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

Environmental Impact Assessment of works for upgrading E-60 East-West Highway section between Ruisi and Agara West (km 95 to km 114)

(Contract Number TEWHIP/CS/QCBS-07)

July, 2012

COWI

Gamma

List of Acronyms

EA	Environmental Assessment
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EWH	East - West Highway
FS	Feasibility Study
HSE	Health, Safety, Environment
HS	Health and Safety
GoG	Government of Georgia
HGV	Heavy Goods Vehicle
KP	Kilometre Post
MCMP	Ministry of Culture and Monument Protection
MESD	Ministry of Economy and Sustainable Development of Georgia
NKUK	Nippon Koei UK
MLHSA	Ministry of Labour, Health and Social Affairs
NGO	Non-Governmental Organization
AH	Affected households
AP	Affected people
RAP	Resettlement Action Plan
QC/QA	Quality Control and Quality Assurance
RD	Roads Department of the Ministry of Regional Development and Infrastructure of Georgia
MoE	Ministry of Environment Protection
MRDIG	Ministry of Regional Development and Infrastructure of Georgia
RBG	Red Book of Georgia Protected Species
RoW	Right of Way
SEP	Stakeholder Engagement Plan
TEM	Trans-European Motorway
ToR	Terms of Reference
WB	The World Bank
WHO	World Health Organisation

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1 Non-technical summary

Introduction

Due to its geographical position Georgia has gained the status of an important transport corridor connecting Europe and Asia and the development of the transport infrastructure has become a national priority. The Government of Georgia requested the World Bank to support modernization of the East-West Transport Corridor. Two projects for the improvement of the E-60 East-West Highway are ongoing with the Bank financing and additional financing for the Third East-West Highway Improvement project is now under preparation. It will cover a section of the Highway between Ruisi and Gomi. Future investments will complete improvement of the Highway from Gomi to the already rehabilitated Rikoti tunnel. A Regional Environmental Assessment (REA) and an Environmental Management Framework (EMF) were developed for the entire corridor Sveneti- Ruisi-Rikoti Tunnel. An Environmental Impact Assessment (EIA) has been carried out for Ruisi- Gomi section of the Highway, including an Environmental Management Plan (EMP). The objective of the EIA for Ruisi-Gomi section was to identify expected environmental impacts and risks of the proposed works, recommend measures for their mitigation, and develop a plan for monitoring environmental compliance during construction and operation of the section of E-60.

Technical and Environmental Standards and Regulations

Technical design of the highway improvement is in compliance with the Trans-European Motorway (TEM) standards. The project will be implemented in compliance with the Georgian legislation and environmental standards, as well as the World Bank's safeguards policies. According to the Georgian law, the proposed project requires EIA, conduct of the environmental expertise, and issuance of a permit for impacting the environment. The project triggers World Bank OP/BP 4.01

Environmental Assessment, OP/BP 4.11 Physical Cultural Resources, and OP/BP 4.12 Involuntary Resettlement.

Environmental Screening

The proposed works for the improvement of Ruisi-Gomi section of E-60 include widening of the existing carriageway between Ruisi and the town of Agara for converting it from a two-lane into afour-lane motor road, and construction of a four-lane sections of road on a new alignment between Agara and Gomi. Road works of the described scope and scale determine classification of the Third

East-West Highway Improvement project as a Category A for environmental assessment purposes, requiring the conduct of a full scale Environmental Impact Assessment (EIA) and development an Environmental Management Plan (EMP).

Public Participation

The Bank policies and the Georgian legislation require meaningful public participation and involvement in the process of EIA and environmental management planning. The main principles of public consultation include:

- Conduct of at least two public consultation meetings for an environmental Category A
- project at the EIA inception phase and at the stage of mature drat EIA report;
- Disclosure of the draft EIA report to public through the convenient media in a national language;
- Announcement of the venue and time of stakeholder consultation meetings through central
- and local means of public communication;
- Invitation for written comments/questions on the draft EIA; and
- Incorporation of public feedback into the EIA report and re-disclosure of the finalized document.

The initial consultations on the environmental implications of the proposed project and the scope of the forthcoming EIA were carried out at the early stage of its preparation. Feedback received during these consultations was fully incorporated into the draft EIA report. The advanced draft report was posted on the web page of the Roads Department (RD) of the Ministry of Regional Development and Infrastructure of Georgia on February 7, 2012. Several hard copies of the document were made available at the office of Kareli local self government (sakrebulo) located within the project implementation area. RD organized public consultation meeting to discuss the draft EIA report on February 15, 2012. It was hosted by Kareli local self government. Present EIA report was finalized with incorporation of the feedback received through this consultation.

Sensitive Environmental Receptors and Potential Impacts

The Ruisi-Gomi section passes mostly through the significantly transformed landscape, away from protected areas and biodiversity hotspots. The main environmental impacts are expected at the construction phase and come from clearing of the right-of-way (RoW); establishment / operation ofwork camps and temporary access roads; operations/ servicing of construction machinery; sourcing of construction materials; earth works and works in waterways.

Clearing of the RoW will be required for widening of road in the sections where the highway alignment remains unchanged, and for cleaning a new route for the re-aligned sections. This would imply removal of topsoil, removal of shrubs, and cutting of up to 350 trees. Establishment of construction camps and access roads is associated with generation of solid waste and waste water, compression of soil, and noise disturbance for nearby population. Parking, operating and servicing of construction machinery will carry the risk of operational spills of oils and lubricants and generation of noise, vibration, dust, and emissions. Supply of the highway construction with asphalt, stones, gravel, and sand may carry the risk of landscape degradation, erosion, and disturbance of aquatic life in rivers. Con-

struction works will also have implications for the occupational health and safety of workers/personnel.

Impacts of the improvement of the Ruisi-Gomi section during its operation phase are much less significant and diverse. Three environmental aspects of the highway operation will be air pollution from automobile emissions, noise, and pollution of soil and surface water with litter and drainage from the highway. Acceptable noise levels will not be exceeded in the short to medium term perspective and are likely only in case of traffic increase projected in a long term. Finally, traffic safety will be an important issue with health, social, and environmental implications.

Project Alternatives

Various alignments of the highway carry different levels of environmental risks, which has been critical in environmental analysis of project alternatives.

No “showstoppers” have been identified during EIA and the anticipated impacts can be managed by application of adequate construction standards and good environmental practices. Nonetheless, a “do nothing” option was considered as one of the project alternatives. While it has no environmental and social impacts resulting from construction works, operating the highway in its current poor condition has negative environmental impacts from traffic jams, noise, low speed, and high emission. Under the "do nothing" scenario local communities would lose opportunity of benefiting from all positive effects associated with the highway improvement, including profits resulting from increased cargo turnover and tourism. Therefore, as the potential positive impacts of the project surpass its possible negative impacts, the “do nothing” option was discarded.

Out of the five considered alternative alignments three were discarded at an earlier stage due to the anticipated significant negative impacts, including alteration of land use patterns, major resettlement needs, risk of road flooding, and likely damage to an identified archaeological site. Two preferred alternatives were analysed in depth: one being widening of the road within its present alignment, and the second option - with partial re-alignment of the road to bypass settlements of Agara and Gomi. The latter was selected for implementation due to the least scope of required resettlement, minimal loss of productive agricultural land, best perspective for traffic safety, no damage to the known physical cultural resources, and the least risk of road flooding.

Project Description

The length of Ruisi-Gomi section of the E-60 Highway is 19 km. It is a part of a larger program for reconstruction of the Tbilisi-Leselidze motor road. The project will support expansion of the existing two-lane road into a four-lane road, as well as construction of four-lane sections on a new alignment where re-routing is necessary. Widening of the road within the present right of way will occur mostly to the south of the existing carriageway. Re-alignment will allow bypassing densely inhabited settlements. At km 105 a rest area will be arranged. The project includes building of five junctions and four new bridges over the Prone and Ptsa rivers, as well as over the railway and a rural road.

A central reservation will separate two pairs of highway lanes. Paved shoulders will be provided for breakdown and emergency use. Surface water drains, safety

barriers, lighting and signage will be arranged for safe operation of the upgraded section of the highway. Following the TEM Standard, each width of each lane will be 3.75 m; shoulders - 3.75 m; paved berm - 3.00 m; unpaved berm -

0.75 m; and the central reservation - 5.00 m (including safety barriers). The total width of the road will make 27.50 m. For highway sections to be upgraded without re-alignment, the existing carriageway will be repaired, and a new two-lane carriageway will be built alongside.

Based on experience gained from other similar road projects it can be assumed that construction may involve a total workforce of about 200. Out of these 60% to 70 % may be local workforce, which could be hired as semi-skilled or un-skilled workers during the construction period.

Environmental Impact Assessment Methodology

The EIA of Ruisi-Gomi section of the highway is comprised of (i) determination of the scope of the work; (ii) collection of the detailed baseline data; (iii) assessment of expected impacts; (iv) outlining of mitigation measures; and (v) development of environmental management and monitoring plans.

The EIA process was a combination of desk work and field work, comprising of literature review, data collection from various agencies, visual observation and fact finding along the RoW, and analysis of all collected information. Impacts of the project activities to be implemented outside the RoW - such as construction camps, temporary access roads, etc. - have been fully considered as well. On initial stage of the EIA, spatial boundaries of the study area were defined to allow identification and assessment of the expected impacts and to enable comparative assessment of project alternatives in a given environment.

Environmental and Social Baseline

The EIA report presents information about the physical, biological, and socio-economic characteristics of the environment alongside the project alignment. The purpose of this description is to establish environmental baseline, to identify potential sensitivities, and to su ggest a de qu a te response through measures that are appropriate to avoid, minimize, or mitigate potential adverse impacts.

The 19 km section of the highway to be upgraded under the proposed project passes through rural areas, where environmental pollution is insignificant. No polluting or noise-intensive industries exist in the region nowadays. Physical environment around the subject section of the highway is pretty diverse, but not rich in its biodiversity. Landscape around it is mostly altered and land is either cultivated or degraded. There are no designated protected areas in the vicinity of the project site. No protected plant species were registered during field surveys, except several specimens of planted walnut trees. Neither occurrence of rare or endangered mammals was registered. Rivers and adjacent floodplains are the only types of sensitive habitats of fish and reptiles, which fall under potential direct impact zone of the project during the construction phase.

The baseline studies included the following components:

- Climate and meteorology;
- Geology, geomorphology;
- Hydrology, hydrogeology;

- Soils, landscape and land use;
- Air quality;
- Noise;
- Seismic conditions and hazardous processes
- Flora and fauna; and
- Historical, archaeological sites and human environment.

According to the environmental baseline data, the highest environmental sensitivity of the proposed project is proximity of a part of the designed re-alignment to the river. Associated risks of the construction phase include possible deterioration of water quality and disturbance of aquatic life, while risks of the operation phase are water damage to the road embankment and flooding due to artificial limits imposed on the water stream by placement of the embankment. These risks were carefully examined from engineering and environmental viewpoints and were found moderate. Construction phase impacts may be mitigated by applying conventional good practice of works in waterways as described below. Structural damage to the embankment in the observable future is excluded through a proper design solution tailored to the physical structure of soil and the landscape of the site, while detrimental changes of the water flow parameters are unlikely because the road embankment is to be placed only along a small stretch of one bank of the river.

Research of the social baseline revealed a single most sensitive human aspect of the project implementation, which is the required land take. Livelihoods of the majority of affected households considerably depend on the land plots and small businesses the ownership and use of which will be altered in the course of the project implementation. This finding emphasizes the importance of diligent planning and timely provision of adequate compensation and restoration of livelihoods to be conducted under the frames of the Resettlement Policy Framework developed for the project.

Expected Impacts and Mitigation

The results of the EIA show that majority of the potential environmental impacts of the project are associated with the construction phase and are temporary in nature. The main approach of the EIA was to provide adequate recommendations for the prevention or mitigation of negative environmental impacts of the project. These recommendations are applicable during road design, construction, and operation phases. Taking into account the location and sensitivity of human settlements and environmental receptors, the following mitigation measures were developed for mitigating the main risks associated with the project implementation:

- Impact on vegetative cover: Clearing of the right of way, especially in the re-aligned parts of the highway, will imply removal of vegetation, including cutting of trees. Loss of vegetation will be kept at the possible minimum. The trees removed from the State owned areas will be compensated through re-planting along the right of way at a ratio of 1:3, and those cleared from private land plots will be compensated in accordance with the Resettlement Action Plan. Selection of species for planting will be based on the natural composition of local flora. Greening of the construction sites along the right of way, as well as maintenance of there-planted areas for a year will be included in the

assignment of a works contractor. RD will be responsible for further maintenance of plantations.

- Disturbance of local communities: Movement of construction machinery, location of thetemporary work camps, and temporary storage of construction materials and waste will be planned to avoid or minimize barriers for free movement of the local population. Deterioration of the air quality near populated areas will be controlled through oversight on the technical condition of construction machinery. Operation of engines in idle regime will be discouraged. In the event of existence of especially sensitive receptors, operation of construction machinery will be limited to the regular working hours.

- Operation of work camps and access roads: Work camps and temporary access roads will belocated preferably in the already transformed areas to minimize landscape and ecosystem degradation. The camps will be organized to have designated areas for storage of materials and waste, and will be equipped with septic tanks. Areas designated for fuelling/servicing of machinery and for storing of hazardous substances will be provided with ground lining and barriers preventing release of spillage.

- Air pollution: Air pollution can appear during earthworks, gravel crashing, concrete mixing,and transportation in case of improper maintenance and operation of equipment, inadequate storage of fine-grained materials, and movement of vehicles on unpaved or dusty surfaces. To reduce generation of dust and reduce emissions, construction equipment will be maintained in good working condition and mixing equipment will be sealed. Concrete mixing plants will be installed at least 300 m away from settlements windward. Speed limits will be set for construction vehicles and all loose material will be covered with tarpaulins when transported off-site with trucks. A wheel-washing facility will be provided and ensured that it is used by all vehicles before leaving all sites. All unpaved roads and significant areas of uncovered soil will be sprinkled during working hours in dry weather conditions.

- Operation of construction machinery: The technical condition of the construction machinerywill be checked on regular basis to minimize air pollution from exhausts oil and soil/water pollution from leakage of fuel. The risk of operational and emergency spills of fuel and lubricants will be mitigated by designation of special parking and servicing sites, to be located away from waterways and other sensitive environmental receptors.

- Earth works: Prior to excavation, top soil will be removed and stored separately for laterreinstatement of the area. Landscape restoration will be carried out to ensure stabilization of slopes. This would include seeding of grass and planting trees.

- Construction of bridges: Works in the waterways will be planned to avoid constructionduring fish spawning periods. River banks will be checked for stability in the course of works and reinforced as necessary to minimize erosion. Barriers of inert materials will be used toavoid

sedimentation from terraced sides of river beds. Working time will be minimized during filling the bridge footings with concrete. If temporary re-direction of river stream becomes necessary, piping, channels, and fish-passes will be arranged to allow alternative water flow and fish movement. Technical condition of machinery operated in and near waterways will be checked on daily basis to avoid leakage and operational spills of fuel and lubricants. No stockpiling of construction materials and waste will be allowed in or nearby the waterways.

- Accumulation of construction waste: Temporary storage of waste will be organized byseparating construction debris, household solid waste, and hazardous waste. The latter, comprising of used filters, tires, and lubricants from machinery, will be kept in a closed and isolated storage. Out transportation of waste from the construction sites will follow a time- bound schedule. Formal instructions will be obtained from local authorities for the final disposal of waste in the existing landfills. Access material, such as soil and rock, may be disposed outside municipal landfills if authorised by local authorities, as permitted by national legislation, and in compliance with conventional good environmental practice. Volumes of disposable waste will be minimized to the extent possible through re-cycling and back-filling of material as feasible.

- Operation of quarries and borrow pits: Purchase of inert construction materials will beallowed only from the licensed legal and/or physical bodies. Extraction of these materials will also be allowed on the grounds of a special license. Opening of new borrow pits will be avoided if those already in operation can be used instead. Operation of quarries and borrow pits, as well as extraction of gravel from river terraces, will be carried out strictly in accordance with the conditions of a license issued by the State authority and enforced by the Ministry of Energy and Natural Resources.

- Historical, cultural, and archaeological sites: All known historical and cultural monumentsalong the right of way were identified and mapped during the EIA. The Highway alignment will not cause physical damage to these monuments. There is a high likelihood of chance finds during earth works, though. If an artefact is encountered by a works contractor, physical activities on site shall be immediately suspended and the RD be promptly notified. RD then contacts the Ministry of Culture and Monuments Protection. The latter defines and manages further steps and actions aimed at proper handling of the encountered cultural property. Works may resume if and once cleared by the Ministry of Culture and Monument Protection.

- Occupational health and safety: Work camps will be established and operated to ensure themaintenance of adequate hygiene and sanitation. Workers and other personnel involved in the project will be provided with personal protection equipment and gear. They will receivetraining on the safety rules and course of action in case of emergencies. Special safety regulations will be provided and conformed during works in waterways.

Environmental Management Plan

This EIA report contains the EMP with a full set of the proposed mitigation measures, as summarized above, and monitoring indicators. It also describes the role of RD in overseeing adherence of construction works with the recommended mitigation measures and identifies the needs for RD's technical and institutional capacity building for ensuring full environmental compliance of the project. A supervision consultant will be hired by RD to provide technical control and quality assurance of civil works. Environmental monitoring will be an integral part of the consultant's assignment and information on the compliance with EMP will be included into the supervisor's regular reporting to the RD. RD will have an overall responsibility for applying due environmental diligence. This will include ensuring quality of the supervision consultant's performance, site inspections, timely response to any issues identified by the consultant or by RD inspectors, and record keeping on all environmental aspects of the project implementation.

Before commencement of works the selected works contractor will be asked to develop and agree with the RD a plan of traffic management for the period of works. The works contractor will also develop and agree with the client a plan of greening and landscape reinstatement at a relevant stage of contract implementation.

Operation of the Highway

The improvement of the E-60 highway aims at minimizing the need of interventions during its operation and maintenance. Ensuring safe and good environmental performance will be a high priority at the operations stage and will comply with the requirements of the national legislation and the best international practices. RD, through an outsourcing arrangement, will permanently maintain and, in a longer term, improve greening along the right of way to be provided by the construction contractor for landscape reinstatement and as a compensation for trees removed during works. Regular collection of solid waste will be organized along highway. The State technical control of the highway through regular oversight and inspection will be provided. Operation of the upgraded Ruisi- Gomi section of the highway is unlikely to cause increase of noise levels beyond the established acceptable levels in short to medium term perspective, and therefore no mitigation measures are required at present. In case the noise level limits are exceeded in future due to increase of traffic volumes forecasted in a long term perspective, RD will install noise barriers and consider additional greening along the rights of way.

2 Introduction

The Georgian Government has embarked on a programme to upgrade the major roads of the country, managed by the Roads Department (RD) of the Ministry of Regional Development and Infrastructure. The initial studies are focused on E-60 East-West Highway (EWH), which is the main route from the neighbouring Azerbaijan and Russia, with connections to Turkey and Armenia. Georgian government with its own budget completed the upgrade of the first 15 km of the E60 from outside of Tbilisi at Natakhtari to Agaiani. In 2006, International Development Association (IDA) approved the First East-West Highway Improvement Project (First EWHIP), to upgrade the next section on the E60 Highway from Agaiani to Igoeti (about 13 km) and additional financing for reconstruction of the Rikoti tunnel. Second East-West Highway Improvement Project (Second EWHIP) prolonged the upgrade from Igoeti to Sveneti, a segment of about 24 km, and was also funded by World Bank. Third East-West Highway Improvement Project (TEWHIP) aimed on upgrading the next consecutive section of the E60 East-West Highway from Sveneti to Ruisi (15 km).

Additional financing (under the TEWHIP) has been sought from the World Bank for upgrading of road segment of 19 km from Ruisi to Agara West, located at 95-114 km north-west of the capital Tbilisi (Figure 4.1).

Preliminary work on this section began with a Feasibility Study (FS) and a strategic environmental and social study. A Feasibility Study (FS) was conducted by Kocks Consult between December 2008 and August 2009. , including theRegional Environmental Assessment. was carried out by Nippon Koei UK (NKUK) between March and August 2009.

The project must comply with the Georgian law and with the World Bank (lender) policy, both of which include environmental and social safeguards. The overall Third East-West Highway Improvement Project is classified as environmental assessment Category A, according to the World Bank OP/BP 4.01, as well as the road section from Ruisi to Agara West, which is to be upgraded from additional funding for the TEWHIP.

According to the national regulations and requirements of the lender, full-scale EIA of the project was conducted.

The outcome of the EIA is a full scale analysis of the selected improvements, environmentally and socially sound and consistent with international practice.

The purposes of the EIA are to:

- examine the project's potential negative and positive environmental impacts and recommend any measures needed to prevent, minimise, mitigate, or compensate adverse impacts and to improve environmental performance;
- analyze project alternatives;
- provide technical information and recommendations for selection and designing of the best option out of several alternatives;
- ensure that affected communities are appropriately engaged on issues that could potentially affect them; and
- Develop an Environmental Management Plan, which will include a mitigation programme, a monitoring plan and assessment of institutional capacity for its implementation.

This report presents assessment of impact of the project on biophysical and social environment for Ruisi - Agara West (95 km to 114 km) section of the road.

The Environmental Impact Assessment was prepared in cooperation with the Roads Department of the Ministry of Regional Development and Infrastructure and the Ministry of Environmental Protection of Georgia.

3 Legal and policy framework

3.1 Overview of Georgian environmental legislation and WB policy

The EIA for the present project will be based on the national Environmental regulations, the World Bank Policy and relevant guidelines. OP/BP 4.01 on Environmental Assessment is considered the “umbrella” policy as it was the first to be developed and establishes the framework within which other policies are applied.

The EIA for Ruisi - Agara West road section was performed according to the requirements of the EHS Guidelines for Toll Roads together with the General EHS Guidelines document (International Finance Corporation, WB group, April 30, 2007).

The overall EIA was performed according to recommendations given in WB technical paper No. 376 "Roads and the Environment. A Handbook" (1997).

The World Bank environmental and social safeguards include:

OP/BP 4.01 En-vironmental Assessment (1999),

OP/BP 4.04 Natural Habitats (2001),

OP/BP 4.36 Forests (2002),

OP/BP 4.11 Physical Cultural Resources (2006),

OP/BP 4.12 Involuntary Resettlement (2001) and others.

The requirements of the Georgian EIA system are set forth in the laws On Environmental Impact Permit (2007), Ecological Expertise (2007), On Licenses and Permits (2005) and others; and guidance is available from the MoE. All the named laws together with laws and regulations on the water, soil and air including relevant quality standards have been applied.

Environmental legislation of Georgia. Environmental legislation of Georgia comptises the Constitution, environmental laws, international agreements, by-laws, presidential decrees, ministreial orders, instructions, regulations,

etc. Georgia is a party to international conventions, including the environmental ones.

Below is a list of Georgia's environmental legislation as it pertains to the proposed project:

Table 3.1 *List of laws and regulations relevant to the project*

Year	Law / Regulation
1994	Law on Soil Protection (amend. 1997, 2002)
1996	Law on Entrails 1999, 2002, 2004, 2005)
1997	Law on Wildlife (amend. 2001, 2003, 2004)
1997	Law on Water (amend. 2003, 2004, 2005, 2006)
1997	Civil Code of Georgia
1997	Law on Compensation of Land Substitute Costs and Damages due to Allocating Agricultural Land for Non-Agricultural Purposes
1999	Law on State Complex Expertise and Approval of Construction Projects
1999	Law on Protection of Atmospheric Air (amend. 2000, 2007)
1999	Forestry Code of Georgia
1999	Law on Compensation of Damage from Hazardous Substances (amend 2002, 2003)
1999	Law on Licensing Design-Construction Activities
1999	Law on Rules for Expropriation of Ownership for Necessary Public Needs
2000	Law on Regulation and Engineering Protection of Coastline and River Banks
2002	Regulation on Environmental Impact Assessment approved by Order No. 59 of the Minister of Environment.
2005	Law on Red List and Red Book of Georgia (amend. 2006)
2005	Law on Privatization of State-owned Agricultural Land
2005	Law on Registration of Rights to Real Estate
2006	Law on Regulation and Engineering Protection of Sea and River Coasts of Georgia
2007	Law on Cultural Heritage
2007	Law on Ecological Examination
2007	Law on Service of Environmental Protection
2007	Law on Public Health
2007	Law on Entitlement of Ownership Rights to Lands Possessed (Employed) by Physical and Legal Persons of Private Law
2011	Methodology for Estimation of Environmental Damage

Other laws and regulations related to social and land ownership aspects applicable to the project include:

- Civil Code of Georgia
- Law of Georgia on Privatization of State-owned Agricultural Land r.
- Law of Georgia on Entitlement of Ownership Rights to Lands Possessed (Employed) by Physical and Legal Persons of Private Law
- Law of Georgia on Registration of Rights to Real Estate).
- Law of Georgia on Rules for Expropriation of Ownership for Necessary Public Needs
- Law of Georgia on Compensation of Land Substitute Costs and Damages due to Allocating Agricultural Land for Non-Agricultural Purposes.

3.2 Road construction related regulations in force in Georgia

Design of bridges, viaducts, overpasses and pipes is regulated by norms and rules 2.05.03-84. Design of road tunnels - by norms and rules II-44-78.

Construction norms and rules (SNR 2.05.02-85 Motor roads) regulate traffic safety, environmental issues, set forth main technical and traffic operation norms, crossings and intersections, paving aspects, etc.

According to this document for category I road[1] the following environmental aspects are distinguished:

- the distance to residential area must be at least 200m from the edge of the carriageway;
- along with technical and economical aspects environmental impacts must be taken into account;
- prior to arrangement of temporary infrastructure and preparation of road embankment, topsoil must be removed and stockpiled until subsequent use for recultivation after completion of construction and removal of all temporary facilities;
- in case the road is built near the residential area (in a distance of 200 m), noise reduction measures (speed reduction) must be allowed for.

[1]Road categories are attributed according to daily intesnsity of traffic: caregory I –7000 vpd; category II – 3000-7000 vpd; category III –1000-3000 vpd; IV – 100-1000 vpd; V- up to 100 vpd

For this purpose, shield walls, plant barriers, etc may be suggested. Details and recommendations are given in Chapter 6.5.1;

- roads along the rivers, lakes and reservoirs must be built with consideration of protection zone boundaries for the surface water bodies.

3.3 Environmental Permitting procedure – national and WB regulations

According to the national legislation, the project needs the impact permit issued by the MoE based on the conclusions of the EIA report submitted by the proponent for the consideration of decision-makers.

The permit application/issuance procedure for the planned development, including EIA coordination and establishment of the timeframes for information disclosure and public review and discussion under ***The Law of Georgia on Environmental Impact Permits***will include the following steps:

Step 1. Publication of information on the project in central and regional newspapers. The advertisement has to include the project title, location, place and the date, time and venue of public disclosure meeting(s). It will also identify locations where the EIA can be reviewed and where comments may be submitted.

Step 2. Within one week after publishing the information in the newspapers, the proponent will submit the EIA report (hard copy and electronic version) to the Ministry of Environment Protection. A period of 45 days is allowed for receiving public comments on the EIA. Between 50 and 60 days after publication, a series of meetings to receive comments from the stakeholder (which may include government agencies, local authorities, NGOs, community members) must be carried out. Within five days of the meetings, minutes of the meetings (summary of comments and discussions) are to be submitted to the Ministry of Environment Protection.

Step 3. All comments received from the stakeholders at the meeting or in writing will be reviewed and addressed in the final version of the EIA. A copy of all written comments, the minutes together with the comment-response section will be included in the final EIA as an Annex. The final EIA will be submitted to the Ministry of Environment Protection and made available to the public, along with a project location map, an executive summary, of the planned development, reports on emissions and allowable limits. The permit will then be issued or denied within 20 days from registration of the submission.

According to the national regulations (Law on Construction permit, 2004; Law on Licenses and permits 2005) construction/ modernisation of highway requires Construction Permit. (Procedures for obtaining the permit are described in the Law of Georgia of Construction permit.)

According to the national legislation administrative body issuing the permit (the Ministry of Economy and Sustainable Development) ensures involvement of the other Ministries including the Ministry of Environment Protection in permitting process. For the project subjected to construction permit, authorisation (construction permit) incorporates elements of environmental impact permit.

Environmental impact permit is required for running asphalt/concrete plant. License for use of natural resources – in case decision is made to use own quarry are required under the national legislation (Authority responsible for issuing the licence is Ministry of Energu and Natural respirces). All other issues such as temporary disposal of inert construction waste and unusable asphalt are regulated based on agreement with local authorities.

According to the World Bank regulations the section of the road under consideration was screened as Category A project. According to the national regulations and requirements of the lender, full-scale EIA of the project is to be conducted.

3.4 Comparison of the national legislation and WB requirements

The following considerations reveal the main differences between the World Bank guidelines and the national legislation:

- Screening and Classification: The Bank's guidelines provide detailed description of procedures for screening, scoping and conducting EIA and explain a complete list of stages, which are not envisaged under the national legislation.

- Considering ecological risk, cultural heritage, resettlement and other factors, the Bank classifies projects supported by them under categories A, B and C. As mentioned, in the Georgian national legislation, EIA is carried out only if a developer seeks to implement projects listed in the Governmental Decree on the Procedure and Terms of the Environmental Impact Permit. This list is compatible with the category A projects of the Bank classification. According to the Georgian legislation EIA is not required in other instances, while the World Bank guidelines may require limited EA or Environmental Reviews for the B category activities , as well.

- Environmental Management Plans: The Georgian legislation does not specify format of environmental management plans (EMPs) and stage of their provision for the projects subject to EIA and do not request EMPs for the projects not requiring EIAs. The World Bank guidelines require EMPs for Category A and B projects and provide detailed instructions on the content.

- Involuntary Resettlement: The national legislation does not take into account the issue of involuntary resettlement at any stage of environmental permit issuance. The Georgian legislation considers social factor only with regard to life and health safety (e.g. if a project contains a risk of triggering landslide, or emission/discharge of harmful substances or any other anthropogenic impact). Thus, the national legislation does not consider resettlement as an issue in the process of issuing environmental permits, unlike the Bank which takes a comprehensive approach to this issue.

- Responsibility for the EIA: While the Bank's document establishes the responsibility of a Borrower for conducting the environmental assessment, the national legislation provides for the responsibility of a project implementation unit to prepare the EIA and ensure its consultation. According to the Georgian legislation the MoE is responsible for monitoring of project implementation and compliance with the standards and commitments provided in the EIA with a less clearly defined role in relation to EMPs. The "Project Proponent" is responsible for implementing "self-monitoring" programs for the projects subject to the EIA. The WB guidelines stress the role of EMPs, which are important for all categories of projects and the Project Proponent is requested to ensure inclusion of monitoring schemes and plans in the EMPs. Monitoring of performance compliance against the EMPs is an important element of the WB requirements.

- Consultation: The Bank provides for consultations for A and B Category projects (at least two consultations for Category A projects) and requires a timetable of consultations from the Borrower. Until recently the national legislation contained only a brief reference to this issue without providing real tools of its fulfilment. The amendments to the Governmental Decree On the Procedure and Conditions of Environmental Impact Assessment established the requirement of public consultation of the EIA, which obligates a developer to (i) ensure public consultation of the EIA, (ii) publicate the information, (iii) receive comments within 45 days, (iv) arrange consultation not later than within 60 days of the publication date, invite stakeholders and determine the consultation venue).

