39.7	47.2	41.7

Meore kesalo									
					No Mitigation				
Building N	Distance from the source of noise	Current		Construction	Distance from the source of noise	After construction		2025	
		Day	Night			Day	Nigh	Day	Night
160	263	51.6	46.0	54.8	350	45.3	41.4	48.9	43.4
161	280	43.5	38.4	53.7	376	43.8	39.9	47.5	41.9
162	281	42.9	37.9	53.7	385	43.5	39.6	47.2	41.6

5. Tsiteli Khidi

Location of Tsiteli
Khidi on the map

Tsiteli Khidi

Numbers of buildings adjacent to the project zone

The layout of the buildings in Tsiteli Khidi

Table of excess values						
Tsiteli Khidi						
	Current		Without Mitigation			
			At present		2025	
	Day	Night	Day	Night	Day	Night
Sum of excess (number of Buildings)	1	2	0	0	0	2

Tsiteli Khidi									
						No Mitigation			
Building N	Distance from the source of noise	Current		Construction	Distance from the source of noise	როცა აშენდება		2025	
		Day	Night			Day	Nigh	Day	Night
163	40	57.2	49.9	69.7	40	57.4	49.7	61.2	54.1
164	163	47.1	41.0	64.2	163	51.8	44.4	55.9	48.7
165	189	44.9	38.9	59.6	189	47.1	40.6	51.2	45.0

166	92	51.6	44.7	57.0	92	44.9	38.5	49.1	42.9
167	240	42.6	37.0	54.6	240	42.5	36.8	46.7	41.1
168	294	41.3	35.6	53.1	294	41.2	35.2	45.3	39.6
169	319	40.8	35.1	53.1	319	40.8	34.7	44.9	39.0
170	372	38.2	32.8	49.8	372	38.2	32.3	42.3	36.7
171	406	38.1	32.6	48.7	406	38.2	32.2	42.3	36.6
172	485	37.1	31.3	47.6	485	37.1	30.9	41.2	35.3
173	98	52.8	45.5	64.0	98	52.9	45.2	56.8	49.5
174	147	48.2	41.3	60.3	147	48.4	40.9	52.5	45.3
175	192	41.7	34.8	57.6	192	46.8	39.2	50.9	43.5
176	163	46.8	39.7	53.2	163	41.7	34.4	45.8	38.7
177	173	45.6	39.0	58.4	173	45.8	38.8	49.9	43.1
178	175	46.6	40.1	58.9	175	46.7	39.8	50.8	44.1
179	246	42.7	35.8	53.7	246	41.8	35.7	45.9	40.1
180	260	42.8	36.1	52.4	260	40.8	34.7	44.9	39.1
181	317	40.9	34.4	53.7	317	42.7	35.4	46.8	39.7
182	255	41.8	36.0	53.8	255	42.7	35.6	46.8	39.9
183	286	40.7	35.0	52.3	286	40.9	34.0	45.0	38.4

13.8 Appendix 8 Laboratory Tests

The boreholes were conducted at the bridge locations, heavy cutting or embankment location. Both the cohesive and non-cohesive soil samples were taken. In order to identify particle size distribution of existing soil, particle size distribution via sieve test were conducted. Based on visual observation of site, test-pits, results of laboratory testing and processing of materials, the consultant obtained following information:

* Physical-mechanical properties of clay soils
* Chemical composition of soils;
* Water chemical composition;
* Particle size distribution of soils
* Atterberg Limits
* Uniaxial &Triaxialtests and shear tests
* Consolidation tests
* UCS tests on rock samples
* PLI (Franklin) test on rock samples

Under the data of field geotechnical and laboratory tests conducted along the project road profile, the following layers were identified based on Engineering Geological Elements (EGE). From the Borehole log sheet the following EGE were established.

* EGE- 1, 1 Pebble (50 ~ 55%) and crushed stone (20 ~ 25%) with sand. It is extended along the road.
* EGE- 2 Brown clay loam with semi-solid consistence. It is extended along the road profile.
* EGE- 3 Crushed-stone (20-25%), pebble (25-30%) and boulders (10-15%). It is extended mainly in the first, foothills part of the section.