The present EIA was carried out with consideration of both the national and the WB requirements complementarity basis.

3.5 Institutional Framework

The GoG agencies undertaking supervisory, monitoring, project management, procurement or financial responsibilities are described below.

The RD responsibilities will include, at a minimum, accepting the feasibility study and final designs and accepting road sections after completion of rehabilitation. Maintenance also falls under the responsibility of the RD, but is

sourced out to private enterprises. Maintenance includes winter maintenance, regular checks and repair of the road, including drainage facilities, bridges, guardrails, road signs etc. Garbage collection alongside the road also is among the duties of RDthrough contracted company.

MoE is in charge of issuing the Environmental Permit for the Project, following the examination of the EIA and the subsequent State ecological examination. The rights of the MoE as the competent authority are the following:

- to intermit, limit or stop any activity which has or is likely to have adverse impact on the environment, as well as unreasonable use of natural resources;
- to issue a series of licenses (for natural resources use) and permits (for environmental pollution);
- to control the execution of mitigation measures by the developer; to receive free and unrestricted information from the developer about the utilization of natural resources, monitoring systems, waste management etc. and explanations from authorities concerning the Project.

The following ministries/departments of the government play a certain role in the approval/agreement process for the Project, including but not limited to:

- Ministry of Economy and Sustainable Development;
- Department of Natural Resources under the Ministry of Energy and Natural Resources;
- Aency of Protected Areas under the Ministry of Environment Protection (MoE);
- National Environmental Agency of the MoE;
- Department of Cultural Heritage Preservation (under the Ministry of Culture and Monument Protection);
- Department of Spatial Planning and Construction Policy of the Ministry of Economy and Sustainable Development;
- Ministry of Labour, Health and Social Affairs; and
- Ministry of Agriculture.

The Local Executive Bodies perform the main administrative functions in each district, including the local land-use issues and land allocation function.

4 Description of the project

4.1 Background

Ruisi - Agara West section of the E-60 highway is a part of 49 km road between Ruisi and Rikoti. The current EIA covers the 19 km long section from Ruisi to the West of Agara of E-60 Highway as illustrated in Figure 4.1.

The existing road sub-section from Ruisi to Rikoti is a two-lane carriageway road with a paved width of about 9.00 m. The shoulder width varies between 2.50 m and 3.00 m.

Upgrading of the Ruisi - Agara West section will convert the present two-lane road to a four-lane highway, comprising 2 two-lane carriageways separated by a central reservation, with a paved shoulder for breakdown and emergency use, plus surface water drains, safety barriers, lighting, signage, etc.

The ToR for the FS requires the adoption of the TEM Standard (Trans-European North-South Motorway). To meet these requirements each lane will be 3.75 m wide and each carriageway will be provided with a 3.75 m shoulder, 3.00 m paved and 0.75 m unpaved berm; the central reservation will be 5.00 m (including safety barriers) so the completed road will be 27.50 m wide. Where the existing road is widened, the present carriageway will be repaired and refurbished, and a new two-lane carriageway will be built alongside.

The road section under study begins at 94.5 km, runs through cultivated land along villages of Ruisi and Urbnisi, and goes to Aradeti settlement at 102.7 km. From Ruisi up to Sagolasheni widening of the road from 2 to 4 lines is planned. In sever metres from Sagolasheni the road sligtly shifts to the south to smooth the curve of the road. Leaving Aradeti at 104.4 km it runs through non-settled cultivated land until reaches Agara. The new section of the road bypasses Agara from the south. Agara is situated along the route from 108.3 km to 111.1 km. The road sub-section from Agara to the end of road sub-section under study at 114 km runs through unsettled agricultural landscape.

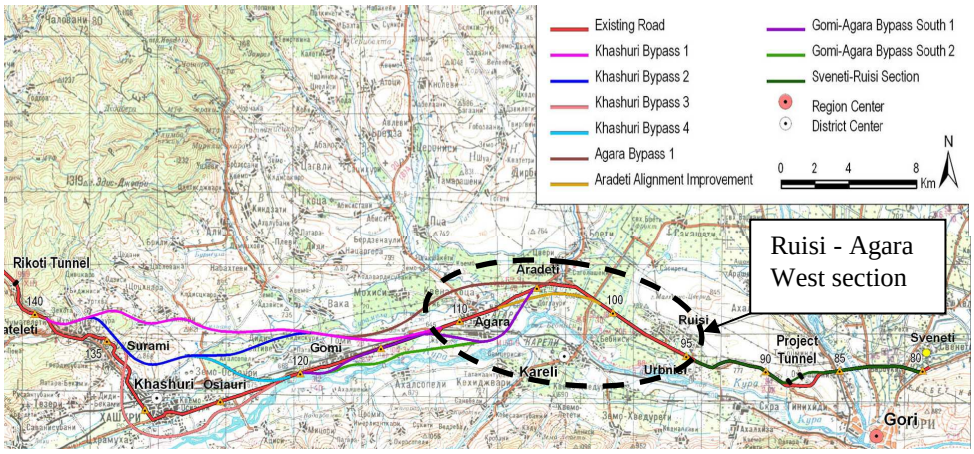


Figure 4.1 *The section from Ruisi to Agara West of E-60 Highway. Alternative route alignments subjected to technical and environmental/social appraisal*

4.2 Road elements and construction technology

4.2.1 Structural elements of the designed road

Along the section under consideration, construction of the following is envisaged:

- five junctions
- four bridges (over the Prone River and Ptsa Rivers, over a railway and a rural road);
- two underpasses and three crossings for cattles;
- 30 culverts.

Junctions

Five 2-level junctions will be established:

- Urbnisi - Ruisi (overpass type - "diamond" access) – km 94 + 531 of the designed road (Figure 4.2);
- Bebnisi - Ruisi (overpass type - "diamond" access) – km 97 + 800 of the designed road (Figure 4.3);
- Kareli - Upper Breti P50 (overpass type - "partial cloverleaf" intersection) – km 101 + 300 of the designed road (Figure 4.4).
- Aradeti - Agara, Kvenadkotsa (overpass type - "partial cloverleaf" intersection) – km 105 + 200 of the designed road, (Figure 4.5).
- Agara -Kvenadkotsa (overpass type - "trumpet" access) – km 112 + 200 of the designed road, (Figure 4.6).

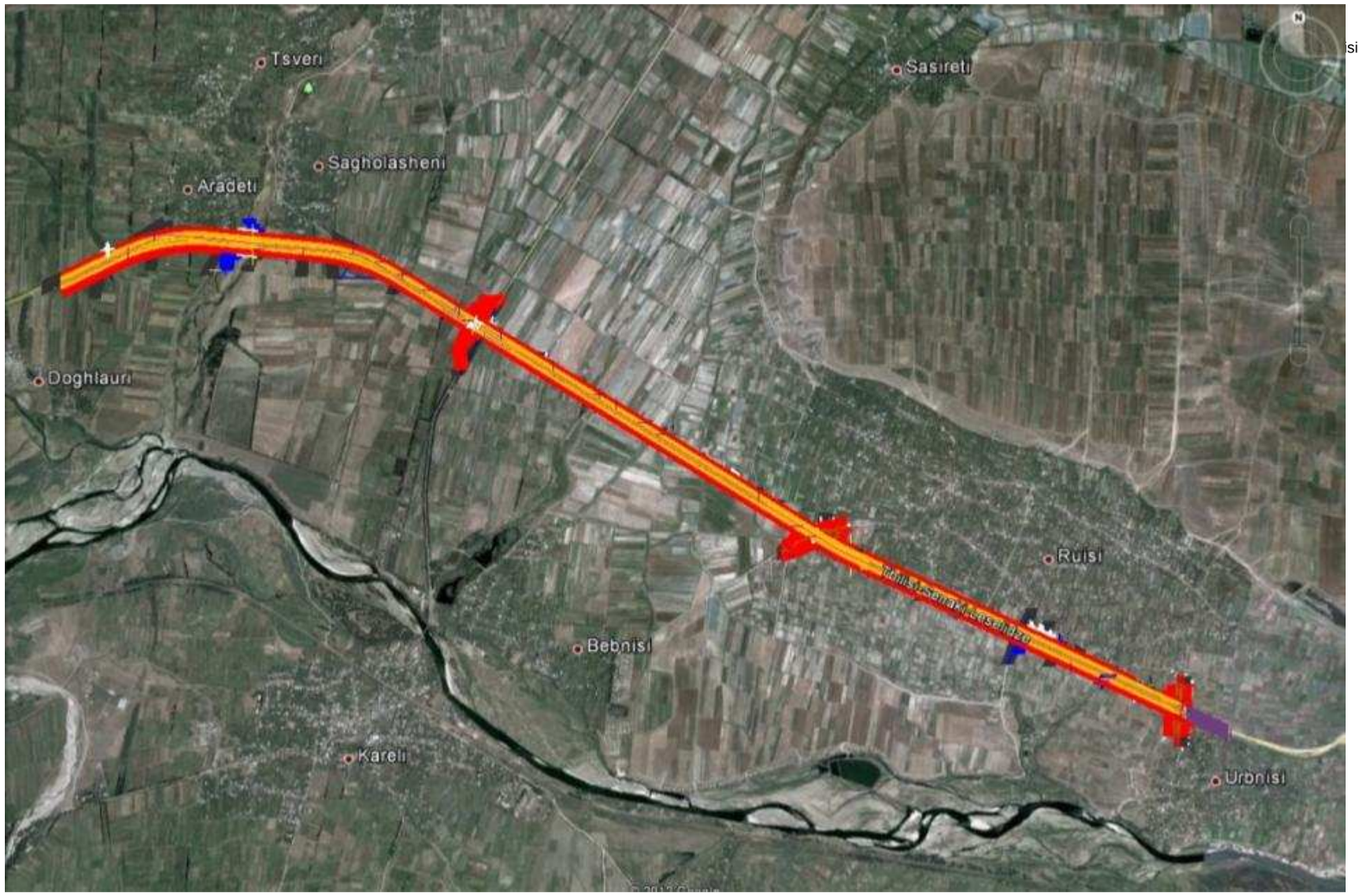


Figure 4.1 a. *Ruisi-Aradeti section of the E-60 highway*

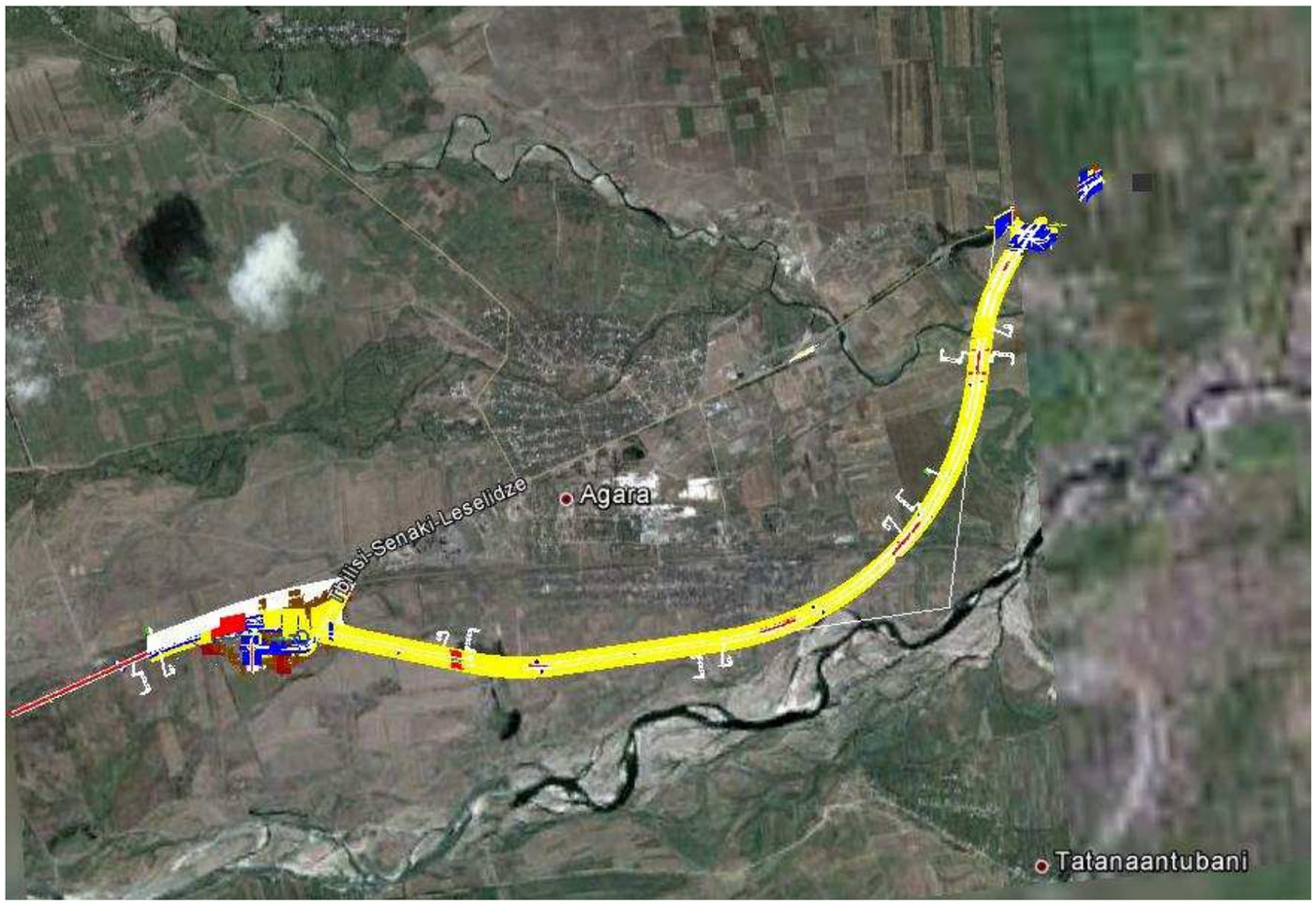


Figure 4.1 b. *Agara bypass section of the E-60 highway*

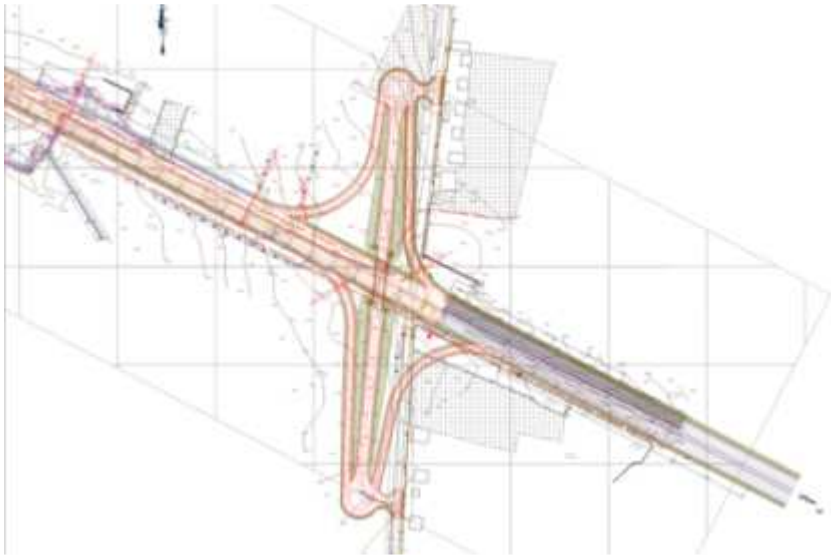


Figure 4.2 *Junction Urbnisi-Ruisi*

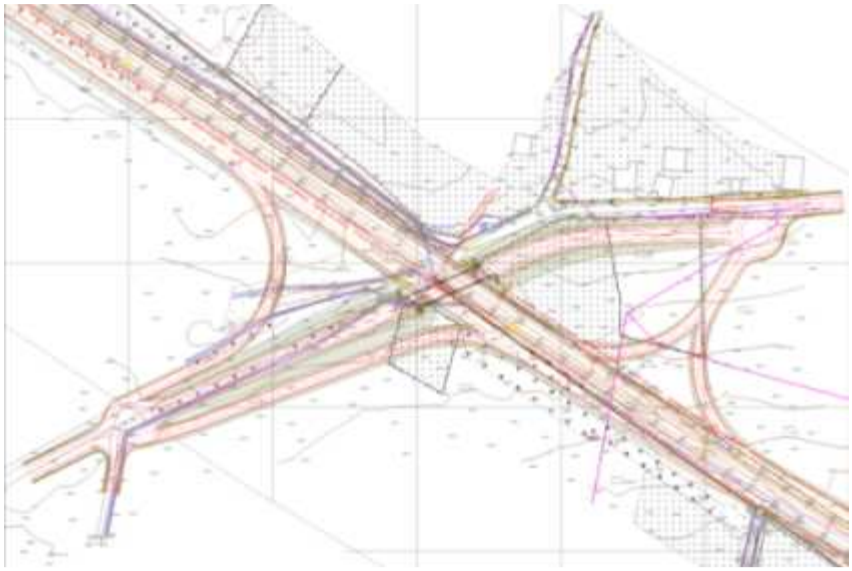


Figure 4.3 *Junction Bebnisi-Ruisi*

Figure 4.4 *Junction Breti – Kareli*

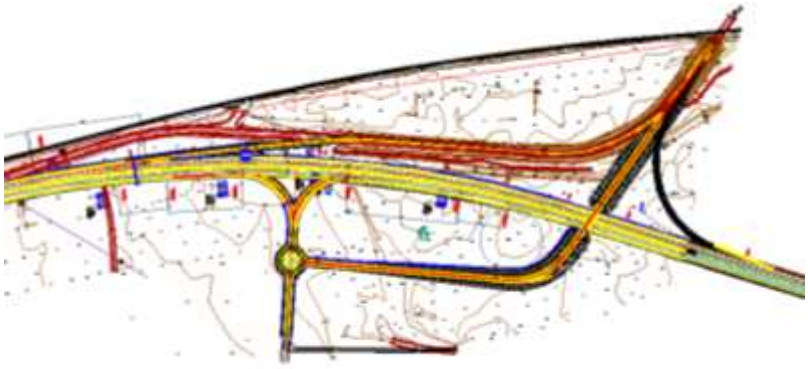


Figure 4.5 *Junction Aradeti – Agara, Kvenadkotsa*

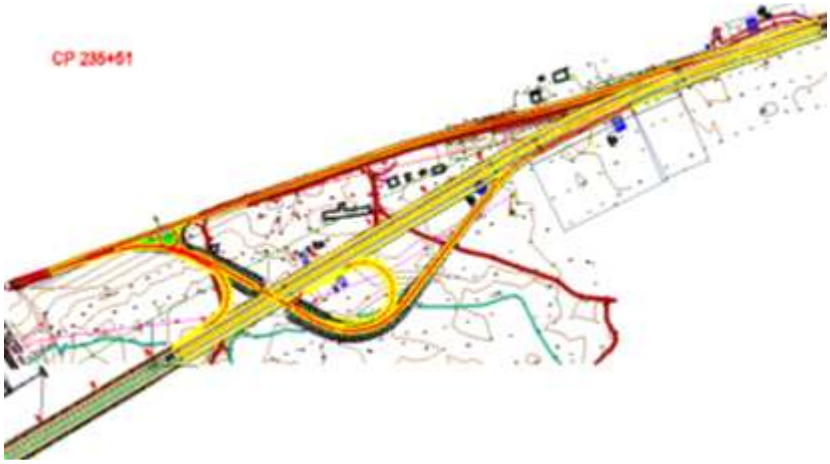


Figure 4.6 *Junction Agara- Kvenadkotsa*

Bridges

There are four bridges within the boundaries of the section under consideration: over the Prone River, over the Ptsa river, a railway and a rural road.

The existing bridge over the Prone River will remain and serve the traffic of the existing road. For the needs of the project 2 new bridges will be built over Prone and Ptsa Rivers (at km 9+000 and km 12 + 000 of the designed road). This will be a 120 m long structure, with two lanes, each 13.25 m wide. A 1 meter sidewalk for pedestrians is also provided. At km 13 + 750 and km 15 + 500 of the designed road two new bridges over the railway and a rural road will be built.

Bridges will be constructed mainly from Reinforced Cement Concrete (RCC), with gabions, brick and stone facing. Most bridges will consist of two decks, each 14.5 m in width, comprising: two 3.75 m carriageways; a central safety strip of 2 m; and a sidewalk of 1.5 m on either side, with a concrete barrier and handrail. Where bridges cross an existing road or rail-line, there will be a 40 m width between two struts.

No	Bridge/passage	Length, m	Width, m
1	Overpass, access road to Ruisi and Urbnisi	61,9	11.5
2	Overpass, access road to Ruisi-Bebnisi	61.9	11.5
3	Overpass, access road to Kareli	61.9	11.5
4	Bridge over the river Pron	183.5	29.05
5	Overpass, access road to Agara East	67.75	11.5
6	Bridge over the river Ptsa	143.66	29.3
7	Bridge Overpass	91.3	29.3
8	Overpass, access road to Agara West	67.75	29.3

Overpasses

Overpasses are made to ensure the smooth movement on the project road and for regional and among regional needs.

Design of the overpasses was developed with consideration of Snip 2.05.03-84 “Bridges and Tunnels. Designing Norms», adopted by the Order #1-1/251 (February 18, 2011) of the Ministry of Economy and Sustainable Development of Georgia, other normative documents in force in Georgia,topo-geodesycal and engineer-geological field research materials. Location of underpasses is agreed with local government and leadership of Roads Department of Georgia.

Constructions of overpasses mainly are similar. The difference is in crossing’s corner between the axis of overpass and of designed road (see table 11.1). That is why interface the conditions of spam structure of overpass and abutment.

Spam structures of overpass are of building-monolithic constructions, which are made of 27.0 m or30.0 m prestressed concrete beams, interconnected 20 cm thickness monolithic reinforced concrete plate. On abutment, according to the interface, monolithic reinforced concrete plate is sidelong cut off on vertical cross. 22 ropes of prestressed rope armature of low relaxed ASTM A416-8 brand with 0,6” 270 K withAp=1.394 cm2 area section and 194,66 kN stretch force are used for prestressing. For main constructionsand monolithic plate and beam connector anchors is used armature rods various diameter of A500 grade. Concrete class according on durability to compression for Beams is foreseen B40 and for monolithic plate – B30.

Overpass piers are made as three-rack-mount frame. Frame racks are united by a reinforced concrete crossbar having 13,0 m length and 1, 2x1,4 m profile which decreases in height up to 0,6 m at the end. Racks and girders are armored with various diameter armature of A500 class. Concrete class on compression according to durability are foreseen B25.

Racks are embedded in pile foundation capping of monolithic concrete rectangular shape with size

9,80x2,0x1,5 m which unites three drilled-break piles of 1,5 m diameters with 20.0 m length. For overpass located on km 0+059.00 and km 3+516.30 piles are sink in solid and semi solid in clay with gravel and macadam tabs and on km 3+516.30 located overpass is mainly in ground with clay and sand with gravel tabs.

Abutments are designed as three 20 m length and 1,5 m diameter drilled-break piles that from the top are united as case wall, wings and under farm piles made in solid capping length 12,7m and height 1,2m and thickness 1.92m. Wings are 3,3 m length and thickness varies between 0,3-0,5 m. Armature is foreseen to A500 class and concrete class on compression according to its durability B40.

Elastomers are used for reclining Spam structure beams (reclining materials of rubber-steel).

From bank on spam structure construction for providing step less pass on pass road props between wings are placed typical concrete passing piles.

For deformation between abutments and span structure is juncture attachment construction.

Overpass passing a part with 8.5 m width is designed for double line movement. Along roadway on both sides are made sidewalks of 1.0 m width which have standard steel railling and concrete curbs.

Cover of passing a part is made of asphalt concrete layer thickness 7 cm.

For the removal from passing a part atmospheric precipitation water is foreseen arrangement with double longitudinal and cross-sectional inclination.

At the angles of overpass are foreseen arrangement the concrete stairs on the ground bulk.

River Prone Bridge

Over the river Prone is foreseen to construct a new bridge on the existing bridge crossing for each direction of movement with separate span structures, piers and abutments.

Design of the bridge was developed with consideration of the Snip 2.05.03-84 “Bridges and Tunnels. Designing Norms» adopted by the Order #1-1/251 (February 18, 2011) of the Ministry of Economy and Suatainable Development of Georgia, other normative documents that are in force in Georgia,topo-geodesycal and engineer-geological field research materials. Location of bridge is agreed with local government and leadership of Roads Department of Georgia.

Designed bridge crossing crossed wide terrace in grove of river Prone. The right bank is higher than the left bank.

Design road line is at the approach bulk of existing bridge, which affects projecting conditions of new construction.

Within bridge crossing river bed is built weakly using attenuated, thin layered sandstones and clay on which are spread very attenuated, thin layered sand stones and this one at the existing bridge from the right side within the access bank is covered with yellow-brown plastic sand consisting 20-25% gravel and pebbles and the left access side is covered with 2,0m strong and semi strong brown clay up to 10-15% clay and gravel tabs. Outside access embankment very attenuated thin-layered sandstones a d clay is covered with 1.5-2,5 m capacity strong and semi strong brown clay up to 10-15% grove and clay tabs.

At the bridge passage alignment river expense according to the hydrological calculation within 100 year repeatability is 196 m3/sec and within 10 year repeatability 96 m3/sec and average calculation level of high river water is 646.80 m (UTM system WSG-84). Total bottom wash level as local wash funnel bottom level is received surface level with very attenuated thin layer sand stones and clay minus 1,0 m.

According to the above mentioned during stating the bridge scheme the main determinative factor was of marks of project road passage and location of abutments by foreseeing bridge length minimization. In addition, the condition that linear axis of bridge passage is approximately 50° corner at the river flow axis. According the above mentioned has been appointed the new length (183,50m) for bridge and bridge scheme. Was taken into account that the bridge is located in close proximity to areas of conflict and, where necessary, require a prompt recovery, in consequence of which was adopted by the beam split-circuit bridge.

Both bridges are located on flat 1.48% linear falls with inclination toward the right bank. Bridge scheme towards different direction is various: For Tbilisi – Rikoti direction has been appointed scheme13,5+6x27,0 and in the opposite direction has been appointed scheme 27,0+13.5+5x27,0.

Spam structures of pass roads are of building-monolithic constructions, which are made of 27.0 m prestressed concrete beams, interconnected 20 cm thikness monolithic concrete plate. On abutment, according to the interface, beams plate is sidelong cut off on vertical cross. 22 ropes of prestressed rope armature of low relaxed ASTM A416-8 brand with 0,6” 270 K with Ap=1.394 cm2 area section and 194,66 kN stretch force are used for prestressing. For main constructions and monolithic plate and beam connector anchors is used armature rods various diameter of A500 grade. Concrete class according on durability to compression for Beams is foreseen B40 and for monolithic plate – B30.

Each designed bridges have two abutments and seven piers.

First and second piers of Tbilisi – Rikoti Tunnel direction bride are based on strongly attenuated thin layer sandstones and clay in turn on ground and the

rest piers are based on weak attenuated thin-layered sandstones and clay in turn on ground.

Bottom of the piers is made of concrete that class according to durability at compression is B40. Foundation has two steps from river flow with half circle endings. First (lower) step width (along bridge) of foundation is 6,0 m and length (across bridge) is 12,0 m. Second step sizes are 3,8x10,0 m. First step is 4,0 m in height and second is 3,0 m.

Pier body is made of two oval shaped monolithic concrete pillar with 1,8x2,5 m amplitude size and with different height according to the bridge linear profile. Pillars at the top are united with rectangular profile girder. Middle part profile sizes are 2,2x1,4 m and at the ends - 0,6 m, girder length is 14,20 m.

Abutments are constructions made of three 20 m length and 1,5 m diameter drilled-break piles, that on the top are united as case wall, wings and under farm plate made in solid Rostverk length 12,7 mand height 1,2 m and thickness 1.92 m. Wings length are 3,3 m and thickness varies between 0,3-0,5m.

Construction armature is foreseen for A500 class and concrete class on durability to compression is B25.On piers are placed support parts of Spam structure of rubber steel (elastomers).

Pierconstruction is recommended to becarried-out during low water.

Construction of bridge passage part is of 7cm thick asphalt concrete layer on concrete monolithic plate.

Bridge passage and one-sided sidewalks also passage and dividing line is divided with bars constructed within spam structure monolithic desk. Railings are made of rolling steel of individual design.Water from the passage is taken away with the help of spam structure longitudinal inclination. Between spam structures and between spam structure and abutments is foreseen arrangement ofdeformational juncture construction.

Bridge access embankment is formed from sand gravel ground and embankment slope are guarded to side Tbilisi with Reno-mattress and opposite – turf.

Cattle crossings

The design of cattle crossings was done with consideration of the SST Roads:2009, and SNIP 2.05.03-84 “Bridges and Tunnels. Designing Norms» accepted by the Order #1-1/251 (February 18, 2011) of the Ministry of Economy and Sustainable Development of Georgia,topo-geodezic and engineering-geological field study material. Location of the underpasses is agreed with local Government and RoadsDepartment of Georgia.

Cattle pass construction placed on different pickets is similar. Cattle pass is made of two sections that have construction of monolithic reinforced rectangular profile.

Pipe based on sand grit cover which is 1,5 m thick and on which is arranged monolithic reinforced plate at the heading and at the end where is arranged tooth against slipping. Two section reinforced concrete constructions are placed directly on base plate.

Monolithic reinforced concrete cattle crossing section is a closed rectangular section with holes it 4,0x2,5 meters. In the middle of the cattle crossing, arrange sections joining lateral seam. The thickness of a sidewall is 30 cm, the upper and lower walls' thickness 40 cm. For reinforcement of section used AIII grade bars with different diameter. 1,0 m thick sand concrete equalizer layer made on reinforced concrete construction of pipe. Walls are covered with waterproofing layer which is guarded from sides with half brick sequence wall and from above with 6sm guard layer of fine-grained reinforcement concrete and is reinforced with 6mm diameter AI class armature with 15x15sm unit steel grillage. Cattle crossing concrete class on compression according to durability foreseen by B25. Depth of structure in some cases is arranged according to the height of bulk and in other cases road base cover is of 0,5 m thickness..

On the top and bottom of cattle crossing, arrange heads. Heads consist of sidewalls, and, if it's necessary, the portal wall. Variable sidewalls heights in vertical and horizontal section have trapezium shape and form with longitudinal axis angle 20°. Walls are reinforced from the spatial steel Skeleton AIII grade Ø12 mm steel bar. The concrete rank of wall on compressive according to strength regarded B25.

Between slope walls on the bottom on sand-grit base that is of 30 cm thick is arranged monolithic concrete plate is of 20 cm thick.

The design for the cattle crossing trail at km 0+741.700, km 2+472.500, km 8+154.500 and km 9+824.000 is provided.

Figure 4.7 *Construction of the crossing as a, simple box culvert underpass*

The table below provides a list of road underpasses and their locations.

Table 4.1 *Location of underpasses*

1	0+741.7	Cattle crossing	4 x 2.5
2	1+572.53	Underpass	8 x 4.5
3	2+472.5	Cattle crossing	4 x 2.5
4	5+775.77	Underpass	8 x 4.5
5	8+154.5	Cattle crossing	4 x 2.5
6	9+824.0	Cattle crossing	4 x 2.5

Culverts

To guard road from surface water and flooding and also to implement irrigation system culverts are placed on the terrace. The design of the culverts is developed with consideration of SNIP 2.05.03-84 "Мосты и трубы. Нормы проектирования» approved by the Order #1-1/251(February 18, 2011) of the Ministry of Economy and Sustainable Development other normative documents that are inforce in Georgia.

Construction of culverts is analogical to each other. Culverts represent rectangular section construction consisted of two- three monolithic r/c sections. Culvert is based on different thickness (0,4 ÷1,2 m) thick on the sand – grit bottom, on it is arranged with a 30 cm thick monolithic concrete slab on the top and bottom teeth against of slip-on the foundation of slab placed directly of the reinforced concrete bisectional constructions of culvert.

Monolithic reinforced concrete culvert section is a closed rectangular section with holes it 1,25x1,50 meters. In the middle of the culvert, arrange sections joining lateral seam. The thickness of a sidewall and the upper and lower wall's thickness are 20 cm, to haunch – 40 cm. For reinforcement of culvert used AIII grade bars with Ø12 work bars, AI grade with Ø8 – for constructive bars. 1,0 cm thick sand concrete equalizer layer made on reinforced concrete construction of culvert. Walls are covered with waterproofing layer which is guarded from sides with half brick sequence wall and from above with 6 cm guard layer of fine-grained reinforcement concrete and is reinforced with 6mm diameter AI grade armature with 15x15 cm unit steel grillage. Culvert concrete class on compression according to durability foreseen by B25. Depth of Culvert in some cases is arranged according to the height of bulk and in other cases road base cover is of 0,5 m thickness.

On the top and bottom of culvert, arrange heads. Heads consist of sidewalls, and, if it is necessary, the portal wall. Variable sidewalls heights in vertical and horizontal section have trapezium shape. Walls are reinforced from the spatial steel Skeleton AIII grade Ø12 mm steel bar. The concrete rank of wall on compressive according to strength regarded B25.

Between the sidewalls, arrange monolithic concrete slab with thickness 20 cm.

In the ultimate sections of culvert on the head of wall will concrete monolithic reinforced concrete parapet for entrap of ground bulk,

The design of the culverts is similar, the difference is in entrance head which is arranged as a well. The well represents rectangular shape construction in the overhang sections, which from the three sides on the top part of wall has arranged trapezium shape water intake hacks. On the bottom of well is arranged variable thickness reinforced concrete base with thickness from 0.2 m to 0.4 m. For the well construction regarded the compressive strength of concrete grade B25, and for the reinforcement - class AIII steel rods.

Underpasses

To ensure the smooth movement on the designed roads and for local (village) movement needs underpass are made.

Design of the underpasees is done with consideration of SNIP 2.05.03-84 "Bridges and Tunnels. Designing Norms» adopted by the Order #1-1/251 (February 18, 2011) of the Ministry of Economy and Sustainable Development of Georgia, other normative documents in force in Georgia,topo-geodesycal and engineer-geological field research materials. Location of underpasses is agreed with local government and leadership of Roads Department of Georgia.

Constructions of underpass mainly are similar. Underpass is building monolithic reinforced concrete construction with rectangular profile. Structure are on sand grit cover, which is 1,5 m thick, and on which is arranged monolithic reinforced plate at the heading and at the end where is arranged tooth against slipping. Two section reinforced concrete constructions are placed directly on base plate.

Monolithic reinforced concrete culvert section is a closed rectangular section with holes it 8,0x4,5 meters. In the middle of the culvert, arrange sections joining lateral seam. The thickness of a sidewall and also the upper and lower walls' thickness are 70 cm. For reinforcement of structure used AIII grade bars
with different diameter. 1,0 cm thick sand concrete equalizer layer made on reinforced concrete construction of culvert. Walls are covered with waterproofing layer which is guarded from sides with half brick sequence wall and from above with 6 cm guard layer of fine-grained reinforcement concrete and is reinforced with 6 mm diameter AI grade armature with 15x15 cm unit steel grillage. Structure's concrete class on compression according to durability foreseen by B25.

On the top and bottom of structure, arrange heads. Heads consist of sidewalls, and, if it's necessary, the portal wall. Variable sidewalls heights in vertical and horizontal section have trapezium shape. Walls are reinforced from the spatial steel Skeleton AIII grade Ø12 mm steel bar. The concrete grade of wall on compressive according to strength regarded B25.

At the underpass is covered with 4,0 cm thick asphalt concrete layer.

Between slope walls on the bottom on sand-grit base that is of 30 cm thick is arranged monolithic concrete plate is of 20 cm thick.

At the ultimate sections at the top of the wall, will made monolithic reinforced concrete parapet to restrain base ground of road

In total,along the design section, around 30 reinforced concrete culverts will be arranged. The structure will be covered with 2-3 cm thick fine-grained concrete layer, on the outer surface water proof insulation will be done.

Table 4.2 Location of the culverts according to the FS (Dimensions 1.25x1.5)

#	Location	#	Location	#	Location	#	Location	#	Location
1	0+190.72	7	0+668.44	13	1+831.90	19	4+667.45	26	8+111.16
2	0+434.76	8	0+732.37	14	2+456.34	20	5+068.67	27	8+401.26
3	0+668.44	9	0+859.48	15	2+685.41	21	5+088.14	28	8+582.60
4	0+732.37	10	1+194.00	16	3+522.24	22	5+765.44	29	9+478.34
5	0+190.72	11	1+438.40	17	4+084.35	23	6+880.37	30	10+174.12
6	0+434.76	12	1+590.72	18	4+281.30	25	7+676.32		

4.2.2 Design parameters of the road

Cross section parameter

According to the road classification, the following design speeds are to be used:

- Flat and undulated terrain 120 km/h
- Hilly terrain 100 km/h

According to the Georgian standards, the geometrical parameters of the project road section referring to the design speed of 120 km/h are as follows:

- Number of lanes: 4
- Lane width: 3.75 m
- Carriageway width: 2 x 7.50 m
- Shoulder width : 3.00 m (paved) and 0.75 m berm (unpaved)
- Median width: 5.00 m (including barriers and paved shoulder)
- Total road width 27.50 m

According to the Georgian standards, the geometrical parameters of the project road section referring to the design speed of 100 km/h are as follows:

- Number of lanes: 4
- Lane width: 3.50 m
- Carriageway width: 2 x 7.00 m
- Width of shoulder: 2.75 m (paved) and 0.75 m berm (unpaved)
- Median width: 5.00 m (including barriers and paved shoulder)
- Total road width 26.00 m

The minimum cross fall in the carriageway is 2.5 % with an unpaved shoulder inclination of 4 % for all design speeds.

4.2.3 Design speed

According to road classifications, the following projected speeds are used:
Aflat and slithly notched relief 120 km/h
Hilly relief 100 km/h

4.2.4 Horizontal and vertical alignment parameters

The minimum recommended radius shall be specified taking into account forces arise during driving through a curve.Considering the design solution adopted for the road section, the main design parameters are as follows:

Design elements	Design Speed	
	100 km/h	120 km/h
Min. horizontal curve radius	450 m	700 m
Max. inclination	5 %	4 %
Min. incurved curve radius	10,000 m	15,000 m
Min. whipped curve radius	3,000 (1,500) m	5,000 (2,500) m
Note: Values (volumes) in parenthesis are allowed only in hilly reliefes		

However it should be noted that the horizontal alignment will generally follow the existing road, but with possible spot realignments at locations where the current design may jeopardize traffic safety.

4.2.5 Sight Distance

The sight distance of stopping (braking) shall provide the visibility of any object higher than 0.20 m above the surface in traffic lane. The height of the eye of the driver is considered to be 1.2 m above the surface of carriageway. The required distance between driver and object depending on the design speed is given in Table.

Design speed (km/h)	100	110	120
Sight distance of stopping (meters)	200	225	250

The sight distance of decision making is relative long in distance, which allows the driver to perceive the whole direction of road safely and get ready promptly and carry out manoeuvres necessary for driving (speed increase, speed reduction, change of line etc.).

The design parameters for sight distance of decision making are given in Table

Designspeed (km/h)	100	110	120
Sight distance of stopping (meters)	300	325	350

4.2.6. Value of bend on horizontal curves

Theminimumvalueofradiusinhorizontalcurveswith-crossslopeof2.5%isdependingonthedesign speed.Theradiusescorrespondingtominimumvalues of bendare presented in-theTable

Design Speed (km/h)	100	110	120
Horizontal curve radius (meters)	2300	2700	3300

4.2.7. Carriageway expansion

Curvewideningisrequiredif the curveradius islessthan1,000m. Thewidening-will always bedeveloped at the insideof thecurve. Therecommended widenin-gamountisshown in the Table

Radius (m)	>850	650	575	425	325	225	140	95	80	70	60	50	40
Expansion W(m)	0,4	0.5	0.6	0.7	0.8	0.9	1.2	1.4	1.5	1.6	1.7	1.8	2.0

4.2.8 Traffic signs and sign arrangement works

Road signs of individual designing and pillars' constructions are elaborated by taking into account Construction norms and rules 2.03.01-84, 2.05.02-85, II-23-81, III-18-75, State standards (GOST) 10 8.7, 8713-79, 5264-806, 23457-86 and TEM standards requirements.

Selection of road signs and types and sizes of marking has been carried out by taking design speeds into account: on the highways – 120 km/h, at the road's junctions with the local (secondary) roads – 60 km/h. Respectively, the sizes of marking (layout) lines and road signs on the highway exceed their analogues at the junctions destined for local roads.

According to standards, security barriers (guardrails) will be installed on straight paths in the plan and on all embankments having big radiuses, work-

ing marks of which are equal or exceed 3.0 m. On those curves, radius of which is less than 600 m, barriers will be installed on every embankment, working marks of which are equal or exceed 2.0 m.

According to the technical standards acting in Georgia, which are in accordance with international requirements, guide posts along the whole length of the road, on straight paths in the plan and curves, radiuses of which exceed 600 m will be installed. On the curves, radiuses of which are less than 600 m, intervals l_0, l_1, l_2, l_3, l_4 will be taken according concrete values relevantly to the table below.

R	l_0	l_1	l_2	l_3	l_4
80	5	15	20	30	40
120	10	25	35	45	50

The guide posts will be located also on both sides of culverts 5 pieces on each side according to the following scheme: 1,5m interval on the axis, 2,10m –within the interval of 2 m.

Location list		
№	Pole location	Working Marks, m.
1	1+90.0	1.9
2	4+35.0	2.1
3	6+69.0	2.9
4	7+31	2.1
5	8+60	2.3
6	11+94	3.6
7	14+38	3.4
8	15+91	3.7
9	18+32.0	2.9
10	24+56.0	3.6
11	26+85.0	1.7
12	35+22.0	1.7
13	40+85.0	3.5
14	42+81.0	1
15	46+67.0	2.5
16	50+69.0	3
17	50+88.0	6
18	57+65.0	2.4
19	68+80.0	1
20	76+76.0	4.1
21	81+11.0	2.4
22	84+00.0	2.8
23	85+83.0	2.5
24	94+78.0	2.1
25	101+74.0	

4.2.9. Pavements

Two different pavement structures will be used:

- Concrete pavement structure for the motorway
- Asphalt pavement structure for all Slip Roads and all Minor Roads

The following shall apply to the motorway, concrete pavement structure, construction category I:

28 cm	Concrete;
30 cm	Crushed Aggregate Course ;
27 cm	Granular Base Course;
85 cm	Total Pavement Construction.

The following shall apply to slip roads and minor roads, asphalt pavement structure, construction category III

4 cm	Asphalt Wearing Course;
4 cm	Asphalt Binding Course;
14 cm	Asphalt Bearing Course;
58 cm	Granular Base Course;
80 cm	Total Pavement Construction.

Concrete pavement

Concrete pavements are already constructed on preceding sections of the highway. The pavement designs for the constructed sections were carried out in accordance to the German pavement design standard RStO 01. Due to the good performance of the constructed concrete pavement, RD requested a rigid pavement design alternative in accordance to the German RStO 01. Unreinforced concrete pavement structures are suitable in normal applications except where differential movement, subsidence or appreciable settlements are expected.

The proposed pavement structure was designed according to "AASHTO, Guide for Design of Pavement Structures" and according to "RStO 01 the German Guideline for determination of Pavement Structures". Traffic load and other design parameters were evaluated for a 20 year design life cycle. At this stage of the project the pavement design and determination of the layer thicknesses aims at a constant pavement structure along the full length of the road which is suitable for the varying traffic loads.

The recycling and reuse of the old asphalt pavement material is considered a basic requirement and will also add to the reduced need of new material. The cold mix recycling method should be considered for the whole length of the existing road.

4.3 Project alternatives

The Feasibility Study consultant has initially considered five alternative alignments for the road section under study (see Figure 4.6), which were subject to an initial technical appraisal by Kocks and an environmental/social appraisal by NKUK:

- ***Agara Bypass North*** extends KB1 and 2 eastwards around the north of Agara and rejoins the E-60 west of Aradeti.
- ***Gomi-Agara Bypass South 1*** includes two bypasses to the south of Gomi and Agara, and widening the existing road between Gomi and Agara and Agara and Urbnisi.
- ***Gomi-Agara Bypass South 2*** includes a new route to the south of Gomi and Agara, leaving the E-60 west of Gomi and rejoining to the west of Aradeti.
- ***Aradeti realignment*** takes a route approximately 0.5 km south of the existing highway, to provide a smoother curve.
- ***Wideningthe existing road*** - widening the existing carriageway between Gomi and Urbnisi, with no bypasses.

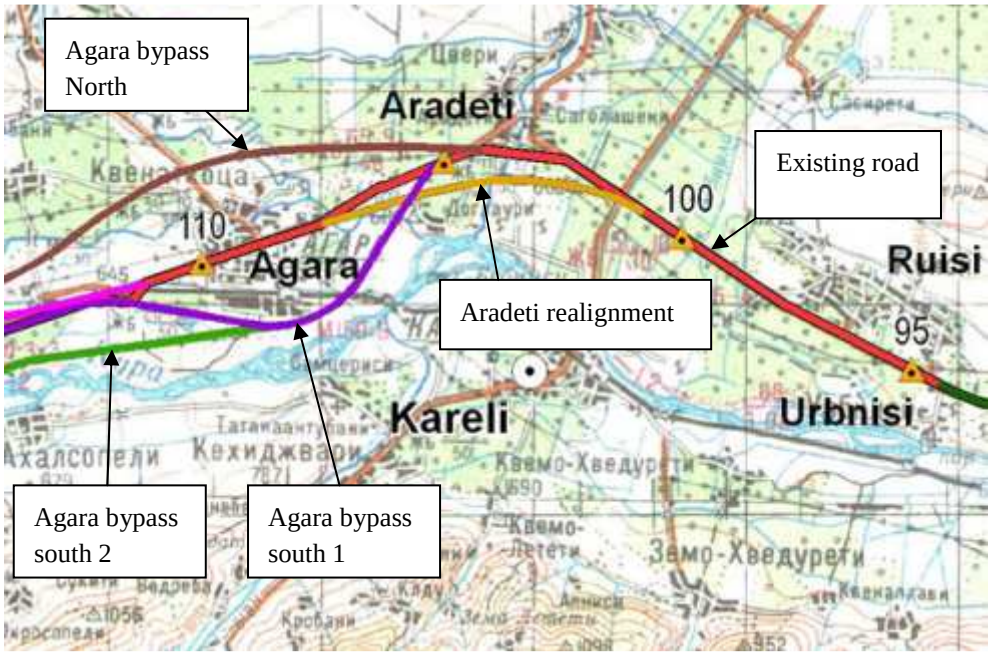


Figure 4.8 *Alternative route alignments subjected to technical and environmental/social appraisal*

Agara Bypass North would start at km 104. The proposed bypass would make a large loop north of Agara and would continue westwards between the villages Moxisi and Agara before joining the Khasuri bypass alternatives north of Gomi. Considering the impact of the northern alternative on the agricultur-

al (private) land and the negative attitude of the regional stakeholders on land needs of the most productive soils, it is ***recommended to exclude*** this alternative from further evaluation.

A Gomi/Agara Bypass South 1 alternative to bypass Agara and Gomi was developed to avoid impacts on the agricultural land north of the existing road. The southern alternative would branch off the Aradeti village and make a loop around Agara. Alternatively the Agara south bypass branch off at about km 106 from the existing road. At km 111.5 the bypass will join again the existing road. The proposed alignment would avoid demolishing of buildings, but cross partly private land parcels.

Gomi-Agara Bypass South 2 was developed in order to straighten the south alternatives for bypassing Agara and Gomi by connecting directly the proposed southern bypass of Agara with the proposed southern bypass of Gomi. This alternative would shorten the south alternatives by about 0.5 km and would minimise land acquisition, since most part of the alignment is located within the Mtkvari river basin. Gomi-Agara bypass south 2 alternatives are located within the Mtkvari River basin and would require additional measures to protect the road from flooding. This option performs more poorly than the other southern alternative and therefore ***is not recommended for further evaluation***.

Aradeti realignment - for smoothening of the road alignment and locating the road away from the village of Aradeti, an alignment improvement was considered between km 101 and km 108. The proposed alignment would shift the existing road approximately 600 m to the south in order to reduce noise and pollution levels for the population of Aradeti. The proposed realignment would reduce the road length by about 430 m (Figure 4.9). At the same time it would require a substantial acquisition of land including the loss of some agricultural land. The new alignment would make an adverse impact on archaeologically vulnerable area and would be more unfavourable from an environmental point of view than the widening of the existing road. The advantages of the alignment alternative are mainly related to a smoother alignment and reduction of the route length. Though an important step in the improvement of traffic safety in the Aradeti alignment alternative is seen by the regional stakeholders, the Aradeti alignment alternative is ***not recommended for further investigations*** and evaluations due to the need of extra land and the potential of an adverse impact on a significant archaeological site.

Both alternatives of upgrading of the existing road to a four-lane standard or bypassing Gomi and Agara to the south meet the initial evaluation criteria and therefore are recommended for further study (Figure 4.2).

Relying on the information given above EIA report includs analysis and comparison of:

- *The **"zero" alternative** - assuming that the project was not implemented;*

- *Upgrading of the existing road to a four-lane standard, without changing present road alignment* - ***Project alternative 1****;*

- *Gomi-Agara Bypass South 1* ***Project alternative 2****.*

Taking into account the above mentioned and in case of carrying out mitigation measures, the expansion of the existing road and Agara bypass south route is considered a prioritized alternative

4.4 Traffic volume

According to the Roads Department, the traffic in 2008 averaged between 5.800 and 9.100 vehicles per day on the existing road sections. Travelling westwards traffic flow splits at the intersection of E-60 and the Khashuri – Borjomi Road in Khashuri. The main traffic flow continues along the E-60 corridor towards Rikoti Tunnel and about 1/3 of traffic continues westward towards the city of Borjomi.

Recent traffic flows data in the studied road sections is missing. However comprehensive traffic survey was implemented by Kocks Consult during the preparation of the Feasibility study. Available traffic flow data was adjusted using daily and seasonal conversion factors and linked with forecasted economic growth in the country.

Annual and daily average traffic and its composition at selected locations in the study corridor was included in the EIA report (according to the traffic survey performed by Kocks Consult).

4.5 Road construction phase

4.6.1 Mobilization

Prior to commencement of works, the contractor must identify the location of the camp, equipment stationing area and agree on/receive a permit for its use from the state or the land owner.

Preconstruction activities connected with the Highway rehabilitation works specified in the project documentation include the following:

- Preparation of temporary camp sites in the vicinity of the road bed at the eastern and western portals of the Highway in accordance with environmental requirements;
- Selection of temporary disposal sites for construction debris of the Highway and surplus material of the road;
- Land acquisition/compensation (road-site, commercial, orchards, etc);

- Obtaining permits for the operation of asphalt/concrete plants;
- Obtaining mining licenses or concluding sub-contracts for the supply of aggregate materials;
- Developing waste management plan and having it approved by the client;
- Developing traffic management plan and having it approved by the client;
- Development of work camp or construction yard site map and having it agreed with the client.

An approximate area for the camp is from about 3ha to 5ha. Selection of the camp site must be done in consideration of land ownership/land use and environmental aspects. The site must not be closer than 100m to any surface water body. Alternatives for the site selection are presented below with related advantages and disadvantages to consider.

Alternative 1. The only 'free' uncultivated space within the project section of the road potentially available for the camp is near the bridge over the Prone.

Alternative 1 - Advantage	Alternative 1 - Disadvantage
Vegetation is sparse; The area is not developed, which means that loss of arable land or harvest is not envisaged and impact on vegetation is low The area is located near the river – water can be used for technical needs	The site is in the area potentially considered as sensitive from the viewpoint of archaeological importance Landform of the area – slanting towards the river Location near the surface water body – if the works are not organised properly, there is a risk of surface water pollution

Alternative 2. Another option is a temporary land take of cultivated land.

Alternative 2 - Advantage	Alternative 2 - Disadvantage
Enough space for the camp The area is flat Distant from the river,- i.e. less risk of water pollution	Temporary loss of arable land for the camp and road accesibility Loss of crops/harvest and related income of the owner Potential impact on soil Need for compensation Technical water to be carried in by tank-cars – increased traffic and related impacts

Alternative 3. Setting up an equipment yard, instead of a camp. Workers moving daily to and from the operation ground.

Alternative 3 - Advantage	Alternative 3 - Disadvantage
Less space required, i.e. less impact on the environment Less water required – no need of the on-site canteen, showers If the personnel is stationed in the settlement, additional income for the residents.	Will depend on the site selection of the equipment stationing yard.

Keeping in mind that offsetting up a camp and an equipment yard is not related to any serious earthworks/excavations and any permanent buildings or structures, Alternative 2 or Alternative 2+3 may be less damaging on condition that the sites will be managed with strict adherence to all environmental requirements by the contractor.

However, prior to final decision-making, all advantages and disadvantages must be carefully rated.

Recommendations for selection and management of the site. Prior to the camp site selection and setting up a temporary access roads by the contractor, special attention must be given to the landuse and available vegetation of uncultivated areas. The site/route must be selected so as to minimize impact on vegetation. As far as feasible, the plot devoid of trees and shrubs must be given a priority. The site must be cleared of vegetation.

Should any trees be cut, timber may either be used during the construction or given to the community as fire wood. Procedure includes - handing over the timber to the Ministry of Economy by the RD, signing a takeover certificate allowing the municipality to dispose of the timber locally. Following to that the timber can be given to community at discretion of the local authorities. Should some of the tree belt be damaged, it must be restored aftercompletion of the works. Same species of the trees should planted to 'offset' the loss.

Top soil must be removed and temporarily stockpiled in a preselected area. The amount of the topsoil with consideration of the area required for the camp/yard (3-5 ha, top soil thickness about 0.25m) will be about 750 – 1,250m^3. Adequate measures for protection of the top soil storage area from runoff and wind must be provided until subsequent reintroduction. After completion of works, removal of all temporary facilities and waste the topsoil must be 'returned', the site restored to the status close to the initial.

Bio-toilets are recommended for the sewage purposes.

With consideration of the landform and location of the selected site, the runoff management and discharge options must be looked into and agreed with the Ministry of Environment Protection. If there is a risk of soil pollution with spilled fuel/oil, the storm water drainage system must be equipped with an oil trap.

All other wastewater (from showers, canteen, etc) must be collected, settled and treated prior to discharge.

For onsite storage of fuel/oil special precautions must be undertaken. The storage area must be protected with impermeable layer to avoid percolation into the ground. The secondary containment capable to retain the amount stored in the fuel/oil tank should provided. The fuel dispatch point must be equipped with a drip tray. The installation of fuel storages and fuelling/maintenance of machinery closer than in 50m from the riverbed is prohibited.

Domestic waste generated at the camp site must be temporarily stored in containers fitted with lids to avoid attraction of scavengers or scattering around by wind. An agreement with a waste collection service must be reached. Waste must be regularly removed to agreed landfill under the mentioned contract and agreement with local municipality.

Separate area should be provided for the collection of other waste. Waste must be separated. Scrap metal, if any - subsequently delivered to scrap metal collection points in the area. Inert waste may be reused for the needs of the project or under agreement with relevant authrities elsewhere in the region. The rest – disposed to the landfill as agreed with the local municipality.

Access roads must be routed so as to avoid unnecessary damage of vegetation, soil. Existing roads must be used to the possible extent. As soon as defined, the rout should be strictly kept to. No shortcuts should be allowed.

Responsibility for proper environmentally sound management of the sites (camp, yard, operation ground, access roads) and implementation of mitigation measures must be defined in the contract between the Roads Department and the contractor.

4.6.1.1. Water supply and waste water management

According to technical specifications prepared for the tender, construction contractor is responsible for provision of technical water, lighting, power supply for the project and pays relevant fees. Contractor is to ensure portable water supply – including temporary reservoirs, and pipes, which, upon the completion of work, will be removed from the area.

Contractor is obliged to develop and agree work organization plan which is to cover main units/facilities such as fuel and material storage, concrete mixer, car wash, etc. (whichever available).

Water supply

Water is used for drinking and industrial purposes. Drinking and domestic water source depends on the construction camp location.

At the moment, exact number of staff and the number of personnel to be accommodate in the camp is unknown. Base on experience from other similar project we can suppose that the total number of employees will be about 200.

In case construction contact will be given to a foreign company we can assume that around 70% of the employed will be local. The local staff living close to the project site, there will be no need to provide accommodation. Although, the calculation presented below is done with consideration of 200 'water users'.

Due to the fact that the territory is an inhabited zone, the nearest water supply can be used for drinking-household purposes. In case a portable water reserve is needed reservoirs made of material allowed for use in contact with food products can be used, for technical water – metal reservoir can be provided.

Assuming 200 employees in the camp and 25 liters per capita per day consumption rate, water demand calculated for 250 business days a year totals:

$$200 \times 25 \times 250 = 1250\ m^3/sec,\ 5\ m^3/day$$

Water will also be needed for operating showers. According to the construction norms and rules, the rate per person per day totals 500 liters. In case of three showers, the needed amount of water per year will be:

$$3x500x250=375\ m^3/sec,\ 1.5m^3/day$$

The total amount of portable water per year consumed during construction phase will be $495m^3/y$, $1.95m^3/day$

Surface waters can be used for industrial purposes. Three rivers flow in the project area (Prone, Ptsa and Mtkvari). High water is observed in spring and autumn. Water level in summer is stable, in winter-versatile. Rivers are fed by snow, rain and underground waters. Water is used for irrigation. As the water consumption depends on the volume of atmospheric water, in some/drought years, water consumption in Ptsa and Prone can be reduced, accordingly, alternative water sources must be found.

Assuming, the construction camp will be equipped with proper infrastructure, including: parking lots for cars and equipment, concrete unit (possibly), technical workshops, wood processing unit (possible), storages for construction materials, etc. Proprity will be given to commercial car washing facility, however, if a car wash is arranged onsite, 5 units of construction machinery and transportation means will be possible to wash every day. Assuming that to wash one vehicle 350 liters of water is used, with consideration of 250 operation days, amount of water needed for washing vehicles will be:

$$5x350x250=12.5m^3/sec,\ 0.25\ m^3/day$$

For operating a concrete factory, the needed amount of water depends on the volume of production. On average concrete unit with capacity $50m^3/h$ uses $0.3m^3$ water per m^3mixture of concrete. Considering that the concrete factory will work one shift, 160 day a year, which means that amount of concrete will be $160x8x50=64{,}000\ m^3/year$. Accordingly, required water volume will be

$$64{,}000x0.3=19{,}200\ m^3/sec.$$

Hence, the estimate amount of technical water needed for technical water supply of the construction camp will be $19212.5\ m^3/sec$.

Sanitary and other waste waters

Volume of sanitary waste water is estimated as volume of consumed portable water, minus 5% loss, i.e. sanitary waste water volume will be around 470 m^3/y, 1.9m^3/day.

Due to the fact that there are no sewage systems in villages, bio toilets or collector pits (considering the volume of waste water) will be designated on the site. Collected waste water will be removed according to the agreement made with the local municipality.

Because the water used in concrete production is fully consumed in technological processes. In case decision is made to arrange car wash area on the site, generated waste water volume will be 95% of the total used water (5% difference is due to evaporation or other reasons). Correspondingly, the amount of waste water will be 11.9 m^3/year, 0.05 m^3/day. For treatment of the car wash waste waters, compact oil trap must be installed. However, as already mentioned above, preference will be given to washing vehicles at a commercial car wash.

Waste water treatment

Composition of sanitary waste water generated at the camp site must comply with the 91/271/EEC (May 21, 1991) requirements for urban waste water of, inparticular:

- Suspended solids -30mg/l
- Biological oxygen demand (BOD) - 25mg/l
- Total nitrogen-15 mg/l
- Total phosphorus-2mg/l

For industrial waste water, the oil trap (removal of oil products and suspended solids) must provide a total petroleum hydrocarbon concentration <0.3 mg/l, suspended particle concentration-30 mg/l.

Waste water will not be discharged into the surface water body.

4.6.1.2. Power Supply

According to the technical specification prepared for the tender, contractor is responsible for provison of power supply for the object and is entitled to pay relevant fees. Power supply will be from the state network.

4.6.2 Road construction works

The construction process involves a variety of activies, such as:

- RoW cleaning via excavators/bulldozers and removal of debris to agreed location.
- Trench arrangement with a backhoe crawler excavator for drain systems and ditches.
- Ditch arrangements from reinforced cement-concrete.
- Soil rolling with hardware. Import of inert materials with trucks, roll 500-800 mm for railway bed formation.

- Ready-made concrete filling with special vehicles for 280 mm concrete pavement arrangement.
- Handling the road upper layer manually; Unifying spot resilent carburizing; road marking; Barrier and traffic sign arrangement;
- Repair works for the existing highway if needed-mainly small scale works, with the means of backhoe crawler excavator, concreting, etc.
- Landscape harmonization and tree planting.

The Project will comprise the following interventions:

- stripping and stockpiling of topsoil;
- preparation of the ground - clearing (removal of trees, bushes, debris);
- grading operations and the laying of cross-drain pipes/culverts. In fill areas, the grading is brought up in layers and compacted. In cuts, the excavation is carried on until the subgrade elevation is reached, and then the earth is compacted;
- base course forming on the subgrade. The base course material may be gravel, sand, crushed stone, or more expensive and permanent materials;
- surface course forming over the base. This material may be sand, asphalt, blacktop, concrete, or similar materials;
- replacement, repair and rehabilitation of existing bridges;
- construction of selected short bypasses and a new short connection;
- provision of new rest areas at selected sites;
- provision of road furniture and marking in accordance with international standards.

Construction works shall be performed in conformity with valid standards, norms, recommendations and instructions. The works shall be performed in accordance with typical technological diagrams as well as design specifications, following the Best Available Technology practice and provisions set in Technical Specifications (Section VI, Volumen III of the Bidding documents)

It is expected that the construction phase should take up to 24 months

4.6.3 Off-site works

Off-site works will relate to the extraction of construction materials from already existing licensed quarries. The contractor should purchase required materials from an authorised, licensed provider.

During the design stage licensed quarrys were defined, pre-testing of material performed. Results proved that inert material on the project area, in general, fits requirement for fillers, pavements and base materials, but in most cases, needs sieving.