Due to the detailed laboratory tests, the large quantity of test results made it possible to carry out statistical analyses of the soil properties determining characteristic parameters for design (EN 1997-1:2006 underlines their optional application explicitly).

In the case of soil properties, a normal distribution often already shows an adequate compliance. Depending on the available data set, much more complex distributions, as e.g. the Weibull distribution or the beta distribution, could give a better compliance with derived values, but in fact, normal and lognormal distribution are well-known and their compliance is often already satisfying.

The principal parameters of the layer are sumarized in the tables below:

Table 13.8.1. Soil parameters in the first part of LOT-1 (km 0-11)
First part of LOT-1 (km 0-11)

			Clay (high plasticity)			
			min	max.	Avg	Char.v.
Gravel content	Gr	[%]	0,0	59,8	11,5	
Sand content	Sa	[%]	15,8	68,9	30,2	
Silt content	Si	[%]	10,5	93,6	43,0	
Clay content	Cl	[%]	20	69	39,9	
Natural moisture content	w	%	5,7	49,2	20,0	15,6
Void ratio			0,3	1,0	0,7	0,6
Degree of *Saturation*		[%]	33,9	100,0	70,3	61,9
Liquid limit	w_L	[%]	31,3	128,0	78,3	67,6
Plastic limit*	w_P	[%]	23,4	47,7	33,6	30,6
Plasticity index	PI	[%]	29,0	89,0	45,9	37,8
Consistency index	CI		0,6	1,6	1,3	1,2
Inner friction angel	φ	°	6,0	27,0	17,2	14,0
Cohesion*	c	kPa	9,0	69,0	41,6	30,2
Bulk density*	ρ	g/cm³	16,5	20,5	18,2	1,78

* Due to the high plasticity index expansive clay should be assumed. In the light of the other test results high quantity of clay minerals could be found in the soil.

** Due to the boring technology the values should be corrected. In the boring process the shale and hard marl have been grinded.

			Clay (medium plascity)			
			min	max.	Avg	Char.v.
Gravel content	Gr	[%]	0,0	53,5	10,1	
Sand content	Sa	[%]	14,6	53,7	33,8	
Silt content	Si	[%]	4,6	56,7	39,2	
Clay content	Cl	[%]	5,0	42,0	15,3	
Natural moisture content	w	%	7,6	30,6	23,0	20,1
Void ratio			0,6	1,0	0,7	0,7
Degree of *Saturation*		[%]	54,5	100,0	86,5	78,8
Liquid limit	w_L	[%]	44,2	69,8	56,9	52,8
Plastic limit	w_P	[%]	22,9	42,3	33,2	29,8
Plasticity index	PI	[%]	17,9	30,2	23,7	21,4
Consisteny index	CI		0,9	2,0	1,5	1,4
Inner friction angel	φ	°				20
Cohesion	c	kPa				30
Bulk desnity	ρ	g/cm³	16,1	20,7	18,9	1,81

			Conglomerate (sandy silty gravel)			
			min	max.	Avg	Char.v.
Gravel content	Gr	[%]	49,1	61,2	55,3	53,3
Sand content	Sa	[%]	14,3	37,5	24,3	20,4
Silt content	Si	[%]	10,4	53,7	23,9	16,6
Clay content	Cl	[%]	1,9	22,0	9,3	6,0
Natural moisture content	w	%	7,6	9,8	8,5	8,0
Liquid limit	w_L	[%]	50,1	75,9	58,7	54,2

Plastic limit	w_P	[%]	22,8	47,6	33,5	29,8
Plasticity index	PI	[%]	19,1	33,5	25,1	22,5
Inner friction angel	φ	°				35
Cohesion	c	kPa				15
Bulk desnity	ρ	g/cm³				1,95

Table 13.8.2 Soil parameters in the second part of LOT-1 (km 11-20)
Second part of LOT-1 (km 11 -20)