Table 4.3: List of quarries in the Kvemo Kartli region

Region	Distance until the settlement, km		License	Owner	Material	Annual yield
Khashuri	Khashuri	10	00168	Gomi 98	Sand, gravel	38500
Qareli	Akhalsopeli	1.5	00239	Ushangis bichebi	Sand, gravel	90000
Khashuri	Khashuri	3	00326	Kama	Sand, gravel	180000
Khashuri	Khashuri	3	00326	Kama	Sand, gravel	180000
Khashuri	Khashuri	3	00326	Kama	Sand, gravel	180000
Khashuri	Agarebi	0.5	00368	Guram Kilaberidze. P.e	Sand, gravel	300000
Khashuri	Khashuri	5 - 10	00369	Guram Kilaberidze. P.e	Sand, gravel	400000
Qareli	Mokhisi	3.5	00386	Gzebi +	Sand, gravel	150000
Khashuri	Station Gomi	3	00398	Akvariumi	Sand, gravel	220000
Qareli	Qareli	8 - 10	00450	Rostom Mikhanashvili. P.e	Sand, gravel	200000
Gori	Gori	8 - 9	00459	Valeri +	Sand, gravel	50000
Qareli	Qareli	8 - 10	00502	Balasti X	Sand, gravel	400000
Qareli	Urbnisi	1	00518	Deltekari	Sand, gravel	200000
Qareli	Station Qareli	4	00527	Broli	Sand, gravel	115000
Qareli	Station Qareli	0.5 - 1	00550	Bazaltis industrial	Sand, gravel	142000
Qareli	Agara	0.6	00553	Bazaltis industrial	Sand, gravel	142000
Qareli	Station Agara	1.5	00570	Givi Gakashvili P.e	Sand, gravel	70000
Qareli	Qareli	8	00616	Pent holding	Sand, gravel	40000
Gori	Gori	1 - 1.5	00649	Serviceair Ltd	Sand, gravel	800000
Khashuri	Khashuri	1.5	00693	Sergo Betashvili .	Sand, gravel	143550

Khashuri	Khashuri	5	00775	David Kharazishvili	Sand, gravel	30000
Khashuri	Station Gomi	2	00874	David Belidze	Sand, gravel	50000
Khashuri	Khashuri	4	00889	Teona Ltd	Sand, gravel	177900
Khashuri	Khashuri	4	00889	Teona Ltd	Sand, gravel	177900
Khashuri	Khashuri	12	00938	Gomi alkohol and spirit production	Sand, gravel	25000
Khashuri	Khtsisi	1	01009	Solomon Akhalkatsi	Sand, gravel	263700
Khashuri	Khashuri	2	01079	Teona Ltd	Sand, gravel	9300
Gori	Khidistavi	0.5 - 1	01080	Horizonti Ltd	Sand, gravel	255600
Khashuri	Khashuri	5 - 6	01120	Akvariumi Ltd	Sand, gravel	84600
Khashuri	Khashuri	2.5	01181	Givi Mchedlidze	Sand, gravel	73800
Khashuri	Khashuri	2.5	01181	Givi Mchedlidze	Sand, gravel	73800
Khashuri	Khashuri	2.5	01181	Givi Mchedlidze	Sand, gravel	73800
Gori	Gori	3 - 4	100003	Revaz Gogiashvili	Sand, gravel	617100
Gori	Gori	3 - 4	100003	Revaz Gogiashvili	Sand, gravel	617100
Khashuri	Khtsisi	2	100133	Tamaz Shatirishvili	Sand, gravel	93900
Gori	Station Uflistikhe	1	100179	Mshenebeli Ltd	Sand, gravel	66300
Khashuri	Khashuri	4	100187	David Kiparoidze	Sand, gravel	137000
Khashuri	Khashuri	4	100187	David Kiparoidze	Sand, gravel	137000
Gori	Gori	1	100277	Nuovo Global Ltd	Sand, gravel	186600
Gori	Gori	3 - 4	100318	Agmashenebeli Ltd	Sand, gravel	59400
Khashuri	Tskhramukha	1	100397	Datuna 2006 Ltd	Sand, gravel	180000
Gori	Skra	1	100400	Malkhaz Tramakidze	Sand, gravel	60000

Gori	Khidistavi	1,5	100430	Kakhaber Songulashvili	Sand, gravel	55000
Qareli	Qareli	2,5	100441	Rocco Agostino e figli Ltd	Sand, gravel	173100
Khashuri	Kriskkhevi	1,8	100465	Teona Ltd	Sand, gravel	160000
Khashuri	Khtsisi	1	100550	Progresi Ltd	Sand, gravel	86400
Khashuri	Khtsisi	1,7	100551	Progresi Ltd	Sand, gravel	151800
Khashuri	Khashuri	4 - 5	100816	JSP + Ltd	Sand, gravel	0
Khashuri	Khashuri	4 - 5	100816	JSP + Ltd	Sand, gravel	0
Khashuri	Tskhramukha	1.1 - 1.2	100901	Gza 2009 Ltd	Sand, gravel	26100
Khashuri	Kvishkheti	2 – 2.5	100965	Msheneblobis ganviTarebis kompania Ltd	Sand, gravel	131000
Khashuri	Khashuri	10	00290	Organizacia-beTania Ltd	Quartz Sand	50000
Khashuri	Khashuri	10	01188	Samsheneblo qvisha Ltd	Quartz Sand	310200
Gori	Sveneti	1.5	100146	Givi Abalaki mermeze	Sand, gravel	520000
Gori	Sveneti	1.5	100146	Givi Abalaki mermeze	Sand, gravel	520000
Gori	Akhalsopeli	1.5	100458	Ashtrom International Ltd	Crushed Stone	172000
Gori	Sveneti	1,2	100526	Ashtrom Contracting Georgia Ltd	Sand, gravel	123200
Gori	Gori	5 - 6	100565	Ashtrom International represent.	Sand, gravel	336000
Khashuri	Odzisi	1,5 - 2	100771	Sak.Sasheni	Quartz Sand	274500
Khashuri	Kemperi	0	559	Alkazar Ltd	Quartz Sand	700000
Khashuri	Kemperi	0	559	Alkazar Ltd	Quartz Sand	700000
Khashuri	Station Khashuri	5 - 6	01028	Levan Gelashvili	Sand	9000
Khashuri	Khashuri	5 - 5,5	100847	Guram Kilaberidze	Quartz Sand	77000

Table 4.4: *Data onquarries along the road*

№	Quarry Owner	Li-cense #	Location	Explored resources. m^3	Annual yield,m^3	Location towards the existing road	Distance tothe project area, km	Product
1	Basaltindustria Ltd	00550	Kareli municipality. Mtkvari riverbed, 1 km from Kareli station	10,687	142	A turn towards Bebnisi village on the 5th km of the designed highway	3.5	Sand and gravelcom-pound, crushed stone, sand
		00553	Kareli municipality, , Mtkvari riverbed, 0.6 km till borough Agara	8,750	142	A turn to south from a road at Mokhisi village	2	Sand and gravelcom-pound
2	Rocco Agosti-no e figli Ltd	100441	Kareli municipality, Mtkvari riverbed, 2.5 kmfrom Kareli	12,250	173	A turn from the existing road towards Doglaura village after the riv. Prone bridge	2	Sand and gravelcom-pound, crushed stone, sand
3	Gzebi + Ltd	00386	Kareli municipality. Mtkvari riverbed, 3.5 kmfrom vil.Mokhisi	150	15	A turn to south from a road at Mokhisi village	1.8	Sand and grit compound

Note: 1) both quarries of Ballast Industry Ltd are well arranged. They have crushers, washing units, excavators and trash collecting equipment. Operation of the 'Gzebi +'Ltd quarry is temporarily halted because of flooding. 2) Material use: stone and gravel is used for concrete and asphalt-concrete production; basalt is used for blanket; gravel - for pavements.

The contractor may run own quarry, but in this case surveys, quality analysis and obtaining licences and permits from relevant authorities (Ministry of Energy and Natural Resources) will be required.

If the contractor decides to use own quarry the following requirements must be met:

- Only licence quarries may be developed;
- If required, erosion protection must be provided;
- Operation and decommissioning of the quarry must be performed in compliance with the conditions of the quarrying license and with due regard of environmental standards
- Upon completion of works, the quarry and the adjacent area affected by the development should be recultivated: the topsoil reinstated, the status of the site restored to the state close to the initial state (for instance, the site may be planted with vegetation).

Sourcing from river terraces

The sourcing site must be agreed with environmental authorities. Previously exploited or new sites may be used if it doesn´t substantially affect the environment. The advantage of using existing sites is that no new sites would be affected by abstraction. The Contractor shall be responsible for locating and selecting materials complying with the Specification and for ensuring that materials processed for incorporation into the Works comply with the Specifications. Material Report developed under the project provides information on available options (quarries) in the region.

Should material be abstrated from the riverbed, the riverbed and the landform must not be affected. Abstraction of gracel should not be carried out in high water period. The operation site must be protected by a gravel mound (up to 2m wide).

4.6.4 Support Facilities and Services

Works will be carried out by the contractor identified through international tendering. Construction camps and workers' yards will be established. The decision on their location is normally made by the contractor, who will need to seek approval for his proposals from the relevant GoG authorities.

5 Baseline data

5.1 Physical conditions

5.1.1 Climate and meteorology

Eastern Georgia has a primarily subtropical climate, influenced mainly by dry air masses from the Caspian and Central Asia in the east, and humid air from the Black Sea in the west, and largely protected from the colder air in the north by the Greater Caucasus Mountains.

The main characteristics are hot summers and relatively cold winters, and significantly less precipitation than in western Georgia. In the lower parts of the study area average air temperatures peak at around 23 °C in July and August, when daytime temperatures often reach 33-35°C, but fall below 20 °C at night. In winter the average air temperature is around 1-2 °C between December and February, and regularly falls below -10 °C throughout this period.

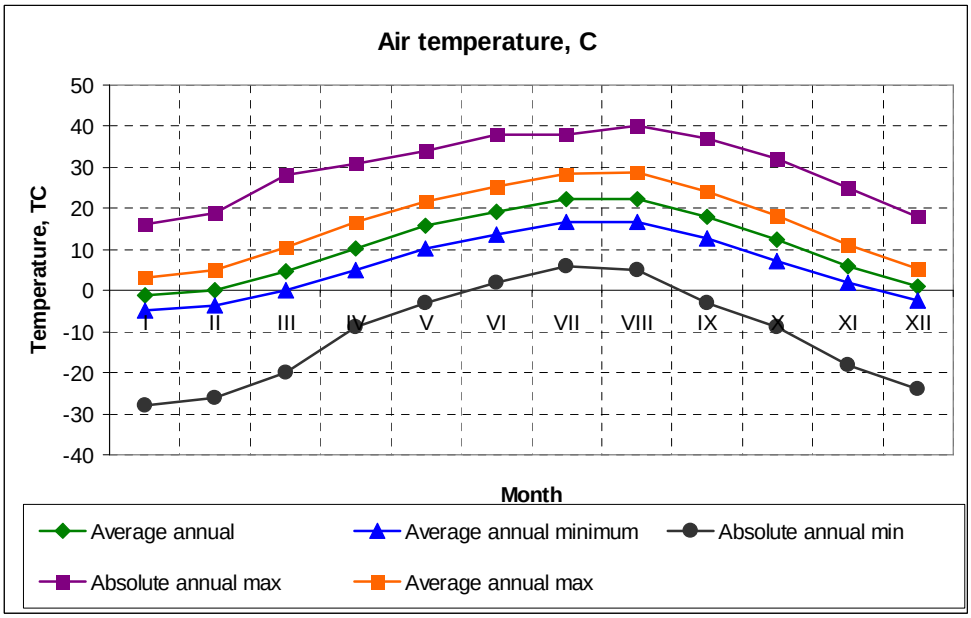


Figure 5.1 *Temperature (according to Gori meteorological observation post, long term observation data averaged values)*

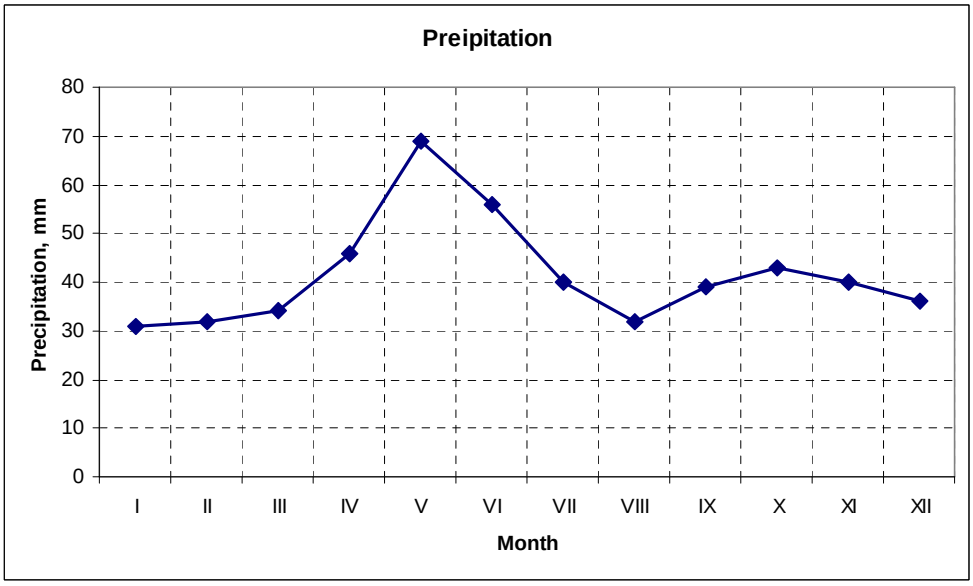


Figure 5.2 *Precipitation (according to Gori meteorological observation post, long term observation data averaged values)*

Annual precipitation on the plain is around 500 mm, and Figure 5.2 shows that spring and autumn are the wettest periods, and that winter is generally drier.

Snowfall is moderate in most winters and the average snow cover on the plain is between 34 to 52 days. Wind speeds are generally quite low, averaging between 1.0 and 1.6 m/s in most months, and winds blow mainly from the north-east or south-west.

Temperatures are significantly lower on the higher ground to the west of the study area, and around the Rikoti Tunnel the average winter temperature is -1 to -3 °C between December and February and only rises to around 17 °C in summer. Precipitation is also much higher in this area, reaching 1100 mm per year, and the annual pattern is different as winter is much wetter than summer, and the average snow cover is between 80 and 100 days per year. Winds are also stronger than in the lowlands, averaging 8-10 m/s in most months, blowing mainly from the east.

Prevailing wind direction and wind speed according to Kareli observation post and wind speed data are shown below in Tables 5.1 and 5.2.

Table 5.1 *Percent distribution of wind direction*

N	NE	E	SE	S	SW	W	NW	Calm
3	0	7	41	1	0	3	45	22

Table 5.2 *Wind speed*

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
m/sec	3.2	4	4.9	5.1	4.6	4.3	4.6	4.3	4.2	3.5	3.4	2.9	4.1

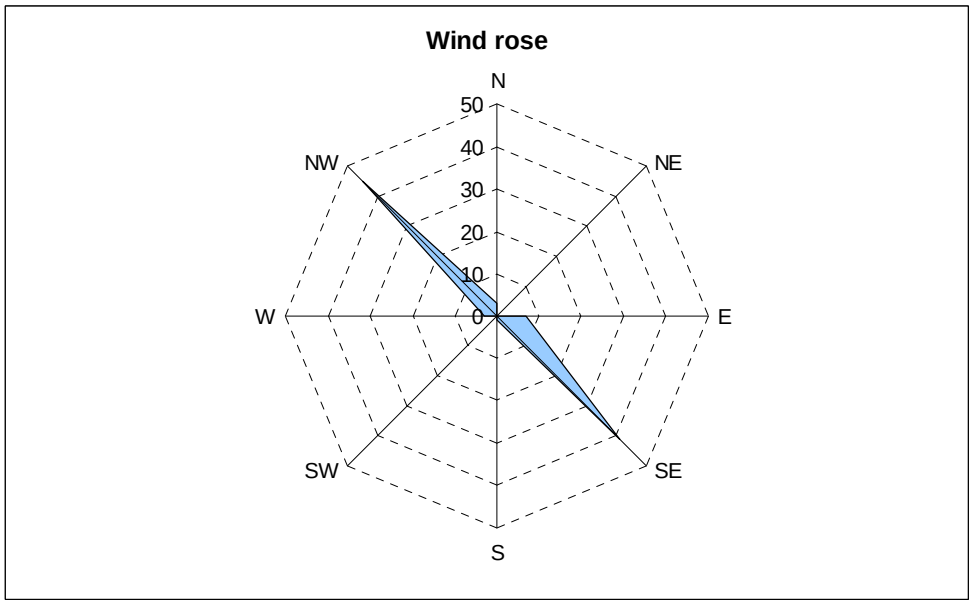


Figure 5.3 *Wind rose (according to Gori meteorological observation post, long term observation data averaged values)*

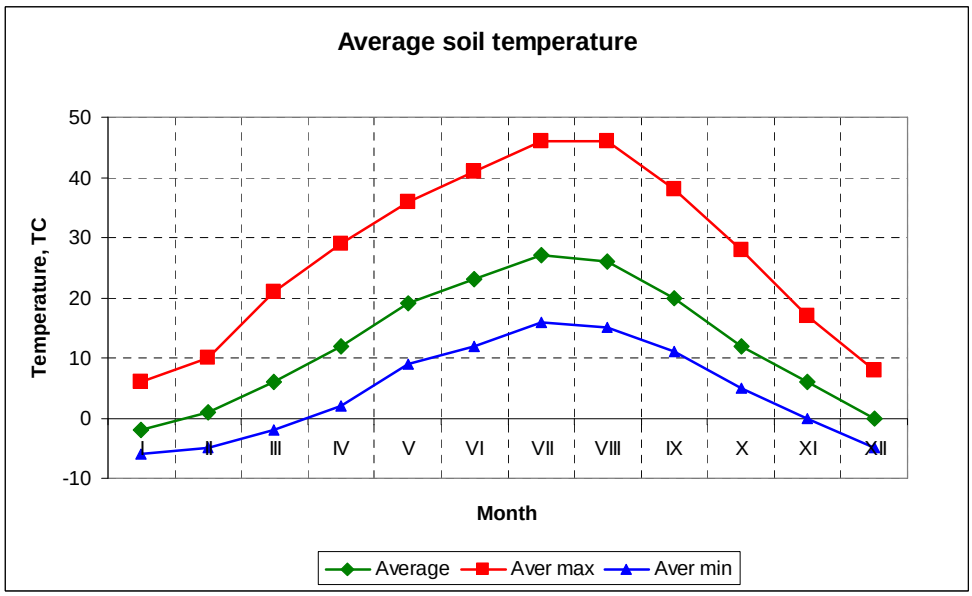


Figure 5.4 *Average soil temperature (according to Gori meteorological observation post, long term observation data averaged values)*

Highest wind velocity, once in 5 years occurrence – 23 m/sec.

Highest wind velocity, once in 20 years occurrence – 26 m/sec.

Normative depth of soil seasonal freezing is 24 cm for clayey soils, 29 cm for sand and silty sands, and 36 cm for coarse fragmental soils.

5.1.2 Geology

The E-60 highway runs through the centre of Georgia, from north-west to southeast, (Figure 5.5). The Ruisi to Agara West section is 95-114 km north-west of the capital Tbilisi, in the River Mtkvari valley immediately east of the Likhi Ridge, which is the natural boundary between the eastern and western Georgia. The highway runs roughly parallel to the river on its northern side. Geologically most of this part of the highway is in the Gori Plain, which is a Neogenic[2]tectonic depression between the two mountain ranges.

The surface of the plain is composed of Quaternary fluvial alluvium (loosely cemented conglomerates[3], clays and sand) deposited by the rivers; and deluvi-al-proluvial material (coarse gravel, shingles, clay and sand), washed from the mountains by rainfall or ephemeral streams.

Topographically the plain is relatively flat, at an altitude of 550-850 m amsl (above mean sea level), with small inclines of 2-4 degrees in places.

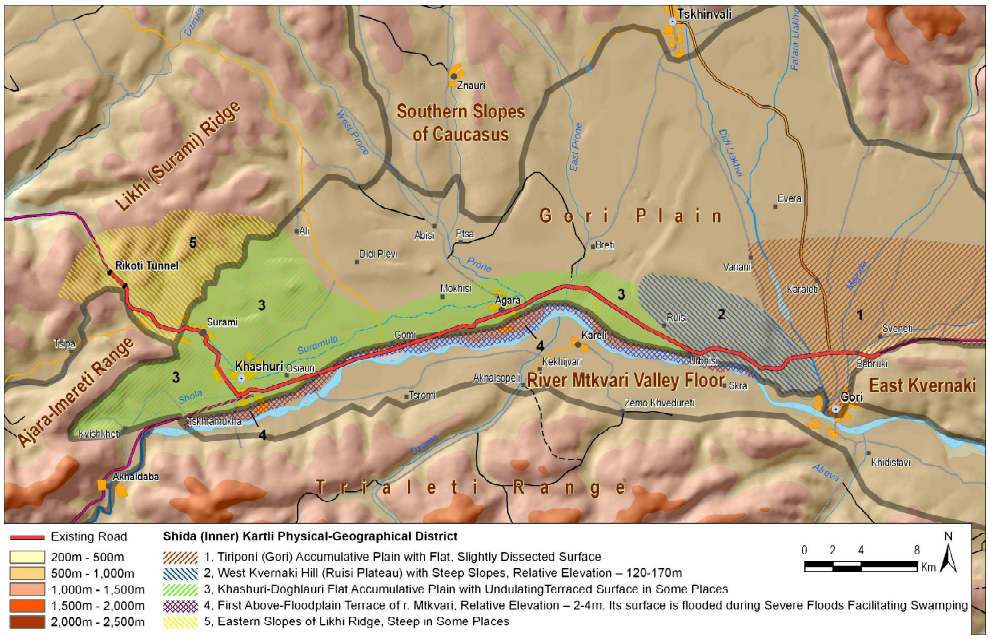


Figure 5.5 *Main physical features of the study area (Source: Regional Environment Assessment, 2009, RD MRDIG)*

5.1.3 Geomorphology

The geomorphologic peculiarity of the study territory, like its landscape and climatic peculiarity, is distinguished for two different characteristics. Most of the eastern part of the territory, where Ruisi - Agara West road section is situated, is a plain-accumulative relief of Shida Kartli, formed under the influence of the erosive-accumulative processes of the river Mtkvari and its left tributaries. The relief of the study territory clearly shows four terrace surfaces

[2]The Neogene is a geological period that began 23 million years ago and ended around 2.6 million years ago with the beginning of the Quaternary

[3]Sedimentary rocks in which rock fragments are cemented in a finer-grained matrix

of the Mtkvari River with two inserted terrace steps developed under the influence of the Mtkvari tributaries forming a plain-accumulative hilly relief in the whole. The plain-accumulative surface is quite intensely crossed with the meridian oriented left tributaries of the river Mtkvari and channels of the irrigation system Within the project area no risks related to gemophology of the site are expected. (Source: Feasibility study, RD MRDIG).

5.1.4 Hydrology

The main surface water body in the region under consideration is Mtkvari. The tributaries of the Mtkvari are the Suramula near Khashuri, the West and East Prone near Agara and Aradeti, and the Didi Liakhvi, Mejuda and West Tortla near Gori. Most of these flows roughly north to south into the Mtkvari, except the Suramula, which runs parallel with the Mtkvari on the northern side of the E-60 and drains into the Prone east of Agara. A total of 60 watercourses cross the E-60 between Sveneti and Rikoti, by means of bridges, drainage pipes, concrete culverts and other structures.

The Mtkvari is the largest river in the South Caucasus and is the dominant hydrological feature in the study area. It originates from springs at 2,720 m amsl on the northern slopes of Mount Kizil-Giadik in Turkey, and runs for 1,364 km through Turkey, Georgia and Azerbaijan, before discharging into the Caspian Sea south of Baku.

The Mtkvari basin covers 188,000 km^2 of mountains (mainly the Greater and Lesser Caucasus) and intermountain tectonic lowlands like the Gori Plain; and the river is recharged by glaciers, snow-melt, rain and groundwater. Around 50% of the annual discharge occurs in spring and 25% in summer, and flash floods can result when heavy rain coincides with the peak of the spring snowmelt.

The river system is polluted (organically and bacteriologically) by the discharge of poorly treated or untreated wastewater; irrigated agriculture and industry (however since 1990s industrial pollution decreased considerably).

Deforestation in the upper part of the basin has led to poor soil protection with damaging mud slides as a result. Moreover, deforestation and overgrazing have led to erosion causing high turbidity of river water.

There are a number of other rivers and streams in the study area, most of which drain into the Mtkvari.

Table 5.3 *Mtkvari – maximum flows ($Q_0 Qm^3/sec$)*

Section	F km^2	Q_0 m^3/sec	C_v	C_s	K	Assurance P %			
						1	2	5	10
Lokani	10500	549	0.41	1.64	_	1310	1190	970	835
Agara	11400	596	_	_	1.086	1420	1290	1050	905
Gpmi	11350	583	_	_	1.081	1415	1285	1045	900

Table 5.4 *Maximum flows of the tributaries in the project area*

Name	P%	Q m^3/sec
West Prone (Ptsa)	1	410
	2	345
	5	270
	10	215
Mtkvari (near Agara)	1	1420
	2	1290
	5	1050
	10	905
Mtkvari (near Gomi)	1	1415
	2	1285
	5	1045
	10	900
Suranula	1	154
	2	122
	5	91.3
	10	68.3

There are two tributaries located within the Ruisi-Aradeti section of the road - the East Prone and the West Prone (Ptsiula River). The East Prone takes off the east slope of Likhi ridge at 1618 m asl elevation. It is 41 km long and has catchment area of 243 km^2; total fall – 996 m. Recharge – atmospheric water (rain, snow melt) and ground water. High water is observed in spring. Water is used for irrigation and water mills. Ptsiula (the West Prone) takes off the south slope of Lokhoni mountain of Surami ridge, at 1600 metres above sea level. The river is 38 km long; total fall - 962 m. Recharge area - 398 km2. High water is observed in spring. Water is used for water mills and irrigation.

Other tributaries of the Mtkvari are the Suramula near Khashuri, the Didi Liakhvi, Mejuda and West Tortla near Gori. Most of these flows roughly north to south into the Mtkvari, except the Suramula, which runs parallel with the Mtkvari on the northern side of the E-60 and drains into the Prone east of Agara.

Suramulatakes off the eastern slope of Surami ridge at 1200 asl. The river flows into the Ptsa near the vil.Kvenatkotsa, while the latter flows into the Mtkvari south to vil.Doglauri. The Suramula is 42 km long, total fall – 578 m, recharge area - 719 km^2. Recharge – snow, rain and ground water. Water regime is stable in summer. Unstable low water regime is typical for winter season. The river may freeze for 3-4 days, however this happens rather seldom. Water is used for irrigation.

As mentioned above the rivers in the project area are characterized by high flows in spring as a result of snow melting and high flows in autumn from seasonal rain, with stable low flows in winter and unstable low flows in summer, depending on the incidence of rain. Some areas are at risk of flooding, particularly in spring, when flash-floods can overrun the floodplains affecting agricultural land and infrastructure, including the E-60 in places.

Ponds available on the area adjacent to village Mokhis of Kareli municipality-have been formed following to excessive sand extraction from the passive riverbed of the Mtkvari. The pond is quarry-sump like type. It consists of two parts (6ha and 4ha water surface) connected by artificial channel. With time, the ponds have transformed into the natural mere. In the recent past, the ponds were supplied with water from the Mtkvari, for this purpose an artificial channel was arranged. Today, this channel is not functioning and is silted and overgrown.

The ponds are supplied by ground water, have no dams, maximum water depth is 8-10 meters, along with that on the bottom of the ponds individual hollows may also be available. Natural drainage does not exist. Because of the presence of underground sources water layers have different temperature. Taking into account that the drainage does not exist the lower strata get warm slowly, therefore the water tempareture is mainly permanent.

Figure 5.6. *View of artificial pond*

5.1.5 Hydrogeology

The main hydro-geological region in the study area is Kartli Artesian Basin of porous, fissured and fissured-karst water, which underlies most of the Gori Plain. The Kartli artesian basin is formed in the depression between the Caucasus Mountains in the north, the Trialeti Range in the south and Likhi Ridge in the west (Figure 5.5).

Major geomorphologic units are the Tiriponi and Mukhrani syncline[4]depressions, overlain by the Quaternary[5]formations and accumulative terraced ter-

[4]A concave-upward fold in rock strata

[5]The Quaternary is the geological time period from 2.5 million years ago to the present

rain of river valleys. The depression is filled by a thick molassa[6]series (up to 2 km) of the Miocene – Pliocene[7]period, consisting of alternating conglomerates, sandstones and clays. This series underlies similarly thick (>200 m) non-dissected Early Quaternary and recent alluvial formations, composed of boulders, shingles and loams[8], with inter-layers of clay. The groundwater associated with these formations is pressurized and frequently self-flowing in boreholes, and is classified as hydrocarbonate-sulphate calcic-sodium type with low mineralization up to 1 g/l. This complies with potable water requirements and the groundwater is widely used for supply of settlements. The deeper Miopliocene lagoonal-continental sediments are only sporadically water-bearing, in layers of loose conglomerates. Here the majority of boreholes are sub-artesian, with water levels at 30-40 m below the ground. Consequently borehole yields are low and rarely exceed 1 l/s. The groundwater from this stratum is mainly of low mineralisation (0.4 – 1.0 g/l) and hydro carbonate calcic magnesium type, and is used for local decentralized water supply.

The Pressurised Water System of the Folded Zone of the southern slopes of the Caucasus Mountains underlies the northern and north-western part of the plain. The hilly/mountainous terrain is dissected, especially north-west of Chumateleti, where the E-60 crosses a complex series of exposed strata, comprising (from south to north) Neogene, Palaeogene[9], Upper and Lower Cretaceous[10], Bajocian(Middle Jurassic[11]), Lias (Lower Jurassic), and Palaeozoic[12]granites of Dzirula crystal massif around the Rikoti tunnel. Some of these have high water content, particularly the Bajocian porphyritic series of tuff breccias[13]and sandstones with andesite[14]layers, and the Cretaceous formations of limestone, sandstones, tuff breccias and dolomitised limestone. This area is characterized by abundant springs, which frequently appear during excavation work.

5.1.6 Landscape and land use

The landscape of this region is generally natural or semi-natural in the uplands of the north, south and west, and mainly anthropogenic in the lowlands

[6]Soft sediment produced by the erosion of mountain ranges

[7]Oligocene, Miocene and Pliocene are the three epochs of the Neogene period

[8]Generally fertile soil composed of sand, silt and clay, roughly in the proportions of 40-40-20%

[9]The Palaeogene is the time period before the Neogene, from 65.5 to 23 million years ago

[10]The Cretaceous is the time period before the Palaeogene, from 145.5 to 65.5 million years ago

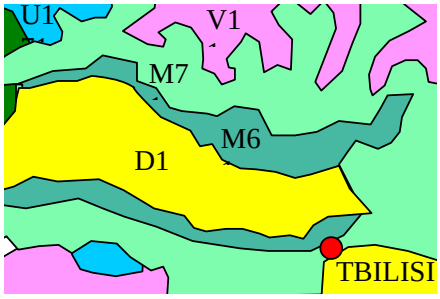
[11]The Jurassic is the time period before the Cretaceous, from 199.6 to 145.5 million years ago

[12]The Palaeozoic is the geological time period from 542 to 251 million years ago

[13]Breccia is a rock composed of angular fragments of minerals or rocks in a matrix (cementing material)

[14]Andesite is an igneous volcanic rock of intermediate composition

of the centre and east, where most of the natural vegetation was removed many years ago to provide land for agriculture.



D1 East Caucasian foothills landscapes with botriochloa and stipa steppes, dry shrub-land (shiblyak), dwarf-shrub vegetation and semi-deserts

M6 Southern Caucasian (transitional to semi-humid) low-mountain landscapes with horn-beam-oak, oak forests and secondary dry shublands

M7 Southern Caucasian middle-mountain land-scapes with beech forests alternating with hornbeam-oak, partly with pine forests and secondary grasslands

U1 Caucasian middle-mountain landscapes with beech-dark coniferous and dark coniferous (spruce-fir) forests, partly with evergreen underwood

V1 Caucasian sub-alpine landscapes with combination of meadows, tall-herb communities, sub-alpine woods and tickets

Figure 5.7 *Major types of landscape in the region*

Under the combined influence of geology and anthropogenic change, the plain near Gori today is a large, flat expanse of arable land, with few hedgerows and little natural vegetation. The land is mainly subdivided into small plots, which are primarily individually-owned and occupied by orchards, vineyards, vegetable gardens, corn fields, hay meadows and pastures. There are also small scattered settlements, and some overgrown secondary meadows in the places that are unfavourable for agriculture.

In the west the Likhi Ridge provides a more rugged and natural landscape, of steep hillsides dissected by narrow plunging gorges, covered by yellow brown soils, which support relatively large areas of mixed deciduous forest, mainly oak, beech and hornbeam.

The landscape is modified near the towns and villages, where the forest is re-placed by meadows and shrub-land, which has grown up after forest clearing. In such areas the arable landscape predominates, together with houses and other buildings. In the east, West Kvernaki hill presents a semi-natural land-scape, with steep slopes dissected by gorges and gullies through which runoff drains into the Didi Liakhvi. These are interspersed with thorny shrubbery and areas of grassland on the mainly cinnamonic soils. There is little cultivation in this area, although the grassland is used quite extensively for grazing.

Figure 5.8 *Typical landscape*

The River Mtkvari floodplain has also been greatly altered by the activities of man, including flood protection, enterprise development (manufacture of building materials, fish ponds, etc), and agriculture. Some natural vegetation remains, but this is limited to isolated fragments of riparian forest, amongst thorny shrubbery and grassland (Source: Regional Environment Assessment, 2009, RD MRDIG).

The land take data will be provided in the Land Acquisition and Resettlement Plan document. The EIA will present general overview of the issues.

5.1.7 Soils

Soils in the Gori Plain are mostly cinnamonic, cinnamonic-calcareous and alluvial loamy in character and relatively fertile, hence the predominance of agriculture.

Cinnamonic soils are formed in conditions of relatively mild and humid climate with little influence of underground waters. Soils are characterized by high level of differentiation. The concentration of humus varies between 3-10%. Their geochemical potential is characterized by acid reaction which decreases with depth and ultimately becomes neutral. Therefore these soils are characterized by a rather high coefficient of washing.

Cinnamonic-calcareous soils occupy rather large areas within the corridor. Lithological composition of these soils is similar to those of brown soils, but

with higher content of carbonate materials. These soils are formed mainly by deluvial sediments.

Alluvial-carbonate soils are widespread along the banks of the rivers. This type of soil is rather diverse. Their basic mass, thickness of the profile, mechanical composition and concentration of carbonates, nitrogen and carbon as well as other characteristics often vary within a wide range. This is natural, since those parameters which determine the type of soil depend on river dynamics, the type of materials brought by rivers, lithilogical and mechanical (size, weight) composition of these materials and many other processes. These soils are characterized by the diversity of alluvial materials and high concentration of carbonates.

Figure 5.9 *Alluvial soil*

Figure 5.10 *Cinnamonic soil*

Alluvial-carbonate soils of young terraces have weak profile and are less stable, while old terraces are more stable because of fine and coarse fractions present.

Analysis of field lab data and reference material revealed presence of seven engineering-geological elements:

GE1 - Earth fill soil, represented by cobbles, gravel, construction material residuals.	Earth fill soil, represented by cobbles, gravel, construction material residuals – is observed at the first layer from surface in most boreholes (minimal thickness is 0.15-0.2m, maximal – 1.0m). Average thickness of earth fill layer is 0.32m. The layer is characterized by unequal content; it is basically represented by cobbles and gravel, with boulder inclusions and construction material residuals at some places. Represented soil is basically filled with silty sand or lean clay, rarely with sand and clay. According to mentioned above the mentioned geological element is not studied in laboratory; also, standard penetration tests were not carried out for GE-1, since these soils are observed on surface everywhere and its thickness for penetration is less than required 0.45m.
GE2 - Lean clay, brown, hard and very stiff, with gravel inclusions to 10-15%	Lean clay, brown, hard and very stiff, with gravel inclusions to 10-15% - is observed in all drilled boreholes below the first or earth fill soil from the surface. Thickness of lean clays exceeds the surveyed depth, 10.0m, at the first 1.8km of the studied territory. Then the layer thickness is reduced and is 2.5m average (minimal thickness is 0.7m, maximal – 3.1m). Physical properties of lean clays are studied in laboratory – 26 tests; grain size distribution – 12 tests; consolidation – 6 tests, compressibility – 6 tests; shear properties – 6 tests.
GE3 - Clay, light brown, firm, with gravel inclusions to 10-15%	Clay, light brown, firm, with gravel inclusions to 10-15% - is observed only in four drilled boreholes below GE 2 lean clays, from 4.5m-8.5m to 13.0-17.0m depth from the surface. Physical properties of clays are studied in laboratory – 8 tests; grain size distribution – 5 tests; consolidation – 3 tests, compressive properties – 2 tests, shear properties – 5 tests.
GE4 - Silty sand, yellowish-brown, plastic, with gravel and cobble inclusions to 20-25%	Silty sand, yellowish-brown, plastic, with gravel and cobble inclusions to 20-25% - is observed locally, in two boreholes, in borehole drilled along the whole route below GE2 lean clays from 1.2-2.3m to 2.8-3m depth from the surface. Layer thickness is small, totals 0.7m. Deaspite of that two samples were collected for lab

	analysis. Physical properties are studied in laboratory – 2 tests; grain size distribution – 1test.
GE5 - Cobbles, gravel, light brown, with lean clay–silty sand filling, with boulder inclusions	Cobbles, gravel, light brown, with lean clay–silty sand filling, with boulder inclusions – is observed in the section from about km 2. The layer is observed below clays and lean clays to the surveyed 5.0-10.0m depth. Physical properties of cobbles are studied in laboratory – 18 tests; grain size distribution – 14 tests.
GE6 - Bluish-grey sandstones, extremely weathered, thin bedded, with clay interbeds	Bluish-grey sandstones, extremely weathered, thin bedded, with clay interbeds is observed at crossing area of the highway at the river Prone. Maximal thickness of the layer is 13m. Twoelements with distinctly different in density and physical-mechanical characteristics are observed - sandstones 6-S and basic clay 6-C.
GE7 –Bluish-grey sandstones, distinctly weathered, thin bedded, with clay interbeds	Bluish-grey sandstones, distinctly weathered, thin bedded, with clay interbeds represents ‘continuation’ of GE6. It is less weathered, therefore physico-mechanical characteristics of the sandstones, in terms of construction conditions are better

Applicably to physical properties geological elements selected at the investigation territory, according to seismic properties, belong to the following categories: GE-1 – II category, GE-2 – II category, GE-3 – II category, GE-4 – II category, GE-5 – II category, GE-6 – II category, GE-7 – I category according to seismicity.

5.1.8 Air quality

The air quality is likely to be generally good in the study area, given its rural character, the predominance of agriculture as the major land use, and the absence of heavy industry. Vehicle emissions are comparatively low because of low traffic volumes, and air pollution is rapidly dispersed due to winds. However, the residents of the settlement closest to the highway may be exposed to elevated levels of pollutants from vehicle emissions.

During rehabilitated road operation it is expected to have increased traffic flow resulting in bigger vehicle emissions.

In the vicinity of the Ruisi - Agara West road sub-section there has been no stationary point for observing the ambient air quality. For this reason ambient air background concentrations will be estimated according to methodological instructions given in “Background Concentrations for Towns and Settled Areas where no Ambient Air Quality Observations are Held“. According to this document possible concentrations of harmful substances in the ambient air are linked to the population.

Table 5.5 *Background concentration rate (Source: “Background Concentrations for Towns and Settled Areas where no Ambient Air Quality Observations are Held“)*

Population quantity in thousands	**Background Concentration Rate, mg/m^3**			
	Nitrogen dio-xide, NO_2	**Sulphur dio-xide, SO_2**	**Carbon mo-noxide, CO**	**Dust, PM10**
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

The traffic on E-60 is probably the main source of air pollution, as traffic is assumed to be significant contributor to atmospheric levels of certain sub-stances worldwide, mainly from the burning of fuel. These include carbon monoxide (CO), nitrous oxides (NO_x), volatile organic compounds (VOC) particulate matter (PM), and to a sulphur dioxide (SO_2).

In the study area the traffic is lighter and generally moves more freely, and winds blow throughout the year, so pollutants produced by vehicles on the E-60 and other roads should be rapidly dispersed in most circumstances. How-ever people living alongside the road may be exposed to elevated levels of traffic pollutants given their proximity to the source, and overall air quality may decrease somewhat during the winter when many people burn wood to heat their houses.

5.1.9 Noise

The rural character of the study area also means that the noise environment is generally quiescent, and there are few sources of anthropogenic noise in and around most villages, apart from the relatively light traffic and occasional farm machinery. As was the case for air pollution, the E-60 is also likely to be the main source of noise in the study area, again produced by traffic.

Limited data have been collected in 2006 and 2009 (near Rikoti tunnel) dur-ing the Regional Environmental Assessment (see Table 5.6). Available data and foreceast for the traffic growth enables to presume that statutory noise levels in the future may be exceeded quite regularly, and that people living

near the E-60 may therefore be exposed to unacceptable levels of noise. Sound is attenuated rapidly by intervening buildings and vegetation, and levels generally decrease quite quickly with distance from the source, so exposure to elevated levels is probably limited to people living within a few hundred meters of the road.

Table 5.6. *Noise and traffic flow on the E-60 in the study area in 2006 (Source: Regional Environment Assessment, 2009, RD MRDIG).*

Location			**Urbnisi**	**Ruisi**
Date			Oct 2006	Oct 2006
Traffic flow (vehicles/h)	*Light vehicles,.mini-buses*		**653**	**732**
	Heavu good vehicles (HGVs),large buses		**61**	**70**
Equivalent level of sound L_{Aaq} (0,5 h) (dBA)			**76.5**	**77.5**
Acceptable daytime noise level in residential areas	*Houses, clinics, nursing homes, schools, etc*	Equivalent	**55**	**55**
		Maximum	**70**	**70**
	Hotels and hostels	Equivalent	**60**	**60**
		Maximum	**75**	**75**

5.1.10 Seismic conditions and hazardous processes

The area of Georgia represents a part of the active seismic zone of the Caucasus. It belongs to the Mediterranean seismic belt. Its architectonical movement and activity is connected with the movement of the neighbouring Eurasian and Afro-Arabic rocks.

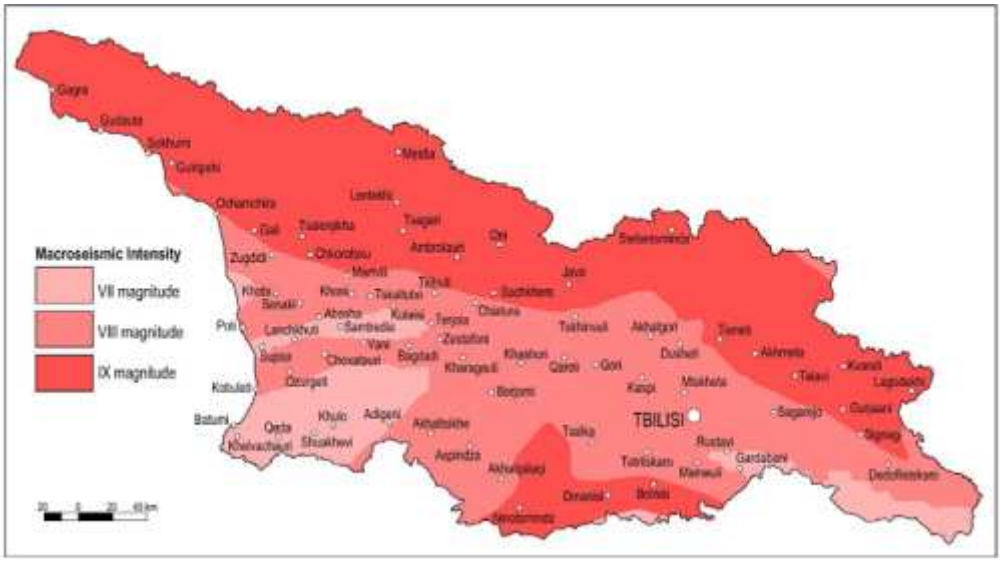


Figure 5.11. *Seismic intensiveness map of Georgia (Source: Construction norms and rules – Asesismic stable construction, pn 36.0101-09)*

The project is located in the high intensiveness seismic zone - the Richter scale (IX). Despite the mostly flat landform without complex topography or major geomorphological processes there are certain natural features that could

be potential hazards for development in the region. These are related to physiography and climate, seismicity in the area, landslide, mudflows, flooding and snowfall. Hazardous processes show certain periodicity. Erosion is intense, in particular in the riverbeds of the Mtkvari and its tributaries. The landslides are observed in the areas with steep slopes, loose composition of some of the exposed strata, seismic activity and precipitation. Particular areas of concern are to Likhi and the South Caucasus ridges.

5.2 Biological environment

5.2.1 Flora

The Kartli plain is represented by several vegetation zones. Xerophilous plants, scrub and steppe vegetation are well developed. There are fruit orchards in the region within which the study area falls. The orchards are composed of apple, pear, peach, mulberry, plum and other drupaceous tree species. The rest of the area - in particular both sides of the river Liakhvi gorge and mount Malkhaziskedi - are used mainly for annual plants (wheat, corn, cabbage, potato, tomato, etc.) or pasture.

Phytogeographical description

In Shida Kartli three vertical zones of vegetation are known:

- lowland and flatland;
- middle mountain zone;
- high mountain zone.

Table 5.7. *Typical vegetation species distribution by elevation above sea level*

Elevation m above sea level	**Description**
500-600	Oak(*Quercus pedunculiflora*), grey poplar (*Populus hybrida*), elm tree (Elm *Ulmus sp.*), willow (*Salix sp.*),medlar(*Mespilus germanica*),hawthorn (*Crataegus sp.*). etc.
From 500-600 to 1000	Downy oak (*Quercus iberica*), European hornbeam (*Carpinus caucasica)*,hornbeam(*Carpinus orientalis*), maple (*Acer camprestre*), European ash(*Fraxinus excelsior*), elm *Ulmus, Pyrus caucasica* etc. In underwood: Common hazel *(Corylus avelana),* rhododendron (*Rododendron ponticum),* cherry-laurel *(Laurocerasus officinalis),* holly (*Ilex colchica),* European cornel *(Cornusmas),* etc.
From 1000 to 1500-1600	Oriental beech forests, in some places Caucasian spruce (*Picea orientalis*), hornbeam (*Carpinus caucasica*), Norway maple (*Acer platanoides*), sycamore (*Acer pseudoplatanus*), etc.
From 1500-1600 to 2200	Fir-pine forests with oriental beech (*Fagus orientalis*), Caucasian linden (*Tilia caucasica*), European aspen *(Populus tremula*), European ash (*Fraxinus excelsior*), Caucasian oak (*Quercusmacranthera*), Caucasian pear (*Pyrus caucasica*), etc. Underwood: Hazel nut tree (*Corilus avellana*), holly (*Ilex colchica*), cherry-laurel (*Laurocerasus officinalis*), rhododendron (*Rhododendron flavum*), etc.
Above 2200	Silver birch(*Betula verrucosa*), acer (*Acertrautvetteri*), European aspen(*Populus tremula*), mountain ash (*Sorbus caucasigena*), oriental beech (*Fagus orientalis)*

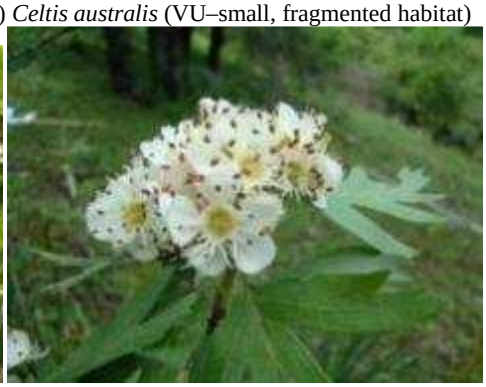
Amagdalus georgica (EN – very limited habitat)

Juglans regia (VU – tertiary relict, small, fragmented habitat)

Ulmus glabra (VU – small, fragmented habitat)

Celtis australis (VU–small, fragmented habitat)

Celtis glabrata (VU–small, fragmented habitat)



Crataegus pontica (VU–small, fragmented habitat)

Pyrus demetrii (EN– very limited habitat)

Figure 5.11. *Endemic and protected species potentially occurring in the project zone*

Above subalpine zone alpine meadows with typical high grasses are located. The survey did not reveal any endangered or protected species (except for

several walnut trees (Red List of Georgia, vulnerable category, although it is artificially cultivated and grows only in homestead plots))

5.2.2 Fauna

Georgia belongs to the Palaearctic region and is characterized by rich biodiversity and a high level of endemism. Anthropogenic strain is very high in this region. For this reason it is one from twenty-five so called "hotspots" that are under attention of the major environmental protection organizations of the world. Due to its geographical characteristics there are a variety of climates in Georgia and this causes diversity of flora and fauna. Several species of fauna are at the edge of extinction, which means that relevant measures must be taken to preserve the existing environment.

Protected species known to be available generally in Shida Kartli are presented in the table below.

Table 5.8 *Protected species in Shida Kartli*

Latin Name	Georgian Name	Common Name (English)	Status
MAMMALS			
Mesocricetus brandti	ამიერკავკასიურიზაზუნა	Branst's hamster	VU
Cricetulus migratorius	ნაცრისფერიზაზუნელა	Grey hamster	CR
Lutra lutra	წავი	Common Otter	VU
BIRDS			
Podiceps grisegena	რუხლოყებამურტალა	Red-necked Grebe	VU
Tadorna ferruginea	წითელიიხვი	Ruddy Shelduck	VU
Melanita fusca	შავიგარიელი	Velvet Scoter	VU
Aquila chrysaetus	მთისარწივი	Imperial Eagle	VU
Aquila heliacal	ბეგობისარწივი	Golden Eagle	VU
Accipiter brevipes	ქორცქვიტა	Levant Sparrowhawk	VU
Falco cherrug	გავაზი	Saker Falcon	CR
Falco vespertinus	თვალშავი	Red-footed Falcon	EN
Buteo rufinus	ველისკაკაჩა	Long-legged Buzzard	VU
Neophron percnopterus	ფასკუნჯი	Egyptian Vulture	VU
Gyps fulvus	ორბი	Griffon Vulture	VU
REPTILE			
Testudo graeca	ხმელთაშუაზღვისკუ	Mediterranean tortoise	VU
Darevskia dahli	დარევსკისხვლიკი	Dahl's Lizard	VU

VU – vulnerable; EN- endangered; CR- critical

The species protected under the Bonn convention available in the Shida Kartli region are given in the tables below.

Table 5.9 *Bat species protected under the Bonn convention occurring in the Shida Kartli region*

Latin Name	Georgian Name	English name

Rhinolophus ferrumequinum	დიდიცხვირნალა	Greater Horseshoe Bat
Rhinolophus hipposideros	მცირეცხვირნალა	Lesser Horseshoe Bat
Eptesicus serotinus	მეგვიანელამურა	Serotine Bat
Myotis blythii	წვეტყურამღამიობი	Lesser Mouse-eared Bat
Myotis mystacinus	ულვაშამღამიობი	Whiskered Bat
Myotis nattereri	ნატერერისმღამიობი	Natterer's Bat
Myotis emarginatus	სამფერიმღამიობი	Geoffroy’s Bat
Myotis daubentonii	წყლისმღამიობი	Daubenton's Bat
Pipistrellus pipistrellus	ჯუჯაღამორი	Common Pipistrelle
Pipistrellus pygmaeus	პაწიაღამორი	Soprano Pipistrelle
Pipistrellus nathusii	ტყისღამორი	Nathusius's Pipistrelle
Plecotus auritus	რუხიყურა	Brown Big-eared Bat

Table 5.10 *Bird species protected under the Bonn convention occurring in the region*

Latin Name	**Georgian Name**	**English Name**
PODICIPITIFORMES		
Podiceps grisegena	რუხლოყებამურტალა	Red-necked Grebe
Podiceps auritus	რქოსანიმურტალა	Slavonian Grebe
Podiceps nigricollis	შავყელამურტალა	Black-necked Grebe
PELECANIFORMES		
Phalacrocorax carbo	დიდიჩავამა	Great Cormorant
CICONIIFORMES		
Botaurus stellaris	წყლისბუღა	Great Bittern
Ixobrychus minutus	მცირეწყლისბუღა	Little Bittern
Nycticorax nycticorax	ღამისყანჩა	Black-crowned Night Heron
Ardeola ralloides	ყვითელიყანჩა	Squacco Heron
Bubulcus ibis	ეგვიპტურიყანჩა	Cattle Egret
Egretta garzetta	მცირეთეთრიყანჩა	Little Egret
Egretta alba	დიდითეთრიყანჩა	Great White Egret
Ardea cinerea	რუხიყანჩა	Grey Heron
Ardea purpurea	ქარციყანჩა	Purple Heron
ANSERIFORMES		
Anser anser	რუხიბატი	Greylag Goose
Tadorna ferruginea	წითელიიხვი	Ruddy Shelduck
Tadorna tadorna	ამლაყიიხვი	Common Shelduck
Anas strepera	რუხიიხვი	Gadwall
Anas crecca	ჭიკვარა	Common Teal
Anas platyrhynchos	გარეულიიხვი	Mallard
Anas acuta	ბოლოსადგისა	Northern Pintail
Anas querquedula	იხვინჯა	Garganey
Anas clypeata	ფართოცხვირაიხვი	Nothern Shoveler
Netta rufina	წითელნისკარტაყურყუმელა	Red-crested Po-chard
Aythya ferina	წითელთვალაყვინთია	Common Pochard

Aythya fuligula	ქოჩორაყვინთია	Tufted Duck
Melanita nigra	შავიყურყუმელა	Common Scoter
Melanita fusca	შავიგარიელი	Velvet Scoter
Mergus merganser	დიდიბატასინი	Goosander
FALCONIFORMES		
Pernis apivorus	ჩვეულებრივიბოლოკარკაზი	European Honey Buzzard
Milvus migrans	ძერა	Black Kite
Neophron percnopte-rus	ფასკუნჯი	Egyptian Vulture
Gyps fulvus	ორბი	Griffon Vulture
Aegypius monachus	სვავი	Black Vulture
Circaetus gallicus	ძერაბოტი	Short-toed Eagle
Circus aeruginosus	ჭაობისბოლობეჭედა	Eurasian Marsh Harrier
Circus cyaneus	მინდვრისბოლობეჭედა	Hen Harrier
Circus macrourus	ველისბოლობეჭედა	Pallid Harrier
Circus pygargus	მდელოსბოლობეჭედა	Montagu's Harrier
Accipiter nisus	მიმინო	Sparrow-hawk
Accipiter brevipes	ქორცქვიტა	Levant Sparrow-hawk
Buteo buteo	კაკაჩა	Common Buzzard
Buteo rufinus	ველისკაკაჩა	Long-legged Buz-zard
Buteo lagopus	ფეხბანჯგვლიანიკაკაჩა	Rough-legged Buz-zard
Aquila pomarina	მცირეარწივი	Lesser Spotted Eagle
Aquila heliaca	ბეგობისარწივი	Golden Eagle
Aquila chrysaetos	მთისარწივი	Imperial Eagle
Hieraaetus pennatus	ჩიაარწივი	Booted Eagle
Falco tinnunculus	კირკიტა	Common Kestrel
Falco vespertinus	თვალშავი	Red-footed Falcon
Falco columbarius	ალალი	Merlin
Falco subbuteo	მარჯანი	Hobby
Falco peregrinus	შევარდენი	Peregrine Falcon
Falco cherrug	ბარი	Saker Falcon
GALLIFORMES		
Coturnix coturnix	მწყერი	Common Quail
GRUIFORMES		
Rallus aquaticus	ჩვეულებრივილაინა	Water Rail
Porzana porzana	ქათამურა	Spotted Crake
Porzana parva	მცირექათამურა	Little Crake
Porzana pusilla	პაწაწაქათამურა	Baillon's Crake
Crex crex	ღალღა	Corncrake
Gallinula chloropus	წყლისქათამი	Common Moorhen

Fulica atra	მელოტა	Coot
CHARADRIIFORMES		
Himantopus himantopus	ოჩოფეხა	Black-winged Stilt
Glareola nordmanni	ველისმერცხალა	Black-winged Pratincole
Charadrius dubius	მცირეწინტალა	Little Ringed Plover
Charadrius hiaticula	საყელოიანიწინტალა	Ringed Plover
Vanellus vanellus	პრანწია	Lapwing
Philomachus pugnax	ტურუხტანი	Ruff
Gallinago gallinago	ჩიბუხა	Common Snipe
Gallinago media	გოჭა	Great Snipe
Scolopax rusticola	ტყისქათამი	Eurasian Woodcock
Tringa totanus	მსევანი	Common Redshank
Tringa stagnatilis	მერუე	Marsh Sandpiper
Tringa ochropus	შავიჭოვილო	Green Sandpiper
Tringa glareola	ჭაობისჭოვილო	Wood Sandpiper
Actitis hypoleucos	მებორნე	Common Sandpiper
Larus ichthyaetus	ხარხარათოლია	Great Black-headed Gull
Larus melanocephalus	შავთავათოლია	Mediterranean Gull
Larus minutus	მცირეთოლია	Little Gull
Larus ridibundus	ჩვეულებრივითოლია	Black-headed Gull
Larus armenicus	სომხურითოლია	Armenian Gull
Larus cachinnans	ყვითელფეხათოლია	Yellow-legged Gull
Sterna hirundo	მდინარისმეთოვლია	Common Tern
Sterna albifrons	მცირემეთოვლია	Little Tern
Chlidonias niger	შავითევზიყლაპია	Black Tern
Chlidonias leucopterus	ფრთათეთრათევზიყლაპია	White-winged Black Tern
CORACIIFORMES		
Merops apiaster	კვირიონი	European Bee-eater
Coracias garrulus	ყაპყაპი	European Roller
PASSERIFORMES		
Muscicapa striata	რუხიმემატლია	Spotted Flycatcher
Ficedula parva	მცირემემატლია	Red-breasted Flycatcher
Ficedula albicollis	საყელოიანიმემატლია	Collared Flycatcher
Ficedula semitorquata	კავკასიურისაყელოიანიმემატლია	Semi-collared Flycatcher

Table 5.11 *Fish species of Shida Kartli*

Latin name	**Endemic**	**Endangered**	**Slow current species**	**Raid current species**	**In up and low streams of the rivers**	**Lake species**
Rutilus rutilus			+			

Leuciscus cephalis			+			
Aspius aspius			+			
Chondrostoma cyri	+				+	
Chalcalburnus chalcoides			+			
Acanthalburnus microlepis	+				+	
Alburnoides bi-punctatus			+		+	
Blicca bjorena			+			
Abramis brama			+			
Rhodeus sericeus			+			
Cyprinus carpio			+			
Carassius carassius						+
Hypophtalmichthys Molitrix						+
Aristichtys nobilis						+
Gobitis taenia		+			+	
Cobitis aurata					+	
Gobio gobio					+	
Gobio persa					+	
Barbus lacerta cyri						
Barbus capito			+			
Barbus mursa				+		
Varicorhinus ca-poeeta			+			
Silurus glanis			+			
Gambusia affinis					+	
Nemachilus brandti					+	
Gobius cephalarges	+				+	

Fish species available in the artificial pond crossed by the Agara bypass section of the road are the same as in the Mtkvari. Besides, according to Shavra Ltd, in 2008 and 2010 common, silver and grass carp fries have been introduced.

5.2.3 Protected areas

There are no protected areas in the project impact zone.

5.3 The socioeconomic and cultural environment

5.3.1 The human environment

Shida Kartli consists of six administrative districts: Gori, Kaspi, Kareli, Khashuri, Tskhinvali, Java, two of which (Tskhinvali, Java) at the moment are de facto out of the jurisdiction of Georgia. The economic and social situation in Shida Kartli deteriorated considerably as a result of the war, as local residents have had to cope with the loss of homes, transport, livestock, agricultural equipmentand land.

Before the conflict in August 2008, the population of Shida Kartli was almost 313,000, and the majority is rural.

Table 5.12 *Population of Shida Kartli (Gori, Kareli, Khashuri districts)*

Location	2003	2004	2005	2006	2007	2008	2009	2010
Georgia	4 342.6	4 315.2	4 321.5	4 401.3	4 394.7	4 382.1	4 385.4	4 436.4
Shida Kartli	310.5	308.9	309.1	314.0	313.6	312.8	313.0	310.6
Gori municipality	146.9	146.4	146.9	135.9	135.8	135.6	135.8	144.1
Kaspi municipality	51.7	51.4	51.4	52.1	52.0	51.8	51.8	52.6
Kareli municipality	49.9	49.5	49.4	49.7	49.7	49.5	49.5	51.6
Khashuri municipality	62.0	61.6	61.4	61.8	61.6	61.4	61.4	62.3

Source: Department of Statistics of Georgia (2010)

Since 2003, the number of births has increased by about 6.7%. Overall death rates declined by around 10.6%. Since 2003, apart from the years of 2004 and 2005, there has been a net negative outflow of people in all municipalities of the region. By 2010 the population of the region reached 310,000, which accounted for 7% of the total population of Georgia. The majority are Georgians (91.1%). Shares of other ethnic groups are as follows: Osetians 5.1%, Axeri 1.9%, Armenians 0.6%, Russians 0.3%, Jews, Greeks, Abkhaziana account for the rest.

The situation in the region deteriorated after the event of summer 2008. 18,000 of people had to leave their homesteads. The road to the Russian market, which, although illegal, still acted as one of the sources of income generation for the local residents, was closed.

According to stakeholders, the study area contains some of most productive agricultural land in Georgia (Kocks, 2009). Agriculture is the basis of the economy. The main produce is cereal, fruit, grapes and cattle breeding (predominantly cattle and sheep).

Irrigation is widely used. Above-ground concrete conduits are often located near/in the vicinity of the highway (E-60). Technical maintenance status of the system is poor, however, some sections have been rehabilitated (Breti, Aradeti area, Mokhisi).

Settlements range in size and economic importance from Gori city to small rural villages. Gori has a population of ~50,000 and is an important administrative and economic centre.

Most dwellings and businesses along the E-60 are located on the north side of the road with the exception of certain businesses, such as filling stations, cafes/restaurants, small hotels and roadside vendors which can be found on both sides of the road.

The main source of income of the rural residents is agriculture related (51%), labour and businesses account for about 30%. Around 16.7% of residents' income is from pensions and social assistance payments. In the towns wage

labour and business (about 70%) dominate with pensions/social assistance at the level of 15%.

Public health services in the region are provided by hospitals, dispensaries, ambulances. Along with the public health establishments, private medical hospitals and clinics also exist.