			Clay (high plasticity)			
			min	max.	Avg	Char.v.
Sand content	Sa	[%]	0,6	28,9	10,8	6,8
Silt content	Si	[%]	14,1	94,4	59,4	48,7
Clay content	Cl	[%]	5,0	66,0	29,7	20,1
Natural moisture content	w	%	13,1	27,7	21,6	19,4
Void ratio			0,5	0,9	0,7	0,7
Degree of *Saturation*		[%]	61,9	100	89,0	84,0
Liquid limit	w_L	[%]	58,0	82,0	67,5	64,5
Plastic limit	w_P	[%]	18,3	30,4	26,7	25,1
Plasticity index	PI	[%]	25,0	35,8	30,1	28,5
Consisteny index	CI		1,0	1,5	1,2	1,2
Inner friction angel	φ	°	13,5	27,6	19,2	15,9
Cohesion	c	kPa	34,4	8532	59,2	56,0
Bulk desnity	ρ	g/cm³	17,8	22,6	20,1	1,94

			Clay (medium plasticity)			
			min	max.	Avg	Char.v.
Gravel content	Gr	[%]	0,0	69,7	7,9	
Sand content	Sa	[%]	0,0	37,2	16,6	
Silt content	Si	[%]	7,4	86,7	50,7	
Clay content	Cl	[%]	0,5	46,0	24,8	
Natural moisture content	w	%	9,3	23,1	19,0	16,9
Void ratio			0,5	0,7	0,6	0,6
Degree of *Saturation*		[%]	70,5	100,0	88,6	83,1
Liquid limit	w_L	[%]	33,0	60,0	49,4	45,8
Plastic limit	w_P	[%]	17,5	33,9	25,1	22,8
Plasticity index	PI	[%]	15,5	29,3	24,4	22,5
Consisteny index	CI		1,0	2,1	1,3	1,2
Inner friction angel	φ	°				20,4
Cohesion	c	kPa				37,6
Bulk desnity	ρ	g/cm³	18,8	21,3	20,1	1,98

			Silty sand			
			min	max.	Avg	Char.v.
Gravel content	Gr	[%]	2,7	69,7	26,5	
Sand content	Sa	[%]	22,4	83,0	53,0	
Silt content	Si	[%]	7,4	46,4	18,9	
Clay content	Cl	[%]	0,5	16,0	5,3	
Natural moisture content	w	%	6,9	12,8	9,6	8,2
Liquid limit	w_L	[%]	25,3	33,0	28,9	27,1
Plastic limit	w_P	[%]	16,7	26,0	19,4	17,2
Plasticity index	PI	[%]	5,0	15,5	9,5	7,3
Inner friction angel	φ	°				28
Cohesion	c	kPa				10
Bulk desnity	ρ	g/cm³				1,80

Due to the shallow depth of the trial pits the results of relevant laboratory test are characterizing the soil properties occurring close to the terrain surface. The alluvial layers are rather cohesive soils containing some gravel and rock fragments.

Table 13.8.3 Soil parameters of the trial pits

			Sandy silt and clay			
			min	max.	Avg	Char.v.
Gravel content	Gr	[%]	0	5,8	2,1	
Sand content	Sa	[%]	21,5	44,4	31,2	
Silt content	Si	[%]	21,1	62,5	36,9	
Clay content	Cl	[%]	15,2	47,6	23,5	
Natural moisture content	w	%	13,8	22,7	18,0	16,4
Liquid limit	w_L	[%]	38,4	60,1	47,7	43,6
Plastic limit	w_P	[%]	21,5	30,9	25,5	23,7
Plasticity index	PI	[%]	16,1	29,2	22,2	19,5
Inner friction angel	φ	°				18
Cohesion	c	kPa				20
Bulk desnity	ρ	g/cm^3				1.80

			Gravelly silt			
			min	max.	Avg	Char.v.
Gravel content	Gr	[%]	37,4	78,4	55,7	
Sand content	Sa	[%]	11,1	31,0	20,3	
Silt content	Si	[%]	10,1	32,2	20,8	
Clay content	Cl	[%]	0,5	6,7	3,2	
Natural moisture content	w	%	7,9	16,0	10,8	9,5
Liquid limit	w_L	[%]	32,2	48,2	39,1	36,7
Plastic limit	w_P	[%]	17,9	25,0	21,5	20,5
Plasticity index	PI	[%]	13,3	28,6	17,7	15,2
Inner friction angle	φ	°				20
Cohesion	c	kPa				10
Bulk density	ρ	g/cm^3				1,8