Shida Kartli is famous for its resorts such as Biisi; Gorijvari; Bazaleti Lake and Tkemlovani.

5.3.2 Historical and archaeological sites

Shida Kartli is known for its rich architectural heritage. The total of around 100 monuments of different historic periods are registered. The most notable monuments include the following: Gori castle (I BC), Uplistsikhe town-museum (I BC), Ateni Sioni (VI AD), Kintsvisi (VII AD), Samtavisi church (XI AD), Tsromi church (626 - 635), Urbnisi, Mother of God Church of Ruisi church (VIII-IX renovated in XI), Sioni Church of Ubnisi (V-VI), St. Marine Church of Ruisi (early feudal epoch), Ertatsminda (XIII), Surami St. George church (XVIII), Gori cathedral (1806-1810).

Figure 5. 13. *Urbnisi and Ruisi churches*

The road will run through the agricultural land which has been cultivated for 60 years already. Archaeological surveys in the region performed since 1951 have not reveal any monuments/artefacts in the area. However south to the road in 0.5-1 km, on the left bank of the Mtkvari, the ancient settlement Urb-nisi is located. To the west of it, the remains of Berikldeebi, Eneolith-bronze age settlement, and burial mounds are registered. Archaeological excavations in the area were carried out in 1979-1983. Survey revealed remains of the Middle Bronze Age graves with black, light-colour, gray (Uzerliktepe type) ceramics. Two architectural horizons of the Bedenic settlements, which were strengthened with adobe fence were revealed at the site. The rest of the find-ings included the Ruins of Adobe buildings, rectangle sacrificial platforms plastered with clay, Bedenic black glazed ceramic of high quality, chestnut-colour and light-colour clay vessels, a fragment of a bronze axe with a pulled down haft, stone and bone tools. The ruins of a circular, burnt building with the disco shaped central heath (plastered with clay) were uncovered belonging to the early stage of the Early Bronze Age. The structure contained cylindrical vessels, platforms plastered with clay and typical Mtkvari-Araks and Uruk

ceramic. The temple and the settlement dating to the Eneolithic Age were also discovered.

Also, an eneolithic age temple and settlement is found, ceramics of which is similar to west Georgian cave settlement (Samele Klde) eneolithic age ceramics and Urukian era ceramics.South of the bridge over the East Prone River, on the right bank of the river, the remains of a medieval church (the so-called Erelaant Sakdari) should be taken into account. The remains do not fall in the direct impact area of the project, but some indirect impact is possible.

At the moment visual examination does not provide clear evidence of artefacts' availability in the area, however a chance find procedure must be put in place.

Figure 5. 14. *Erelaant Sakdari, view from the south*

The section of the road from the right bank of the Prone River to the left bank of the Ptsiula River will cross the so-called Dedoplis Mindori (Queen's field) on the second terrace of the Mtkvari. In this area a large Eneolyth – bronze age settlement, burial places and remains of the Kartli king's palace (II=I BC) as well as of an early medieval settlement have been found.

Figure 5. 15 *Dedoplis Mindori (Queens's field)*

The design section of the road from the turn to the village is shown in the figures bellow. Daglaura runs through a field surveyed by an archaeological expedition in 1979-1981. The survey unearthed early 11 bronze age tombs (III cent. BC), a late bronze age (XIV-XIII cent. BC) burial mound and 56 burials dating back to II-I cent. BC.

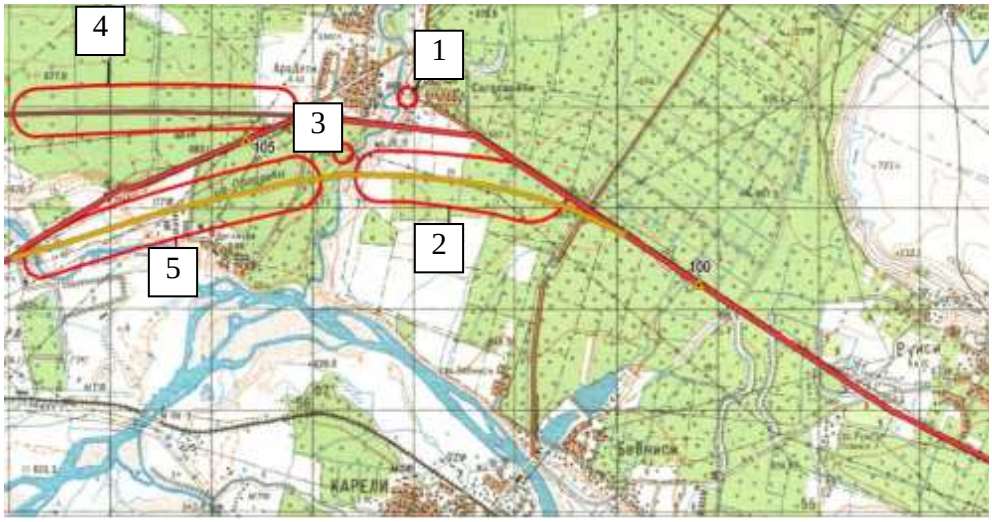


Figure 5 16 *Location of sensitive sites.*

Table 5.13 *Description of sensitive sites*

No.	Description	Location
1.	Salarianis Sakdari, late medieval	South-east to Aradeti, left bank of the East Prone
2.	Berikldeebi – Bronze Age (IV-IIIBC)	West to Kareli turning to East Prone

3	Remains of late medieval settlement	South to Aradeti, right bank of the East Prone
4	North part of Dedoplis mindori – remains of a settlement, church (II-I cent. BC)	West to Aradeti
5	Orgorebi – late bronze age remains of a settlement	Near vil.Doglauri, between the East Prone and the Ptsiula riverbeds, south-east to the bridge, on the left bank of the Ptsiula

6 Expected environmental impacts

6.1 Introduction

Environmental impacts of the proposed Ruisi - Agara West road section's upgrading show in three stages: pre-construction, construction and operation.

Pre-construction phase is mostly related with socio-economic issues, like acquisition of the land/property where the existing road is widened and the new route is built, and possible speculations gaining the compensations for the acquired land.

Construction phase. This is a large and complex development, involving major construction activities, so the construction phase is the period in which the greatest risk of negative impacts is present. However the work will involve basic techniques (excavation, earth-moving, concreting, etc) that are a component of the most construction projects, for which well developed mitigation methods are available.Some of the earthworks, particularly in the steeper terrain in the north-west will be substantial, and embankments are also needed in the Mtkvari floodplain in the south. This will alter the topography and appearance of each site and location from which materials are obtained and where waste is disposed. It could also change the flow patterns of surface and ground-water and affect its quality; moreover, earthworks often cause dust.

Operation. Once it is in operation, the upgraded road is expected to gradually carry more traffic, comprising light/medium vehicles and HGVs engaged in internal travel and transit between the surrounding countries. The road may fall into disrepair, compromising the investment and road safety, if it is not adequately inspected, maintained and repaired. The operating road may affect natural and human environments via traffic noise, air/water pollution, visual impacts, disturbance, etc and measures should be included in the design to avoid some of these. Socio-economic effects will be more significant, particularly for individuals and communities that currently depend on the road and who will be excluded in the future by bypasses and safety measures.

In the area covered by this EIA, the key environmental issues are likely to be:

- *Noise and air pollution impacts on closely located inhabited areas during construction and operation;*
- *Destruction of natural landscape (soil cover, vegetation, eco-systems, habitats, wildlife, relief) in the RoW, construction camp/equipment yards;*

- *Landslips and other mass movements in road cuts during construction activities; erosion from fresh road cuts and fills, sedimentation of natural drainage ways;*
- *Declined water quality and increased sedimentation in the areas near surface water bodies;*
- *Impact of construction activities on aquatic ecosystems of the rivers/streams, lake crossed by the highway;*
- *Soil contamination (RoW, equipment yards, cement/asphalt plants) during construction by oil/fuel, paint spills, waste;*
- *Impact on soil during operation;*
- *Changes in hydrological patterns crossed by the highways induced by installation of bridges, river-bank protection installations and related impact on infrastructure, arable lands and ecosystems located on adjacent territories;*
- *Waste disposal (construction camps and work sites), including waste water and waste alongside the RoW;*
- *Poaching by construction workers;*
- *Impact on cultural heritage - risks of uncovering archaeological material during excavation works;*
- *Heath hazards – noise, air emissions, dust – during construction;*
- *Safety risks – hazardous driving conditions where construction interferes with pre-existing roads, accident risks associated with traffic and transport;*
- *Socioeconomic impacts - loss of business by roadside vendors; land acquisition/compensation (roadside commercial, orchards, etc).*

6.2 Impacts on water resources

Surface Water

Wastewater management, surface and underground water protection have been evaluated according to the Georgian laws and regulations (to the largest extent the law to be applied is the Georgian Law on Water, 1997, amended in 2003, 2004, 2005).

In Georgia surface water quality standards are defined according to the different categories of water use:

- Drinking-economic water use;
- Economic-household water use;
- Fish farming water use. This category is divided into three categories: the highest, the first and the second, according to fish species available and their sensitivity.

For the drinking-economic and economic-recreational water bodies categories quality standards are defined as maximum concentrations of polluting substances permissible for human health in the river waters (Sanitary Rules and Standards for the Protection of Surface Waters from Pollution[15]). The ecologic norms for pollutants in surface waters are established by "The Rules of Protection of Surface Waters of Georgia from the Pollution"[16]. This regulation defines maximum permissible concentrations of polluting substances in water bodies significant for human heath, as well as for fish farming purposes.

The standards imposed by these regulations broadly comply with the EU standards, defined by the Directives 2006/7/EC (bathing water quality), 2006/44/EC (on the quality of fresh waters needing protection or improvement in order to support fish life)

The surface water bodies potentially affected by the project (Ruisi-Agara West section of the road) can be the Prone, Ptsa and Mtkvari River. The watercourses belongs to economic-household water category.

In the initial stage of the project surface water samples were collected to identify the quality of the water in the stream.

Water was sampled in 1.5 litre plastic bottles. For TPH identification special glass 1 litre bottles were used. The samples were analysed according to ISO and EPA methods. The maximum permissible limits (MPC), the list of methods of determination and factual values are given in Table 6.1.

Table 6.1 *Results of chemical testing*

Parameter	**Methods**	**MPC – Standard value**	**Factual values**
pH	ISO 10523		7.8
Conductivity, Sim/m	ISO 7888:1985		0.05616
Dry residue, mg/l	GOST 18164		346.535
Hardness, mg/eqv	ISO 6059		3.936
BOD, mg/l O		<30	2.76
COD, mg/l O	ISO 6060		25.200
NH4	ISO 5664:1984	0.39	nd
K	ISO 9964		3.58
Fe	ISO 6332	0.3	0.82
Cu	ISO 8288	1.0	nd
Mn	ISO 6333	0.1	0.170
Zn	ISO 8288	1	nd
Cl	ISO 9297	350	24.815
NO2	ISO 7890	3.3	nd
NO3	ISO 6777	45	4.100
Pb	ISO 8288	0.03	0.030
TPH	EPA 418	0.1	<0.04

The water is not aggressive to concrete.

[15] approved by Order #297/m (August 16, 2001) of the Minister of Labour, Health and Social Protection of Georgia

[16] approved by Order #130 (September 17, 1996) of the Minister of Environment Protection and Natural Resources of Georgia

The results of analysis show that all characteristic of the water are within allowable limits. As for high iron content, there is no source of its discharge into the water body and it may be considered as naturally occurring, according to the monitoring carried out during the development of the National Report on the State of the Environment of Georgia in 2007-2009.

Groundwater

According to Georgian legislation, groundwater, in contrast to surface water is considered a mineral resource. Water quality is regulated by norms and rules "On sanitary protection of groundwater from pollution", "On sanitary protection zones for drinking and domestic water supply systems and Resorts" and "Sanitary-hygienic requirements of bottled water quality". The norms establish maximum allowable concentration (MAC) of pollutants in water.

The area belongs to Kartli artesian basin. One of the main fields of economy in the region is agriculture. Along with that sugar plant, cement production, abattoirs and meat processing plants and vehicle repair plants, etc used to be available. This led to deterioration of ground water quality. According to the survey carried out during the development of the State of Environment report 2007-2009, in 83 boreholes the maximum allowable concentrations of manganese, iron ions, nitrates, and nitrites turned out to be exceeded.

6.2.1 Water impact assessment: road construction

The causes of potential pollution of surface water (the Prone, the Mtkvari, artificial pond located in the project impact area) include accidental fuel/oil spills from machinery/vehicles, poorly managed solid waste and construction materials, runoff. There will be no risk of pollution with sewage as bio-toilets will be provided.

In order to avoid or mitigate impact the operation of the site should be performed with due consideration to environmental safety measures:

- Should any temporary fuel tank be available, it must be located within at least 100m from the riverbed. The tank must be placed in covered areas with berms or dikes installed to intercept spills, if any. Any spill should be immediately intercepted and cleaned up with absorbent materials.
- Onsite repairs /maintenance and fuelling activities should be limited. Priority should be given to offsite commercial facilities. If impossible, a designated area and/or a secondary containment for possible spills for on-site repair or maintenance activities must be provided. These areas shall be located away from drainage channels surface water bodies. (distance between the maintenance site and the river should be at least 100m);
- Tyre washing unit must be equipped with drainage an settling facilities;

- On-site vehicles and equipment shall be inspected regularly for leaks and all leaks shall be immediately repaired. Incoming vehicles and equipment shall be checked for leaks. Leaking vehicles/equipment shall not be allowed on-site.
- Secondary containment devices (drop cloths, drain pans) shall be used to catch leaks or spills while removing or changing oils from vehicles or equipment. On small spills absorbent materials must be used;
- Usage of off-site vehicle wash racks or commercial washing facilities is preferable. If on-site cleaning is required, bermed wash areas for cleaning activities must be established. The wash area may be sloped to facilitate collection of wash water and evaporative drying.
- Materials and waste must be stockpiled so as to avoid erosion and washing off into the river. Drainage trenches must be established to divert surface runoff from the site,
- Waste collection area must be sited in order to avoid substantial amount of runoff from upland areas without draining directly to a waterbody.
- To prevent runoff contamination, paving should be performed only in dry weather;

Road section, in the area near Mtkvari runs in 250m from the river bed (outside the protection zone).

The risk of impact on ground water during construction is higher for shallow aquifers. Water may be polluted through percolation of contaminated surface runoff, leakage of fuel, etc. The ground water pollution may also be caused by infiltration of contaminated surface water. Within the region of interest, the levels of ground water vary from 0.3-22m in Breti to 1.5-45m in Agara.

The risk of impact on ground water is higher in the bridge construction area, as the works require higher amount of excavation than during the road construction.

Pollution of ground water during road and bridge construction may be avoided/ mitigated by proper management of works (see mitigation measures listed above). The responsibility for mitigation measures rests with the contractor and the 'operator' of the road.

6.2.2 Water impact assessment: road operation

No water discharge into the surface water body will be the case. Runoff from the bridge and the road sectionwithin the water-protection zone will be diverted from the area.

Bridge surface and/or road rehabilitation may lead to sedimentation and pollution of water with heavy metals, petroleum hydrocarbons and con-

struction waste. Proper planning of road/bridge pavement rehabilitation works can be effective measure for protection of water environment.To reduce impact on water environment

- paving should be performed only in dry weather to prevent runoff contamination;
- proper staging techniques should be used to reduce the spread of paving materials during the repair of potholes and worn pavement. These can include covering storm drain inlets and manholes during paving operations, using erosion and sediment controls to decrease runoff from repair sites, and using drip pans, absorbent materials and other pollution prevention materials to limit leaks of paving materials and fluids from paving machines;

Direct/indirect impact on ground water quality during operation is less likely to happen

6.3 Waste management

6.3.1 Waste: road construction

Waste streams generated during construction include: domestic waste, removed asphalt cover, inert construction waste, scrap metal, etc.

To prevent impact of the waste generated during construction on environment it must be collected and temporrily stored in the area selected with consideration of requirements listed below.

Until removal from the site, domestic waste (food waste, plastic bottles, packaging) must be collected in containers with fitted lid to avoid attraction of scavengers, propagation of odour and scattering by wind. The lids also protect waste from rain and snow. The containers must be placed in specially allocated area, in a distance from water bodies and traffic. Waste will be removed to the nearest landfill under agreement with municipality.

Assuming that quantity of domestic waste generated per capita per year totals $0.7m^3$, in approximate total amount of the mentioned waste type produced during construction will equate $200x0.7=140\ m^3$/sec.

In Georgia municipalities are responsible for the collection and transportation of household waste. (However, regular waste collection service is only available in some of the central settlements.). Domestic waste generated during the construction will be collected and delivered to the nearest landfill under the contract.

Hazardous waste generated during construction will include:

- Used tires - 60-70 unit / year;
- Oil filters of construction equipment,vehicles and other machinery - 20-25 unit /year;

- Outdated and damaged accumulators 12-15 unit/year;
- Waste fuel - lubricants - 120-150 kg /year;
- Welding electrodes -50-60 kg /year;
- Ammount of soil contaminated with acidentally spilled oil will depend on the scale of the spill
- Inert construction and demolition waste, possibly asbestes containing, generated during construction/widening of the road.

As so far Georgia does not have hazardous waste landfill, this type of waste will be disposed to agreed landfill facility under relevant agreement. Area allocated for temporary disposal of hazardous waste must be arranged with stricter protection - in particular, containers must have secondary containment, hazardous waste must be stored separately from the inert one. Integrity of the hazardous waste containers must be controlled. Staff involved in hazardpus waste management must be trained in waste management and safety issues. Waste must be removed every 3 day. Treatment, utilisation, disposal of waste must be done by authorised contractor.

Soil polluted with petroleum hydrocarbons because of accidental small scale fuel/oil spills (3-5m^3) can be remediated onsite (eg. in situ bioremediation). Larger spills must be localized, contaminated soil/earth stripped, removed from the site and remediated. New, clean soil must be introduced, followed by recultivation. It is recommended to involve authorised company for this service.

Waste streams generated during construction of the road, the bridges and demolition of the roadside structures/buildings will include inert waste from construction and demolition (road pavement, buildings/roadside structures) activities. Inert materials include earth, soil, rock, cured asphalt, brick, masonry, concrete. These materials do not decompose or produce leachate or other products harmful to the environment. Recyclable materials include but are not limited to: asphalt pavement, cardboard, concrete aggregate, excavated rock, soil (uncontaminated), green waste, wood/lumbers, scrap metal.

For temporary disposal of inert waste, the site within the camp/operation ground must be selected. The waste must be placed so as not to interfere with free movement of machinery and staff, away from surface water (within at least 100m). Waste must be source-separated in order to ensure proper management and enable reuse.

Any waste materials that may be used for the project must be reused on the site, residuals waste - should be disposed at the nearest landfill, as the case may be based on agreement with the municipal authoritiesor under agreement with local authorities used elsewhere for the neeeds of the region. For instance, wood/timber can be handed over to local municipality based on acceptance-submission certificate and subsequently, by decision of the local governance, distributed to the residents. Procedure is as follows: RD hands over material to the Ministry of Economy and Sustainable Development based on a formal certificate. After that material can be given to the local municipality following to takeover certificate .

Special attention is to be paid to asbestos containing waste, which must be handles separately and disposed of in a safe way. Removal of asbestos containing waste (in case generated) must be carried out by qualified specialists. Material must be packed in plastic bags or packed in plastic and marked. On the final disposal site, 4m deep pits must be arranged. Asbestos/asbestos containing waste must be covered with 2m thick soil later.

The Regional Environmental Assessment recommends processing and reuse of removed asphalt pavement. The thickness of the existing asphalt pavement along the section under rehabilitation is from 170 to 200mm. Processing includes the following steps: removal; breaking down to maximum particle sizes of 32.5mm or smaller, depending on the intended use; blending with granular material to comply with the relevant requirements and use as levelling/capping layer or sub-base material. This will solve the problem of waste asphalt disposal. However, as the properties of existing material vary, frequent testing is required to verify compliance with the specifications. Temporary and final disposal of waste will be subject to formal permission from municipal authorities.

6.3.2 Waste: road operation

The waste generated during operation will include roadside litter (unfortunate practice) and waste accumulated at rest/service facilities. The management of the waste generated at rest/service areas is of no great concern. The rest/service facilities shall be equipped with bins for waste collection. Management of roadside litter is more complicated. It is predominantly food waste, plastic and paper that people fly tip. The roadside litter is extremely unsightly and uncollected litter may attract vermin. It may impact animals that may get trapped or poisoned with litter in their habitats. Cigarette butts and filters threaten wildlife, as fish and birds often mistake this waste for food. Litter may end up in rivers and canals, polluting the water supply. And the last but not the least, the litter is also a road hazard that may occasionally contribute to accidents.

Recently a fine for littering has been introduced. However the littering along the highway is more difficult to manage. One way of its reduction is education. It is necessary to:

- ensure that the community is aware of the range of ways to dispose of their waste correctly;
- inform the community of the level of fines that littering incurs;
- may be an element of a roadside litter prevention program, educating the community that littering is illegal, fines apply and behaviours are monitored. The signs may be suitable for placement in a series of two to four signs at 10 km intervals to repeat the message in different ways.

Management of waste during operation will be responsibility of contractor identified by the Road Departement.

6.4 Impacts on air quality

6.4.1Air pollution impact assessment: road construction

The major air quality issue during road construction is the production of dust during earthworks, storage and transportation of soil or other fine-grained materials (cement, sand, etc.), and vehicles moving across unpaved or dusty surfaces. Dust is also emitted during the production of concrete, especially if good production practice for dust emissions mitigation is not followed. It is very difficult to accurately quantify dust emissions arising from construction activities. It is thus not possible to easily predict changes to dust soiling rates or PM_{10} concentrations. Therefore it is necessary to determine the likelihood of a significant impact which should be combined with an assessment of the proposed mitigation measures, such as the following:

- *Spray all unpaved roads and significant areas of uncovered soil with water every four hours on working days, during dry and windy weather;*
- *Provide a wheel-washing facility and ensure that it is used by all vehicles before leaving all sites;*
- *Cover all loose material with tarpaulins when transported off-site on trucks;*
- *Keep at least 300 m distance from residences windward to reinforced concrete production plants.*

Table 6.*2 Tentative list of vehicles and construction machinery*

Name	Quantity
Motor grader with automatic leveling device	2
Automatic tar machine 3.5 m^3	1
Crane with capacity of 10, 16, 25, 40 ton	10
Bulldozer with power of 79 kW, 96 kW	3
Transportable Compressor	6
Demolition hammers	12
Cold recycling machine	1
Bitumen sprayer with capacity of 500 t/h, with automatic grading, highly densifying tabs, gas heater and thermal control	1
Asphalt-concrete plant with a forced stirring, 150 t/h capacity	1
Concrete production plant	4
Electric welding machine	6
Gaswelding device	4
Steel cutter and framework producing device	4
Beam carriers	6
Drilling assembly	3
Grader E xcavator	2
Excavator with a clamshell volume of 0.5 m^3, 0.65 m^3, 1.0 m^3	8
Electric vibrator	12
Automatic Concrete mixer	6
Combined tamper	3

Pneumatic tamper	3
Vibrational tamper	3
Smooth battledore tamper	3
Drilling-Crane machine	3
Labeling machine	1
Irrigation-washing machine	3
Dump truck with 10-12 tn. capacity	25
Flatbed truck with load capacity 20 tn.	6
Flatbed truck with load capacity 7 tn.	4
Concrete spraying set up-plant	1
Milling set up	4

Calculation of polluting substance emissions from the construction machinery engines

Engine exhaust emissions were calculated with the aid of the software Ekolog, version 3 (Integral, St.Petersburg, 2001-2005). As this methodology does not allow for differences in the load regimes of vehicles/machinery,approach suggested under «Методическоепособие по расчету, нормированию и контролю выбросов загрязняющих веществ в атмосферный воздух» (СПб., 2005) was used. According to the mentioned document, maximum single emission is calculated for 30min interval in condition when all operation regimes occur simultaneously.

This interval consists of the following periods:

- Equipment movement without a load(bulldozer return motion, movement for further loading) - is characterized by time T_{mov}
- Equipment movement with a load (excavator moves the material with a clamshell, bulldozer moves the load, etc.) - is characterized by time T_{load}
- Idle run (idling) engine works without equipment movement, excavator pointer stoppage) is characterized by timeT_{idl}

Duration of the mentioned periods depends on specific character of works and type of machinery. Averagevaluesareasgivenbelow[«Методическим пособием по расчету, нормированию и контролю выбросов загрязняющих веществ в атмосферный воздух»] :

Work interval name	$\mathbf{T_{mov}}$	$\mathbf{T_{load}}$	$\mathbf{t_{idl}}$
Time, min	15	11	4

For assessment of atmospheric air pollution maximum values of single bulk maximum emissions from construction machinery operating on the building ground by each pollutant is calculated as:

$G_i = \sum[(M_{movmi} \times t_{movmi}) + 1.3(M_{loadi} \times t_{loadi}) + (M_{\mathbf{idlerun}}i \times t_{\mathbf{idlerun}i})]/(30 \times 60)$ G/sec.

Where: M_{movmi} – and $M_{idlerun}$i- characterise specific emission for vehicle traffic and idling regimes (УПРЗА ЭКОЛОГ, версия 3.00**)**
1.3 M_{loadi-} - characterises specific emissionfor a load mode, which is calculated taking into account that fuel consumption increase along with increase of the load.

Maximum capacity of machinery does not exceed 100 kW (see Table above), therefore below presented are the specific emission characteristics for nominal power 61-100 kW machinery [УПРЗА ЭКОЛОГ, версия 3.00]

Vehicle category	Diesel engine nominal power, kW	Specific emission of pollutants during traffic (g/min)				
		Carbon monoxide	Carbon-hydrogen	Nitrogen oxide	Soot	Sulphur-dioxide
4	61↔100	1.29	0.43	2.47	0.27	0.19
Specific emission of pollutants in idling regime (g/min)						
4	61↔100	2.40	0.30	0.48	0.06	0.097

Sources of emission have been identified based on the mentioned above. Emissions from these sources were calculated with consideration of standard and reference materials.

Dust, welding aerosols from machinery/vehicles (excavator, bulldozer, tractor, etc.) was performed.

Below is presented the 'sequence' of calculation and calculated emission values.

Excavation. Source of emision - excavator
Initial data
Equipment type: single clamshell excavator
Rock strength: Rock f=4
Total dust emisson for a single clamshell excavator is determined as:
$M = Q_{exc} \times (3.6 \times Ex K_{exc}/T_{ec}) \times K_1 \times K_2 \times T \times N_r \times N)/(1000)$, t/year
Q_{exc} -specific dust emission from $1m^3$ from transshipped material, g/m^3 (4.4)
E - clamshellcapacity, m^3 (0.65);
$K_э$ =0.6 (direct clamshell- 2.0 t/m^3; rock capacity 2.7t/m^3);
T_{ec} –excavation time, sec. (30)
K_1 =1.20 – coefficient,which takes into account the wind velocity (2.1-5 m/sec);
K_2 =1.20 –coefficient, which takes into account material moisture. (moisture: 3.1-5%);
T = 7 h –net work time per shift;
$N_г$ = 730 – number of work days per year;
N = 1 – qty of simultanaously operating equipment;

$M = Q_{exc} \times (3,6 \times Ex K_{exc}/T_{ec}) \times K_1 \times K_2 \times T \times N_r \times N)/(1000)$= 4.4 x (3.6 x 0.65 x 0.6 /30) x (1.2x1.2x7x730x1)/1000 = 1.515 t/year

Maximum single dust emission from a single clamshell excavator is calculated as:
$G = Q_{exc} x\ Ex\ K_0 x\ K_1 x\ K_2 x\ N/T_{ec}$, g/sec, K_{exc}-excavation coefficient.
$G = Q_{exc} x\ Ex\ K_0 x\ K_1 x\ K_2 x\ N/T_{ec}$, = 4.4 x 0.65 x 0.6 x 1.2 x1.2 x 1/30 = 0.082g/sec

Calculation of gaseous emission
$G_i = \sum[(M_{movmi} x\ t_{movmi}) + 1.3(M_{loadi} x\ t_{loadi}) + (M_{idle\ run}i\ x\ t_{idle\ runi})] / (30 x 60)$ g/sec

$G(co) = [(M_{movmco)} x\ t_{movmco)}) + 1.3(M_{load.(co)} x\ t_{load.(co)}) + (M_{idle\ run(co)} x\ t_{idle\ run.(co))}]/(30x\ 60) + (1.29x15) + 1.3(1.29x11) + (2.4 x 4)/(30 x 60) = 0.026$ g/sec;

$G_{(CH)} = [(M_{movm(CH)} x\ t_{movm(CH)}) + 1.3(M_{load(CH)} x\ t_{load(CH)}) + (M_{idle\ run.(CH)} x\ t_{idle\ run(CH))}]/(30x60) = (0.43x15) + 1.3(0.43x11) + (0.3x4)/(30x60) = 0.0076$ g/sec;

$G_{(NOx)} = [(M_{movm(NOx)} x\ t_{movm(NOx))} + 1.3(M_{load(NOx)} x\ t_{load(NOx))} + (M_{idle\ run}\ (_{NOx)} x\ t_{idle\ run(NOx))}]/(30x60) = (2.47x15) + 1.3(2.47x11) + (0.48x4)/(30x60) = 0.041$ g/sec;

In compliance with methodical guidance nitrogen dioxide and oxide content, with consideration of nitrogen oxide transformation coefficient, is calculated according to the set coefficients (NO_2 = 0.8 ; NO = 0.13). Hence:
NO_2 = 0.041 x 0.8 = 0.0328 g/sec; NO = 0.041 x 0.13 = 0.0053 g/sec

$G_{(CH)} = [(M_{movm(CH)} x\ t_{movm(CH)}) + 1.3(M_{load(CH)} x\ t_{load(CH)}) + (M_{idle\ run.(CH)} x\ t_{idle\ run(CH))}]/(30x60) = = (0.27x15) + 13(0.27 x 11) + (006 x 4) / (30 x 60) = 0.0045$ g/sec;

$G_{(SO2.)} = [(M_{movm(SO2)} x\ t_{movm(SO2))} + 1,3(M_{load(SO2)} x\ t_{load(SO2))}) + (M_{idle\ run}\ (_{SO2)} x\ t_{idle\ run(SO2))}] / (30 x 60) = (0.,19 x 15) + 1.3(0.19 x 11) + (0.097x 4)/(30 x 60) = 0.0033$ g/sec;

Calculation results

Substance codes	Substance name	Max. emission (g/sec)	Total emission (t/year)
337	Carbon monoxide(CO)	0.0260	0.478
330	Sulphurdioxide (SO_2)	0.0033	0.060
328	Soot (C)	0.0045	0.082
301	Nitrogendioxide(NO_2)	0.0328	0.600
304	Nitricoxide(NO)	0.0053	0.097
2732	Hydrocarbons(CH)	0.0076	0.140
2902	Inorganicdust	0.0823	1.515

In total, during construction 1 excavator will be used. This quantity is considered in caclulation of total emission for entire construction process (K= g/sec x 3600sec x 7h x 730day/10^6= 18.396).

Bulldozer works-spraying source, bulldozer

Initial data

Equipment type: Bulldozer

Rock strength: Rock f=4

Total emission of dust for bulldozeris determined as:

$M = (3.6 \times Q_{bul} \times G_m \times V \times K_1 \times K_2 \times T \times N_r \times N) / (1000 \times T_{bc} \times K_{dc})$, t/y;

Q_{bul}–specific emission of dust per 1 t of transported material, g/t (0.85);

G_m –rock strength, t/m^3 (2.70);

V_- displacement prism volume (m^3) (2);

T_{bc}– bulldozer cycle time, sec (80);

K_p – 2.7 rock strength, t/m^3 (rock strength2.70t/m^3);

K_1 =1.00 – coefficient dependant on wind velocity (2-5 m/sec);

K_2 =1.20 –coefficient dependant on material moisture (3.1-5%);

T = 7 hr – net work time per shift;

N_r = 730 - number of work days per year;

N = 1 –number of simultaneously operating machinery

$M = (3.6 \times Q_{bul} \times G_m \times V \times K_1 \times K_2 \times T \times N_r \times N) / (1000 \times T_{bc} \times K_{dc}) = 3.6 \times 0.85 \times 2.7 \times 2 \times 1 \times 1.2 \times 7 \times 730 \times 1 / 1000 \times 80 \times 1.35 = 0.938$ t/year.

Maximum single dust emission from bulldozer is calculated as:

$G = (Q_{bul} \times G_m \times V \times K_1 \times K_2 \times N)/(T_{dc} \times K_p)$;

$G = (Q_{bul} \times G_m \times V \times K_1 \times K_2 \times N)/(T_{bc} \times K_p) = 0.85x2.7x2x1x1.2x1/80 \times 1.35 = 0.051$ g/sec;

Calculation of gaseous emission

$G_i = \sum[(M_{movmi} \times t_{movmi}) + 1.3(M_{loadi} \times t_{loadi}) + (M_{idlerun}i \times t_{idle\ runi})]/(30 \times 60)$ g/sec;

$G(co) = [(M_{movm(co)} \times t_{movm(co)}) + 1.3(M_{load.(co)} \times t_{load.(co)}) + (M_{idle\ run.(co)} \times t_{idle\ run.(co)})]/(30 \times 60) = (1.29 \times 15) + 13(129x11) + (24 \times 4)/(30 \times 60) = 0.026$ g/sec;

$G_{(CH)} = [(M_{movm(CH)} \times t_{movm(CH)}) + 13(M_{load(CH)} \times t_{load(CH)}) + (M_{idle\ run\ (CH)} \times t_{idle\ run(\ CH)})]/(30 \times 60) = (043x15) + 13(043 \times 11) + (0.3 \times 4)/(30 \times 60) = 0.0076$ g/sec;

$G_{(NOx)} = [(M_{movm(NOx)} \times t_{movm(NOx)}) + 1.3(M_{load(NOx)} \times t_{load(NOx)}) + (M_{idle\ run\ (NOx)} \times t_{idle\ run(NOx)})]/(30 \times 60) = (247 \times 15) + 13(247 \times 11) + (048 \times 4)/(30 \times 60) = 0.041$ g/sec;

In compliance with methodical guidance nitrogen dioxide and oxide content, with consideration of nitrogen oxide transformation coefficient, is calculated according to the set coefficients (NO_2 = 0.8 ; NO = 0.13). Hence:

$NO_2 = 0.041 \times 0.8 = 0.0328$ g/sec; $NO = 0.041 \times 0{,}13 = 0.0053$ gsec;

$G_{(ვ3.)} = [(M_{movm\ (CH)} \times t_{movm\ (CH)}) + 1.3(M_{load\ (CH)} \times t_{load\ (CH} + (M_{Idle\ run\ (CH)} \times t_{Idle\ run\ (CH)})]/(30 \times 60) = (0.27 \times 15) + 1{,}3(0{,}27 \times 11) + (0.06 \times 4)/(30 \times 60) = 0.0045$ g/sec

$G_{(SO2.)} = [(M_{movm(SO2)} \times t_{movm(SO2)}) + 1.3(M_{load(SO2)} \times t_{load\ (SO2)}) + (M_{idle\ run\ (SO2)}x$

$t_{idle\ run(SO2)}$)]/(30 x 60) = (0.19 x 15) + 1.3(0,19 x 11) + (0.097x 4) / (30 x 60) = 0.0033 g/sec;

Calculation results

Substance codes	Substance name	Max. emission (g/sec)	Total emission (t/year)
337	Carbon monoxide(CO)	0.0260	0.478
330	Sulphurdioxide (SO_2)	0.0033	0.060
328	Soot (C)	0.0045	0.082
301	Nitrogendioxide(NO_2)	0.0328	0.600
304	Nitricoxide(NO)	0.0053	0.097
2732	Hydrocarbons(CH)	0.0076	0.140
2902	Inorganicdust	0.051	0.938

In total, during construction 1 bulldozer will be used. This quantity is considered in caclulation of total emission for entire construction process (K= g/sec x 3600sec x 7h x 730day/10^6= 18.396).

Tractor and other equipment emissions are calculated similarly.

Note: Instead of new standards,more strict, old norms for $N0_2$ emissions is in model analysis

Scattering report was conducted for a 250x250 m rectangle, with potential construction yard in its geometric center. Calculating 'step' is set as 50m.

According to the standard related to baseline pollution the baseline level is to be considered if population in the settlement in the impact area exceeds 10000.
Since population along the road is considerably less and no industrial objects along the road section are available – the baseline concentration can be assumed to be zero.

Graphical representation of concentrations calculated for each emitted substance and summary impact groups is given in Annex 1.

6.4.2 Air pollution impact assessment: road operation

Amounts of vehicle emitted pollutants mainly depend on the technical condition of the vehicles, fuel quality and speed. Older vehicles usually have lower fuel consumption efficiency and cause higher emissions of combustion by-products. Increasing speed of the vehicle demands higher fuel supply and therefore results in larger amounts of emitted pollutants.

After upgrading Ruisi - Agara West road section, the speed limit will be set to 120 km/h. The improved road capacity will result in an increased number of vehicles passing the route and in higher emission levels.

From the stand point of the "zero" alternative, the speed would remain the same (80 km/h and 60 km/h along settled areas), but the traffic flow would anyway increase due to economic needs. It would result in appearance of jams, especially near settlements. Lower speed results in lower emission levels but at the same time it prolongs pollution dispersion. Increased traffic flow, low speed and low quality pavement would possibly impair ambient air quality along the route.

Ambient air quality is influenced by a number of factors, listed above. To evaluate and compare impacts of traffic induced air pollution, the modelling of pollution dispersion along the Ruisi - Agara West road section was performed.

Long-term pollution levels were calculated using modelling software *CALRoads View*. It is an air dispersion modelling package for predicting air quality impacts of pollutants near roadways. *CALRoads View* combines the following mobile source air dispersion models into one integrated graphical interface: *CALINE4*, *CAL3QHC*, and *CAL3QHCR*. Combining features of these models enables predicting concentrations of carbon monoxide (CO), nitrogen dioxide (NO_2), suspended particles and other pollutants near roadways and highways. Options are available for modelling near intersections, parking lots, elevated or depressed freeways, and canyons. It is also possible to evaluate air pollution caused by both moving and idling vehicles and to estimate the length of queues formed by idling vehicles at controlled crossings. *CALRoads View* can process up to a year of hourly meteorological data, but if the data is missing, it is recommended to use the worst-case scenario which is described by the worst case wind direction.

For Ruisi - Agara West road section, three scenarios were modelled:

- *Pollutant dispersion calculations using forecasted traffic data (2025 year), assuming that the project was not implemented and the road was not upgraded (the "zero" alternative);*

- *Pollutant dispersion calculations using the same forecasted traffic flow (2025 year), assuming that the Project alternative 1 was implemented and road upgrading consisted mostly of road widening.*

- *Pollutant dispersion calculations using the same forecasted traffic flow (2025 year), assuming that the Project alternative 2 was implemented and road upgrading consisted of road widening and a bypass near Agara.*

In addition to meteorological conditions in air pollution modelling, the main parameters are emission factors. Traffic emissions mostly depend on speed, vehicles technical condition and percentage of Heavy Goods Vehicles (HGV) in the traffic flow.

All the three alternatives for the road section were modelled using the same forecasted traffic flow data for 2025 year (according to traffic survey performed by Kocks Consult, and given in the Feasibility Study and Alternative Alignment Analysis for Upgrading the Section between Sveneti and Rikoti, km 80 – km 144 of the E 60 Highway, 2009). Emission factors were estimated considering traffic fleet composition, type of road and speed. Traffic fleet composition was assumed to be the same for all scenarios, but speed limits were different as it is expected to have 120 km/h (cars) and 100 km/h (HGV) speed limit on the upgraded road (both Project alternative 1 and 2) and 80 km/h (60 km/h in settlements) for both types of vehicles on the existing road, if the project is not implemented.

Table 6.3. *Initial data for pollution dispersion modelling*

		"Zero" alternative	**Project alternative 1**	**Project alternative 2**
Year of prognosis		2025	2025	2025
Composition of traffic flow	Cars, vehicles/day	22446	22446	22446
	HGV*, vehicles/day	2040	2040	2040
	% of heavy transport in flow	8.3	8.3	8.3
	Total number of vehicles/day	24486	24486	24486
Speed limit, km/h	Cars (in settlements)	80 (60)	120 (60)	120
	HGV (in settlements)	80 (60)	100 (60)	100

*Heavy Goods Vehicles

Pollution modelling was performed considering worst-case meteorological conditions mainly described by wind direction, wind speed and atmospheric stability. Higher wind speed and unstable atmospheric conditions enable faster pollutant dispersion and lower concentrations. Therefore modelling was performed under stable atmospheric and worst meteorological conditions, estimated relying on the data obtained by the Gori meteorological observation post (lowest wind speed of 2.9 m/s; temperature reflecting winter period of -1ºC). To model maximum possible pollutant concentrations, the worst-case wind angle was chosen as a run type.

30 min onetime maximum concentrations of carbon monoxide (CO), nitrogen dioxide (NO_2), and particulate matter up to 10 micrometers in size (PM_{10}) were calculated. Pollution dispersion maps are presented in *Annex 1*.

According to the WB policy, the air pollution impact assessment should be performed relying on guidelines and standards of both the WB and of the borrowing country; in cases they differ, the stricter ones should be applied. Maximum allowable pollutant concentrations according to the Georgian regulations (*Georgian Ministry of Labour, Health Care and Social Affairs (2003) Order 38/n "On approval of qualitative environmental standards: Acceptable limit concentrations of pollutants in atmospheric air of residential areas"*) and the WB recommendations (*EHS guidelines, "Air Emissions and Ambient Air*

Quality", based on WHO guidelines) are given in Table 6.4. 30 min onetime maximum concentration under the Georgian standard is assumed to be the strictest and therefore applicable in the evaluation.

It is assumed that if modelled under the worst possible metheorological conditions, 30 min onetime maximum pollutant concentrations will not exceed limit concentrations given below, exceedances of limit concentrations indicated by longer time periods are not likely to occur neither.

Table 6.4 *Maximum Allowable Concentrations (MAC) according to the Georgian standards and WHO guidelines*

		EHS Guidelines*	**Georgian standard**
CO	*1 hour*	30 mg/m^3 (25 ppm)	-
	8 hour daily maximum	10 mg/m^3 (10 ppm)	-
	30 min onetime maximum	-	5 mg/m^3
	24 hour	-	3 mg/m^3
NO_2	*1 hour*	200 µg/m^3(0.11 ppm)	-
	Annual	40 µg/m^3 (0.026 ppm)	-
	30 min onetime maximum	-	200 µg/m^3
	24 hour	-	40 µg/m^3
PM_{10}	*24 hour*	50 µg/m^3	300 µg/m^3
	Annual	20 µg/m^3	-
	30 min onetime maximum	-	500 µg/m^3

* EHS Guidelines are based on WHO Air quality guidelines for Europe

The Ruisi - Agara West road section runs along rural landscapes, with only two bigger settlements of Aradeti and Agara and a few stand alone dwellings. The number of population quantity in the biggest settlement of Agara is under 10,000, therefore background concentrations of pollutants are assumed to be 0 and are not included in dispersion modelling (Source: "Background Concentrations for Towns and Settled Areas where no Ambient Air Quality Observations are Held").

Modelled CO concentrations along the analyzed road subsections were lowest for "zero" alternative, and were varying from 0.01 to 0.04 mg/m^3 at a distance of 5 m from the road and from 0.003 to 0.012 mg/m^3 at a distance of 50 m from the road. Comparing both project alternatives, at a distance of 50 m from the road modelled CO concentrations were almost similar; while at a distance of 5 m from the road bigger CO concentrations were predicted for Project alternative 1 and they were varying from 0.035 to 0.053 mg/m^3. For Project 2 alternative concentrations at a distance of 5 m were varying from 0.033 to 0.044 mg/m^3. CO emissions are mainly dependent on vehicle speed. For both project alternatives it is supposed to have 120 km/h speed along the main lanes, while maximum speed in the case of "zero alternative" would be 80

km/h. Emmission factors are much higher when the speed is 120 km/h comparing with 80 km/h. The highest emission factors of CO are usually estimated at low speeds from 10 to 50 km/h, which is actual for the case of "zero" alternative, as it is supposed to have number of junctions between the main road and small off-roads with low speed and queuing vehicles. Even considering this factor during the modelling, lowest concentrations were predicted for the "zero" alternative, mainly because of the low emission factors at 80 km/h speed. However, if the road would not be upgraded, but the number of pasing vehicles would increase to 24 486 vehicles/day, it is possible to have jams near settlements or number of queuing vehicles near intersections of main road with small off-roads. It was difficult to include all the influencing factors into modelling, and therefore it is supposed that CO emissions for the "Zero" alternative should be higher than modelling results had shown.

Table 6.5 *Modelled pollutant concentrations* in different subsections of the road for the "zero" and for the both Project alternatives*

		Modelled concentrations (30 min onetime maximum)					
		CO, mg/m^3		**NO_2, µg/m^3**		**PM_{10}, µg/m^3**	
		Distance from road		Distance from road		Distance from road	
		5 m	50 m	5 m	50 m	5 m	50 m
Road sub-section from 95-97 km	*"Zero alternative"*	0.018 - 0.028	0.007 - 0.009	15.0 - 19.6	6.1 - 6.4	0.7 - 1.0	0.3 - 0.4
	Project alternative 1	0.022 - 0.026	0.009 - 0.010	19.4 - 21.8	7.5 - 8.2	0.9 - 1.0	0.3 - 0.4
Road sub-section from 97.9-101/5 km	*"Zero alternative"*	0.019 - 0.023	0.007 - 0.009	15.1 - 20.0	6.3 - 7.0	0.8 - 0.9	0.2 - 0.3
	Project alternative 1	0.017 - 0.021	0.007 - 0.010	20.8 - 22.0	7.6 - 8.2	0.8 - 0.9	0.3 - 0.4
Road sub-section from 101.5-106 km	*"Zero alternative"*	0.023 - 0.034	0.008 - 0.016	14.2 - 23.3	5.3 - 9.6	0.8 - 1.0	0.3 - 0.4
	Project alternative 1	0.015 - 0.023	0.008 - 0.011	17.4 - 21.3	7.3 - 11.0	0.9 - 1.1	0.3 - 0.5
Road sub-section from 106 to 110 km (106 - 110.9 km for the designed road)	*"Zero alternative"*	0.01 - 0.019	0.003 - 0.007	18.0 - 24.0	4.0 - 6.0	1.0	0
	Project alternative 1	0.039 - 0.048	0.010 - 0.011	30.0 - 37.0	6.0 - 9.0	2.0	0
	Project alternative 2	0.036 - 0.041	0.007 - 0.014	25.0 - 30.0	6.0 - 10.0	1.0	0
Road sub-section from 110 to 115 km (110.9 - 115.7 km for the designed road)	*"Zero alternative"*	0.024 - 0.027	0.006 - 0.01	20.0 - 28.0	5.0 - 9.0	1.0	0
	Project alternative 1	0.035 - 0.053	0.010 - 0.018	33.0 - 41.0	7.0 - 14.0	2.0	0
	Project alternative 2	0.035 - 0.042	0.007 - 0.014	25.0 - 31.0	6.0 - 10.0	1.0	0
Road sub-section from 115 to 121 km (115.7 to 121 km for the designed road)	*"Zero alternative"*	0.03 - 0.04	0.006 - 0.012	19.0 - 26.0	4.0 - 7.0	1.0	0
	Project alternative 1	0.044 - 0.050	0.009 - 0.014	34.0 - 39.0	7.0 - 11.0	2.0	0
	Project alternative 2	0.033 - 0.044	0.009 - 0.014	27.0 - 31.0	6.0 - 9.0	1.0	0

Biggest concentrations were estimated for the Project alternative 1. It is mainly because of the fact that Project alternative 1 would consist of road widening without changing its alighnment. It would therefore run along both settlements of Aradeti and Agara and would have number of junctions resulting in speed reduction and increased emissions. In case of Project alternative 2 such problem would be eliminated by a planned bypass near Agara, which would help to avoid significant speed reductions and to ensure better pollutant dispersion.

However, modelled concentrations of CO for all the three alternatives at both 5 m and 50 m distances were not exceeding MAC. Moreover, they were negligibly small, and would not cause any air pollution problems.

As in the case of CO modelled concentrations of NO_2 in all analyzed road sub-sections were lowest for the "zero" alternative, and highest - for the Project alternative 1. Modelled concentrations of NO_2 for the Project 1 alternative at both distances of 5 m and 50 m were 35 %higher than for "zero" alternative and 20 % higher than for Project 2 alternative.

Emission factors of NO_2 have almost the same dependence on vehicles speed as compared with CO. It is determined by high emission factors at very low (10 - 30 km/h) and high (100 - 120 km/h) speeds. At 80 km/h speed emissions are moderate, resulting in less amounts of emitted NO_2 as compared with 120 km/h speed. It is the main reason why modelled concentrations of NO_2 were smallest in the case of "zero" alternative. As for Project 1 alternative, it can be distinguished by unsolved problem of junctions between the main route and small off'roads, leading to the settlements of Agara and Aradeti. Number of junctions results in rapid decrease of speed and increased emissions of NO_2. That is the main reason why concentrations of NO_2 were lower in the case of Alternative 2 even the speed along the main route was the same for both project alternatives. The alighnment of Alternative 2 bypasses Agara settlement avoiding speed reductions and possible queues near junctions with the main route.

However, for the "zero" and for the both Projecct alternatives 1 and 2 even maximum modelled NO_2 concentrations did not exceed MAC (200 $\mu g/m^3$ for 30 min period, Table 6.4.). Maximum modelled concentrations of NO_2 for the "zero" and for the Project alternative 1 and 2 were lower than MAC respectively by 57 %, 46 % and 56 %. For the "zero" alternative at 5 m and 50 m distances modelled NO_2 concentrations were lower than MAC by 73 % and 92 %; for the Project alternative 1 the modelled concentrations of NO_2 at distances of 5 m and 50 m from the road boundaries were lower than MAC respectively by 58 % and 88 %; for the Project alternative 2 the modelled concentrations of NO_2 at distances of 5 m and 50 m from the road were lower than MAC by 67 % and 90 %.

It may be concluded that even an increase in the traffic flow will cause no unacceptable air pollution by NO_2 in all three analyzed cases. At selected distances from the road, where transport emitted pollutants could make any negative impact on residents along Ruisi - Agara West road section, NO_2 concentrations prove to be low as compared with MAC. Therefore NO_2 in traffic emissions is not expected to have any considerable negative impacts on hu-

man health. NO_2 concentrations for all the analyzed alternatives would be higher than 0 at a distance of about 200 m from the road centreline, but within this distance the concentrations would be too low to make any negative impact on human health.

Modelled concentrations of PM_{10} for the "zero" and for the both Project alternatives 1 and 2 were negligibly small as compared with MAC (500 $\mu g/m^3$) (Table 6.5). For all the three analyzed cases at 5 m and 50 m distances concentrations of PM_{10} were almost the same and close to zero.

CONCLUSIONS:

- *Negative impacts of air pollution by NO_2, CO and PM_{10} are negligible for the "zero" and for the both Project alternatives 1 and 2;*
- *Modelled concentrations of CO and NO_2 were highest for the Project alternative 1 and lowest for the "zero" alternative.*
- *Concentrations of CO and NO_2 were higher for Project alternative 2 as compared to the "zero" alternative, but it would bypass the settlement of Agara ensuring better conditions for pollutant dispersion and less impacts on the residents.*

No specific air pollution mitigation measures are recommended for Ruisi - Agara West road section; however it is advised to keep proper planning of greenery near settled areas.

6.4.3 Impacts on climate

Usually automobiles and light trucks produce well over 60 % of CO_2 emissions within road transport. In countries like Georgia freight trucks (and in some cases even buses) consume more fuel and emit even more CO_2 than light duty vehicles. Transport related CO_2 emissions in Georgia contribute about 40 % of total CO_2 emissions; from this amount only 60% of CO_2 emissions are related with other than road traffic sources (Source:World Bank, World Development Indicators- Last updated March 2, 2011). Georgia has one of the fastest growing economies in the region, and favorable geographical position. It is expected to have continual increase in goods transit and upgraded roads road modernization project should serve for this purpose. Increased traffic flows will inevitably result in bigger CO_2 emissions.

Upgrading of Ruisi - Agara West road section will result in continual increase of vehicles passing the route therefore it is necessary to calculate amounts of emitted CO_2 along the roads section under study, and to compare "zero" and both upgrading alternatives. CO_2 emissions were calculated relying on forecasted traffic flow and emission factors for relevant fleet composition. Detailed information on initial calculation data is given in Table 6.6.

Table 6.6 *Initial data for CO_2 emissions calculation*

		"Zero" alternative	Project alternative 1	Project alternative 2
Year		2025	2025	2025
Composition of traffic flow	Cars, vehicles/day	22446	22446	22446
	HGV*, vehicles/day	2040	2040	2040
	% of heavy transport in flow	8.3	8.3	8.3
	Total number of vehicles/day	24486	24486	24486
Speed limit, km/h	Cars (in settlements)	80 (60)	120 (60)	120**
	HGV (in settlements)	80 (60)	100 (60)	100**
Emissions of CO_2, kt/year		**8.55**	**10.05**	**10.52**

The comparison of the "zero" and both Project alternatives with regard to CO_2 emissions reveals that the "zero" alternative would ensure smaller amounts of emitted pollutants. It is mainly because of the fact that emissions of CO_2 are dependent on speed: at very low and very high speeds emissions reaches maximum values. If the road wouldn't be upgraded ("zero" alternative) speed limit would remain 80 km/h (except of 60 km/h near Agara and Aradeti settlements), which is almost moderate speed for CO_2 emissions.

Number of small off-roads would connect settlements or individual dwellings with the main route. Numbers of vehicles travelling at a very low speed or queuing with working engines would concentrate near these junctions. Very low average speeds generally represent stop-and-go driving, and vehicles do not travel far. Therefore, the emission rates per kilometer are quite high (when a car's engine is running but it is not moving, its emission rate per distance unit reaches the maximum). Conversely, when vehicles travel at much higher speeds, they demand very high engine loads, which require more fuel, and therefore lead to high CO_2 emission rates. Low emission rates are obtained at moderate speeds of about 65 - 95 km/h.

For the Project alternative 1 the speed limit would be 120 km/h with decelerating near settlements (road widening alternative would not include bypass near Agara). It is the main reason why Project 1 alternative would result in smaller CO_2 emissions comparing with Project alternative 2.

Increased speed along the route would result in larger amounts of emitted CO_2 gases, but on the other hand would help to avoid emissions due to vehicles travelling at very low speed or queuing. One of the measures for CO_2 emissions reduction is proper management of vehicle speed, but it cannot be properly applied for the case under the study, because one of the main reasons for Ruisi Agara West roads section upgrading is to ensure higher speed and better road capacity.

To reduce CO_2 emissions from the transportation sector, attention should be given to more efficient vehicles, alternative fuels. In terms of the perspective of Ruisi - Agara West road section upgrading, all factors influencing

CO_2emissions are hard to foresee. For example, it is possible that in 2025 the consumption of low-carbon fuel (such as biofuel and synthetic fuel) will considerably increase resulting in lower emissions than predicted. However, consistent policy on the topic should be obtained considering all the influencing factors and development of the state.

6.5 Impacts on the noise environment

6.5.1 Noise and vibration impact assessment: road construction

Road construction will introduce additional noise sources to the local area. Road construction noise is caused by construction equipment and operations, i. e., there are two main sources of noise during the construction: noise resulting from road upgrading works, and noise from additional activities, such as transport of materials by HGV along the route. The dominant source of noise from most construction equipment is the engine, usually a diesel, without sufficient muffling. Only in a few cases noise generated by the process dominates (for example, impact pile driving, pavement breaking, etc.). Noise levels during the construction will vary depending on the construction activity and schedule.

The upgrading of the Ruisi - Agara West road section will involve widening of existing road section and building a bypass near Agara settlement. Reconstruction works in this road section will involve usage of some specific machinery (backhoe, bulldozer, trucks, heavy roller and etc.). Noise and vibrations will be inevitable from such activities as digging trenches, soil compaction, breaking of the old road pavement by hydraulic hammer and other

Noise levels from the main road construction equipment and operations are presented in Table 6.7.

Table 6.7 *Construction equipment noise emission levels*

Equipment	**Typical noise level (dBA) approximately 15 m from source**
Air compressor	81
Backhoe	80
Compactor	82
Concrete mixer	85
Derrick crane	88
Bulldozer	85
Grader	85
Jack hammer	88
Paver	89
Pile-driver (impact)	101
Pile-driver (sonic)	96
Pneumatic tool	85
Truck	88

According to the data presented in Table 6.7, frequent exceedances of acceptable noise levels resulting from construction activities are anticipated. In-

creased HGV movement along the route during the construction will be low as compared to the existing traffic flows and will cause no population disturbance.

The Decree # 234n (Ministry of Health and Social Affairs of Georgia, Oct. 6, 2003) defines minimum distances for various construction related activities from "sanitation zones", to protect human health from the impacts of noise and vibration:

- Borrow pits (Art. 32) > 100 m;
- Asphalt plants (Art. 34) > 500 m;
- Reinforced concrete production (art. 35) > 300 m;

Noise limits for various working environments are estimated in General EHS Guidelines "Occupational health and safety" (issued by International Finance Corporation, 2007) which is the main document to rely on for noise and vibration issues. For heavy industry (with no demand for oral communication) limit equivalent noise level is set to 85 dBA; maximum - 110 dBA.

Noise impact assessment was performed identifying sensitive receptors (settlements, dwellings) within minimum distances from realignment boundaries as indicated in the Georgian standards for various construction related activities as it is described above.

It is expected to have adverse noise impacts during road construction, which are not considered to be of high importance. Settlement patterns from Ruisi to beginning of Agara imply that only a few people will be exposed to elevated noise levels during the road construction (most likely the ones working in the fields near the construction sites). More considerable impacts can be anticipated for residents of the southern part of Agara, however vibration and noise impacts are expected to be felt only locally near construction sites and should not have any negative impacts on residents.

To protect human health from the impacts of noise and vibration the following is recommended:

- to keep the requested distances from appropriate activities to the closest dwellings and residential areas;
- to keep restrictions on working hours on week days, weekends or public holidays, no night-time working.

According to the data presented in Table 6.7, most of the road construction activities will result in noise levels exceeding 85 dBA. Therefore it is recommended:

- To enforce the use of hearing protection by using hearing protective devices capable of reducing sound levels at the ear to at least 85 dBA;
- Exposure to hand-arm vibration from equipment such as hand and power tools, or whole-body vibrations from surfaces on which the

worker stands or sits, should be controlled through the choice of equipment, installation of vibration dampening pads or devices, and limiting the duration of exposure (EHS Guidelines, 2007).

6.5.2 Modelling of long-term noise levels: road operation

There are two types of noise caused by the road operation: the noise generated by vehicle engines and the noise generated by tyre-road friction. Noise levels increase with the speed. After upgrading the Ruisi - Agara West road section, the speed limit will be set to 120 km/h. It will result in an increased number of vehicles passing the route because of better road capacity, and higher levels of noise. In case of the "zero" alternative, the speed would remain the same (80 km/h and 60 km/h along settled areas), but the traffic flow would anyway increase because of economic needs.

Modelling of long-term noise dispersion was performed for all the three alternatives, considered for the evaluation: the "zero" and both the Project alternative 1 and 2. It targeted quantitative evaluation of increased noise levels and possible negative impacts on residents near the EWH-60.

Long-term noise levels were calculated using the modelling software *CadnaA* (*Computer Aided Noise Abatement*). It allows calculation and evaluation of different scenarios by choosing and managing different types of noise sources (mobile sources - roads, railways, aircraft; point sources - industrial enterprises etc.), estimating complex structures of roads, bridges, and other structures. Calculation algorithms included in *CadnaA* estimate topography, traffic intensity, speed of vehicles, percentage of heavy transport in flow, road elevation and incline, number of building floors. *CadnaA* calculates day, evening and night noise levels according to traffic intensity, speed and percentage of cars and heavy goods vehicles in the flow. Topography and other obstacles (for example, tree arrays) are also estimated. *CadnaA* uses numerical maps in calculation, and gives noise maps as calculation output, where noise levels are attributed to different colours - one covers 5 dBA noise level and is divided by isolines at every 1 dBA.

For Ruisi - Agara West road section three scenarios were evaluated according to the project alternatives:

- *Noise levels calculations using forecasted traffic data (2025 year), assuming that the project was not implemented and the road was not upgraded (the "zero" alternative);*
- *Noise levels calculations using the same forecasted traffic flow (2025 year), assuming that the Project alternative 1 was implemented and road upgrading consisted mostly of road widening;*
- *Noise levels calculations using the same forecasted traffic flow (2025 year), assuming that the Project alternative 2 was implemented and road upgrading consisted of road widening and a bypass near Agara.*

All the three scenarios were calculated using the same forecasted traffic flow data for 2025 year (according to traffic survey performed by Kocks Consult, and given in the Feasibility Study and in the Alternative Alignment Analysis for Upgrading the Section between Sveneti and Rikoti, 80 –144 km of the E 60 Highway, 2009). Different speed limits are envisaged, namely 120 km/h (cars) and 100 km/h (heavy goods vehicles) speed limit if the road is upgraded (both project alternatives); and 80 km/h (60 km/h in settlements) for both types of vehicles if the project is not implemented. Thenoise caused by traffic on the roads crossing the Ruisi - Agara West road sub-section was also taken into consideration.

The implementation of Project alternative 1 would involve mainly road widening, except near Aradeti settlement the new road would turn slightly south from the current road alignment. Implementation of Project alternative 2 would require building a bypass near Agara and road widening (with the same road alignment near Aradeti, as for Project alternative 1). In case of both project alternatives the distance from the new road alignment to the nearest dwellings of Aradeti will be larger, which should soften negative impacts caused by the road operation. In case of Project alternative 2 the new road near Agara would go south of the settlement and the current road alignment. Therefore negative impacts resulted by road operation would only affect southern part of Agara. In addition to the increased traffic flow and speed, noise levels for both the project alternatives are expected to be higher because of the concrete pavement which increases noise levels approximately by 3 dBA as compared with the asphalt - concrete pavement.

Table 6.8 *Initial data for noise dispersion modelling*

		"Zero" alternative	**Project alternative 1**	**Project alternative 2**
Year of prognosis		2025	2025	2025
Composition of traffic flow	Cars, vehicles/day	22446	22446	22446
	HGV*, vehicles/day	2040	2040	2040
	% of heavy transport in flow	8.3	8.3	8.3
	Total number of vehicles/day	24486	24486	24486
Speed limit, km/h	Cars (in settlements)	80 (60)	120 (60)	120**
	HGV (in settlements)	80 (60)	100 (60)	100**

*Heavy Goods Vehicles

**After road reconstruction all settlements will be bypassed, therefore speed limit restrictions are not relevant.

In the context of the road upgrading, relevant environmental quality regulations and standards mainly relate to the control of air and noise pollution, which may be of concern during both construction and operation of the upgraded road.

The Georgian standards for traffic noise control are regulated by the Decree of the Minister of Health, Labour and Social Affairs (297n of August 16, 2001) on the „Approval of Environmental Quality Standards", which, among other

things, specify the tolerable levels of traffic noise for different zones. According to the WB policy, noise and vibration issues during road operation should be evaluated relying on the General EHS Guidelines "Environmental noise management" (issued by International Finance Corporation, 2007). Acceptable noise levels by both Georgian standards and EHS guidelines are presented in Table 6.9 below.

Table 6.9 *Limit noise levels according the Georgian Noise Quality Standards and EHS Guidelines*

	Georgian Noise Standards		**EHS noise guidelines**	
	7 am - 11 pm	**11 pm - 7 am**	**7 am - 10 pm**	**10 pm - 7 am**
	dBA	dBA	Equivalent, LA_{EQ}, 1 h, dBA	Equivalent, LA_{EQ}, 1 h, dBA
Areas bordering residential houses, schools, and other educational institution buildings	55	45	55	45
Areas bordering hospitals	45	35	-	-
In the living environment: dwellings, rest homes, hostels, dormitories, kindergartens and boarding schools	40	30	35	30
Inside hotels, hostel rooms	45	35	-	-

Neither Georgian standarts nor the EHS guidelines are indicating maximum allowable noise levels in the environment influenced by traffic noise. According to good international practise and standards used in Europe, the maximum noise level for urban areas, mainly influenced by traffic noise, is 65 dBA during the day and 55 dBA at night. These values were used in noise impact evaluation.

According to the modelling results for the "zero" alternative and for the both project alternatives acceptable daytime noise level ($L_d \leq 65$ dBA) would be exceeded in a distance of respectively 25 and 85 m from the road boundaries and acceptable night time noise level ($L_d \leq 55$ dBA) would be exceeded in a distance of respectively 55 and 165 m from the road boundaries. These distances reflect the situation when there are no obstacles on the way. An increased speed after the implementation of both the project alternatives would result in the exceedance of the acceptable noise levels at three times bigger distance from the road as compared with the "zero" alternative.

The road section from 95 km to 114 km of EWH runs through agricultural landscape, passing south from Ruisi to Aradeti settlements, bypasses Agara. Most of the buildings along the route situated in the closest proximity to the road are not residential (Figure 6.1), except those in Aradeti and Agara. Still there are spots where residential houses fall into the area of unacceptable noise levels (mainly those situated within the distance of 165 m from the de-

signed road, where modelled day and night time noise levels exceed maximum acceptable levels) (see Figure 6.2). They are grouped according to location (km of EWH-60) and listed in the Table 6.10

"Zero" alternative and both the Project alternative sections have the same road alignment from 95 km to 106 km - except near Aradeti, where in case of the Project alternative 1 and the Project alternative 2 the road would go few meters south from the current alignment. The main difference between the "zero" and both the project alternatives along the road sub-section from 95 km to 106 km would be road width and speed. Both the project alternatives along the road section under study would result in higher noise levels. In case of the "zero" alternative acceptable noise levels near residential houses are not exceeded, while in case of both project alternatives 16 houses would fall into the zone of the unacceptable noise impact (along the road sub-section from 95 km to 106 km). According to forecasted situation for Aradeti settlement (location 3) the highest modelled noise levels exceeded acceptable night time noise levels by 4 dBA, and 7 dwellings would be exposed to unacceptable noise impact.


Figure 6.1 *Non-residential buildings along the Ruisi - Agara road section*


Figure 6.2 *Residential houses along the Ruisi - Agara road section*

Agara settlement is situated from 108.3 km to 111.1 km of the E-60 EWH. A railway line runs along Agara settlement and crosses the existing road alignment in the outskirts of the settlement. There is a railway station in Agara and therefore speed of the passing trains is low, reaching about 25 km/h, and noise levels induced by the railway are not high.

Modelling results revealed that in case of the "zero" alternative residents of Agara would be exposed to unacceptable noise levels only in the nearest prox-

imity to the road, and therefore negative impact on residents induced by both the road and the railway is not anticipated. It is because the distances from the road boundaries where acceptable noise limits are exceeded are comparatively small (respectively 25 m and 55 m for day and night times, Table 6.10), and because of the low speed on the railway line. However approximately 20 dwellings situated in the closest proximity to the existing road alignment would be exposed to unacceptable noise impact.

Project alternative 1 is supposed to have the same layout patterns near Agara as "zero" alternative, except of increased road width and speed. In this case 61 dwelling would be situated within the zone where acceptable noise levels are exceeded because of the road operation.

The road alignment of Project alternative 2 would form a lap near Agara where number of the houses would be trapped by the designed road from the one side, and by the railway line from another (mainly southern part of the settlement). The distance between the designed road and the railway is 650 m on the western part, and 350 m on the eastern side of Agara settlement, while acceptable noise limits would be exceeded in a distance of 165 m from the designed road. This way negative impact on residents induced by both the road and the railway is not anticipated. Approximately 27 dwellings would fall into the zone where acceptable noise limits are exceeded.

The comparison of data in Table 6.10 reveals that biggest number of dwellings exposed to unacceptable noise limits would be in case of Project alternative 1 (77 along the whole road section under study). Implementation of the Project alternative 2 would have a negative impact on approximately 43 dwellings.

It is worth pointing out that long-term prognosis for noise dispersion might be inaccurate in the way that all impact factors are difficult to foresee. For example, calculations are made using noise emission factors reflecting current traffic fleet. It is obvious that such a long-time period will bring positive changes to the economy of Georgia, resulting in higher percentage of the new cars in the traffic fleet and respectively lower noise levels.

CONCLUSIONS:

- *Upgrading of the Ruisi - Agara West road section from 95 km to 114 km would result in increased noise levels due to a better road capacity, increased traffic flow and speed.*

- *As a result of both project alternatives implementation, acceptable daytime and night time noise levels would be exceeded respectively in a distance of 85 m and 165 m from the road boundaries;*

- *Comparison of modelling results revealed that implementation of Project alternative 2 would result in less impact on residents along the road section under study and it should be chosen as preffered alternative;*

- *To protect residents along the 95 km to 114 km road section from negative noise impacts after road upgrading noise mitigation measures should be applied - it mostly applies to the settlements of Aradeti and Agara.*

Table 6.10 *Results of noise dispersion modelling for three analyzed alternatives ("Zero" alternative, Project alternatives 1 and 2)*

Alternative	Location (km of EWH)	Approximate number of the residential houses under unacceptable noise impact	Modelled noise levels, dB(A)**		Acceptable noise levels are exceeded in a distance of, m	
			Daytime 7 am - 10 pm	Night time 10 pm - 7am	Day time	Night time
"Zero" alternative	1st. 95 km to 96.2 km of the E-60 EWH (1st and 2nd driveways to Ruisi north and south; driveway to Urbnisi)	-	-	-	25*	55*
	2nd. 97.4 km to 98.7 km of the E-60 EWH (5th driveway to Ruisi north, Ruisi - Bebnisi driveways crossing)	-	-	-		
	3rd. 103.3 km - 104.7 km of the E-60 EWH (Aradeti settlement)	-	-	-		
	4th. 108.3 km to 111.1 km of the E-60 EWH (Agara settlement)	20	65 - 69	55 - 65		
Project alternative1	1st. 95 km to 96.2 km of the E-60 EWH (1st and 2nd driveways to Ruisi north and south; driveway to Urbnisi)	4	63 - 64	56 - 58	85*	165*
	2nd. 97.4 km to 98.7 km of the E-60 EWH (5th driveway to Ruisi north, Ruisi - Bebnisi driveways crossing)	5	62 - 65	56 - 58		
	3rd. 103.3 km - 104.7 km of the E-60 EWH (Aradeti settlement)	7	63 - 66	56 - 59		
	4th. 108.3 km to 111.1 km of the E-60 EWH (Agara settlement)	61	65 - 69	55 - 65		

Project alternative 2	1st. 95 km to 96.2 km of the E-60 EWH (1st and 2nd driveways to Ruisi north and south; driveway to Urbnisi)	4	63 - 64	56 - 58	85*	165*
	2nd. 97.4 km to 98.7 km of the E-60 EWH (5th drive-way to Ruisi north, Ruisi - Bebnisi driveways crossing)	4	62 - 65	56 - 58		
	3rd. 103.3 km - 104.7 km of the E-60 EWH (Aradeti set-tlement)	7	63 - 66	56 - 59		
	4th. 108.8 km to 111.2 km of the designed road (Agara settlement)	27	60 - 72	55 - 66		

**In a territory with no obstacles*

***Noise levels exceeding acceptable ones are in bold text*

6.5.3 Recommended measures for noise level reduction

According to the findings described in Chapter 6.5.2, implementation of the Project alternative 2 would result in unacceptable day and night time noise levels next to the closest dwellings along the Ruisi - Agara West road section, therefore noise mitigation measures should be applied. Results of noise dispersion calculation were evaluated in 4 subsections of the road, where residential houses fall into the zone of unacceptable noise levels, as described in Chapter 6.5.2.

Near residential houses situated along the road section under study acceptable noise levels are exceeded by 1 - 4 dBA (Table 6.11), except of those in Agara, where some dwelings are falling within the zone where acceptable noise levels during night time are exceeded by 11 dBA.

To protect residents along the road section under study from unacceptable noise impact, it is recommended to reduce speed in sub-sections of the road where acceptable noise levels are exceeded.

Summary of the recommended noise mitigation measures are given in table 6.11 below.

Table 6.11*Recommended noise mitigation measures*

Location (km of EWH)	Approximate number of the residential houses under unacceptable noise impact	Acceptable noise limits are exceeded by, dBA		Recommended solution
		Daytime 7 am - 10 pm	Night time 10 pm - 7am	
1st. 95 km to 96.2 km of the E-60 EWH (1st and 2nd driveways to Ruisi north and south; driveway to Urbnisi)	4	-	1 - 3	Limit speed to 90 km/h
2nd. 97.4 km to 98.7 km of the E-60 EWH (5th driveway to Ruisi north, Ruisi - Bebnisi driveways crossing)	4	-	1 - 3	Limit speed to 90 km/h
3rd. 103.3 km - 104.7 km of the E-60 EWH (Aradeti set-tlement)	7	1	1 - 4	Limit speed to 50 km/h
4th. 108.8 km to 111.2 km of the designed road (Agara set-tlement)	27	1 - 7	1 - 11	Limit speed to 50 km/h

CONCLUSIONS:

- *Along the road section from 95 km to 106 km there are three spots where residential houses fall within the zone of unacceptable noise levels with the maximum exceedance by4 dBA, though the recommended speed limits (Table 6.11) are permissive for keeping noise to the acceptable levels within short to medum time perspective.*

- *Near Agara the alignment of the new road (Project alternative 2) would go close to the residential houses, resulting in exceedances of unacceptable noise levels by 11 dBA,though the recommended speed limits (Table 6.11) are permissive for keeping noise to the acceptable levels within short to medum time perspective.*

- *Incase the noiselevellimitsareexceededinfuturedue toincreaseof traffic volumesforecastedina long term perspective,it is suggested toinstallnoise barriersandconsideradditional greeningalongthe-rightsofway.*

6.6 Impacts on flora and fauna

Negative impacts of road construction and operation was evaluated according to the main principles indicated in the Law on the Wildlife (1997, amended in 2001, 2003 and 2004), the Law on the Red List and the Red Book of Georgia (2005, amended in 2006) etc. Along with the national legislation/regulations, international requirements (the EBRD policy and the World Bank operation procedures), and the EU Directives to which Georgia is a party were taken into account.

The Flora

Botanical field survey was performed on 19-20 May 2011 within 95 km - 106 km road section, and on 3 - 4 August within 106 km - 114 km road section. The objective of the study was to identify plant communities within the section of interest, reveal sensitive populations and, if found, provide quantitative characteristics thereof. With consideration of expected direct and indirect impact the corridor – 100 m on each side of the centreline – was surveyed.

The method of survey was walkover. The main types of plants, as well as composition, distribution, dominant species, biome sensitivity and commercial value of plants were assessed. The presence of endemic, rare and other protected species in the project impact zone was identified.

The area has a long history of development. Ancient forests covered the area (*Quercus iberica, Carpinus caucasica* and *Fagus orientalis),* butwere destroyed in the course of time. In some places secondary vegetation represented by hemixerophyle and xerophyle shrubs developed.

The main shrub varieties observed within the area are as follows: Jerusalem Thorn (*Paliurus spina christi),* berian Spirea (*Spiraea hypericifolia),* Buckthorn (*Rhamnus pallasii),* Juniper (*Juniperus oblonga),* Dog Rose (*Rosa canina),* Hawthorns (*Crataegus kyrtostyla),* Honeysuckle (*Lonicera caucasica),* Blackthorn Hedge (*Prunus spinosa),* European Smoketree (*Cotinus coggygria),* Cotoneaster (*Cotoneaster racemiflora),* etc. Along with hemixerophytes steppe grasses such as *Botriochloa ischaemum* are present.

The landscape along the road is modified. The area is used for cultivation and orchards. Within the plots, along the irrigation ditches, fragments of wetland vegetation (reed (*Phragmites sp*)andCommon Cattail *(Typha latifolia*)) are found. The species' composition in the area under consideration is poor in terms of diversity. Only common plants are registered. The following habitats may be pointed out: agricultural land (cereal); agricultural land (vegetables); orchards; fragments of secondary forests and shrubs; grasslands; ornamental plants /windbreak along the road.

Along the road berry cultivation plots (planted with the support of the Swedish government), orchards, cereal cultivation plots etc. are observed.

Description of the route by sections is presented in Table 6.12 below.

Table 6.12 *Description of the route by sections:*

Coordinates	Description
X=0414124; Y=4653279; H= 645	On both sides of the road false acacia (Robinia pseudoacacia umbraculifera) bushes and some acacia trees are registered. Other plants are represented by poplars (*Populus tremula* and *Populus piramidalis*) and willows (*Salix sp.,*) Coniferous plants are represented by hydrophobic plants, such as *Pinus nigra*. The project corridor borders with homestead plots. The main plants are walnut-trees (*Juglans regia*), plum (*Prunus divaricata),* apple tree (*Malus domestica)* and peach *(Persica vulgaris)* orchards. Vegetables, corn (*Zea mays)* etc.
X=0410557; Y=4655456; H=667	Free land (grasses, such as Curcuma aromatica, Lamium album, Glaucum corniculatum, Linaria, Senecio sp., etc) alternating with cereal (wheat) fields and pine trees (Pinus nigra) rows, false acacia (Robinia pseudoacacia), trees and shrubs, willow (Salix sp,), poplar (Populus tremula,) Caucasian Lime (Tilia euchlora). In private plots apple tree saplings and berries are cultivated.
X=0410557; Y=4655456; H= 667	Between Bebnisi and Kareli, both sides of the road show pine tree plantings (single row) with individual willows (*Salix sp*.,), Caucasian Lime (*Tilia euchlora),* poplar (*Populus tremula),* Pyramid white poplar (*Populus piramidalis)*. Ornamental plants include: (Iberian spirea (*Spiraea hypericifolia),* (*Siringa vulgaris),* Spanish broom (*Spartium junceum)*; fruit trees and crops. Along the irrigation canal – shrubs, willow (*Salix sp*.,) and poplar (*Populus tremula,*) are observed.
X=0409660; Y=4656061; H=671	In the direction of Agara village, up to the turning to Kareli, the tree varieties include: one 'string' of pine trees (*Pinus nigra),*Horse-chestnut (*Aesculus hippocastanum*,), white mulberry (*Morus alba*), lime (*Tilia euchlora),* poplar (*Populus piramidalis*.) and ornamental bushes, such as Spanish broom (*Spartium junceum)*; Iberian spirea (*Spiraea hypericifolia),* lilac *(Siringa vulgaris),* thuja (*Biota orientalis)*. On both sides of the road agricultural plots and cereal fields are observed. Waterlogged areas show the broadleaf cattail (*Typha latifolia).*
X=0409049; Y=4656464; H=678	Berry orchards, such as raspberry *(Rubus idaeus),* gooseberry (*Grossularia reclinata),* currants (*Ribes vulgare, Ribes nigrum* (12 varieties).
X=0408944; Y=4656529; H=680	Section from Sogolasheni to Agara. The route moves southwest away from the existing route by 70 metres. The new corridor will cross the agricultural lands (orchards, vegetable gardens and cereal plots); the Prone gorge (plants registered in the area are: willow (*Salix sp.),* poplar (*Populus tremula),* oleaster (*Elaeagnu sp.)*. The ecosystem is modified, but still represents an important habitat. Hydrophilic grasses may be

	found near the water. Farther orchards and cultivated plots (crops) stretch. The route bypasses the remains of the former rabbit farm building and runs through wheat fields, crosses the Ptsa River and reaches vil. Agara. Practically no trees grow in this section of the road. Cultivated plots dominate. "Edges' of these plots are used as pastures. Grasses in these areas are low and dominated by plant species resistant to trampling down, such as rosette and crawling.

Biodiversity is quite poor in the direct impactzone and the road corridor. Of protected species in the direct and indirect impact zone only walnut tree (*Juglans regia)*is registered 9vulnerable, tetriary relict, small, fragmented habitat). Although it must be noted that the walnut trees are artificially cultivated in homestead plots. Compensation of loss is considered in the resettlement/land aquisitionplan.

On the right side of the road : BlackPine(Pinus nigra),Asp(Populus tremula),Willow(Salix sp.),Pseudoacacia (Robinia pseudoacacia),Walnuttree(Juglans regia),chestnut (Aesculus hippocastanum)andLinden(Tilia euchlora) can be found. Height of the trees is less than 10m.

The following habitats are located in the project area:

- agricultural land (cereal)
- agricultural land (vegetable)
- orchards
- secondary forest (bushes, mainly fragmented)
- uncultivated land (grasses and shrubs)
- windbreaks and roadside ornamental plants.

Poplar (*Populus hybrida*)

Oleaster (*Eleagnus angustifolia)*

Black locust (*Pina nigra*)

Eastern cottonwood (*Populus deltoides*)

Figure 6.3 *Tree species in the studied area*

Table 6.13 *Description of vegetation along the new alignment:*

Coordinate	Description of the route
X- 0403296; Y- 4653655; H-645 m	The route starts near Agara. Alignment crosses homestead plots (orchards, gourds). Railway runs north to the Mtkvari River. Vegetation is presented by: sea-buckthorn (*Hippophae rhamnoides),* willow (*Salix sp*,), oleaster (*Eleagnus angustifolia*,), plum (*Prunus divaricata*) and poplar (*Populus gracilis*). In homestead plots: walnut (*Juglans regia*), herbaceous plants are found. Dominant species are: sweet wormwood (*Artemisia annua*), wormwood (*Artemisia absinthium*), silver spreader (*Artemisia caucasica*), rough cocklebur (*Xanthium strumarium*), *Alopekurus*, Ornamental thistle (*Cirsium sp.*), etc.
X-0402575; Y- 4653590; H-646 m	Homestead land – orchards. Walnut (*Juglans regia*), plum (*Prunus divaricata*), peach (*Persica vulgaris*), crops and gourds. The section borders with Agara sugar factory (distance 300m). On the river terraces artificial ponds have formed after abstraction of sand. In ponds fish is available. Locals use to fish in there. Near the ponds and the riverbed wetland vegetation has developed - common reed (*Phragmites communis*), cattail (*Typha*), rush (*Juncus*), etc. Farther on undeveloped flatland meadow with xerophylous grasses: thistles (*Cirsium sp*,), teasel (*Dipsacus*), mint (*Mentha*), couch grass (*Cynodon dactylon*), sweet wood (*Glycyrrhiza glabra*), wormwood (*Artemisia absinthium*), etc. Trees and shrubs - oleaster (*Eleagnus angustifolia*), plum (*Prunus divaricata*), willow (*Salix sp* .)
X-0399922; Y- 4654067; H-655 m	Section 'connects' to existing road in 200m from the overpass bridge. Road and railway line run parallel towards Khashuri. Vegetation in the strip between the road and the railway line – shrubs. None of the species have ornamental or commercial values. Farther on both sides of the road are planted with one row of coniferous trees, and Eastern cottonwood (*Populus deltoides*) in row/rows. In some sections black locust (*Robinia pseudoacacia*), willow (*Salix sp*,), poplar (*Populus gracilis*), plum (*Prunus divaricata*), blackthorn (*Prunus spinosa*),

	buckthorn (*Rhamnus pallasii*), oleaster (*Eleagnus angustifolia*), raspberry (*Rubus sp.*), etc. Plants are cultivated, in some places natural. Existing road borders with corn fields. Natural vegetation is strongly altered because of development. Of other plants: Gramineae, Leguminosae, Compositae, Gruciferae, etc. The meadows are used as pastures even in winter. Mentioned to be is that of cultivated plants European black pine (*Pinus nigra*) and poplar (*Populus deltoides*)dominate.
X-0398031; Y- 4653559; H-657 m	On both sides of the road there are 2-3 rows of pine trees and Italian poplar. Other plant (deciduous trees and shrubs) species are: oleaster (*Eleagnus angustifolia*), willow (*Salix sp,*), blackthorn (*Prunus spinosa*), plum (*Prunus divaricata*), raspberry (*Rubus spp.*). On the right side of the road residential houses are located, on the left side – corn fields and undeveloped plots. From this point the road moves away from the existing alignment to the south.

The Fauna

Faunistic field survey was performed on 19-20 May 2011 within 95 km - 106 km road section, and on 29 July within 106 km - 114 km road section. The survey was organised with the purpose of verifying the data obtained from the literature on the animal species composition and areas of their occurrence. A simple methodology of surveying animal footprints, droppings and dwellings was applied to collect information on key species of mammals and birds. The results of the field work confirmed the species' composition reported in the literature and showed extremely little occurrence of animals along the selected route. More evidence of their presence was found in more remote locations.

The area is rural, main field of economy – farming and fruit growing. Main fauna species presented in the area of interest are not diverse. During the walkover similar species were observed along bothe sections of the design road. Birds are prevailing. White wagtail (*Motacillaalba*), blackbird (*Turdusmerula*), whitethroat (*Sylviacommunis*), magpie (*Picapica*) and carrion crow (*Corvuscorone*) dominate. Buzzard (*Buteobuteo*), hoopoe (*Upupaepops*), nightingale (*Lusciniamegarhynchos*), red-backed shrike (*Laniuscollurio*), black-headed bunting (*Emberizamelanocephala*), corn bunting (*Miliariacalandra*), quail (*Coturnixcoturnix*) have also been registered.

Near the residential areas house sparrows (*Passerdomesticus*), common redstart (*Phoenicurusphoenicurus)*, goldfinch (*Cardueliscarduelis* and *Carduelischloris*) is met.


White wagtail (*Motacillaalba*)


Blackbird (*Turdusmerula*)


Magpie (*Picapica*)



Whitethroat (*Sylviacommunis*) Carrion crow (*Corvuscorone*) House sparrows (*Passerdomesticus*)

Figure 6.4 *Bird species in the area*

The survey detected some amphibians and reptiles, such as marsh frog (*Rana-ridibunda*) and Caucasus emerald lizard (*Lacertastrigata*).


Marsh frog (*Ranaridibunda*) Caucasus emerald lizard (*Lacertastrigata*).

Figure 6.5 *Amphibian and reptile species in the area*

None of protected mammal species (Branst's hamster, grey hamster, common otter) known to be available in the region was met.

However, it must be taken into account that the floodplain of the River Mtkvari is an important site that supports a rich fauna, including marsh turtle, and is an aggregation area for migrating birds. Floodplains are also important spawning areas for many species of fish. Because this option brings traffic close to the river it increases the risk of ecological damage from the spillage of toxic materials (fuels, oil, etc) following accidents.River crossings are considered as the most sensitive areas.

Main fish species observed in the river are: khramuli (*Varicorhinus capoeta*); Mtkvari barbel (*Barbus lacerta*). barbel (*Babrnus mursa*), Mtkvari under-mouth (*Chondrostoma*), black brow (*Acanthalburnus microlepis*), Mtkvari bleak (*Alburnus filippi*), spiny loach (*Cobitis taenia*), golden spiny loach (*Cobitis aurata*), Mtkvari gudgeon (Gobio *kurii*), ginger gobi (*Neogobius cephalarges*), amur bitterling (*Rhodeus sericeus*), mosquito fish (*Gambusia affinis*).

Fish species available in the artificial pond are the same as in the Mtkvari River.Operation will have less impact on fauna – both terrestrial and aquatic. Wildlife will be affected during construction. Impact can be mitigated. Certain impact will be on the fish fauna of 'artificial' ponds which have formed by flooding of the pits formed as a result of abstraction of inter material from the riverbed. The main fish species in the area are the same as available in the Mtkvari.According to company Sharva in 2008 and 2010, fries of Common

Carp,Crucian Carp, Bighead and White Carp, and White Amur were introduced. Although it must be noted that in quarry-dish like ponds, living conditions and natural food base in most cases is not enough for fish.

6.6.1 Flora and fauna impact assessment: road construction

General impacts of roads and other linear structures on flora and fauna include the following:

- Removal of roadside vegetation;
- Soil compaction, sealing of soil surface;
- Death of animals caused by road mortality;
- Higher levels of disturbance and stress, including that related to noise;
- Reduction or loss of habitat;
- Barrier effect, reduced connectivity;
- Subdivision and isolation of habitats and resources, breaking up of populations;
- Reduction of habitat below required minimal areas, loss of species, reduction of biodiversity;
- Indirect impact from dust, particles; oil, fuel, etc.

The project will affect farmland, fruit trees and trees along the road. In total 349 trees will be cut, including 235 coniferous (*Pinus nigra*), 12 walnut trees (within private plots) and 102 deciduous trees. The impact may be mitigated by replanting (by planting 3 tree to compensate the loss of one), but first of all unjustified damage to vegetation must be avoided. Access roads, the equipment/machinery stationing yard, and the camp must be established with maximum caution so as to preserve the vegetation/trees.

After completion of the works the same plant species (in triple amount) will be planted along the roadside. For plantation, local species should be used. Safety requirements must be taken into account while planting, so that the trees do not block the view, have acceptable diameter when mature while they are planted in certain locations and their canopies do not reach over the road.

An effective windbreak should have at least two rows of evergreen trees, but using more rows may be even more effective. Depending on the tree species, the trees may be planted at least 2.4 metres apart; planting closer together may require cutting down the trees after 5-10 years to allow natural growth of the others . To maximize efficiency and minimize wind damage to the trees, the outer rows should be trees or shrubs that grow lower to the ground, with the tallest plants in the middle. To provide a windbreak year-round, the tallest row must be of coniferous trees. The rest may be a mixture of deciduous and coniferous trees. The space between deciduous trees must be 2.4 to 3.6 metres, while evergreens may be spaced by 1.8 to 4.3 m. The shrubs may be between 0.9 to 1.8 m apart within a row. If several rows are planted, 3.6 m may be left between the rows, except when planting large deciduous trees, which require 6 metres between rows.

Sensitive areas and risks in terms of impact on fauna- The most sensitive areas in terms of impact on the fauna are rivers, artificial lake and gully crossings where pollution may affect fish and riparian wildlife.

The roadside vegetation zones and roadside plants which act as shelter for birds and small mammals are also attributed to sensitive areas. In the 'edges' of the road hamsters and turtles may be encountered.

Generally speaking the roads are considered as a barrier for some mammals, reptilians and amphibians, both during construction and operation. Other impacts associated with roads/highways are noise and vibration having potential to disturb land and avian species. Dust is generally considered as an impact worth mentioning. It is assumed that dust deposited on the plants in the road impact zone affects food base of the vertebrate and invertebrate species.

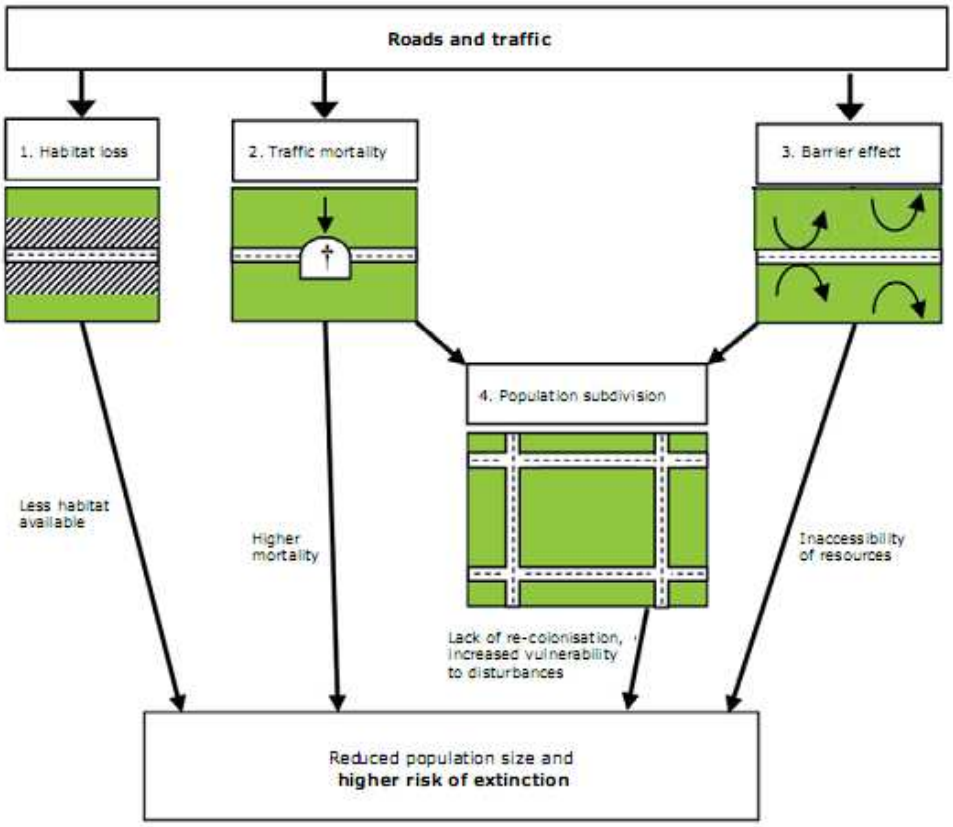


Figure 6.6 *Four main impacts of transportation infrastructure on fauna*

Note: Both traffic mortality and barrier effect contribute to population subdivision and isolation.

Source: From Jaeger et al., 2005b. Reproduced by permission of Elsevier.

An immediate impact related to the construction and operation of roads is noise from construction equipment, and heavy traffic. Animals respond to noise pollution by altering activity patterns, and with an increase in heartbeat and production of stress hormones. Birds and other wildlife that communicate by auditory signals may be confused near the road construction sites.

Heavy metals, carbon dioxide, carbon monoxide and dust emitted during earthworks may all have cumulative effects. The contaminants may be carried far from roads by wind and runoff and add to the negative impact related to construction near/in the riverbed. Works within wet areas or on watercourses may negatively affect fish habitats and disturb riparian vegetation and soils that are essential to support aquatic habitats. The impact of construction activities on aquatic ecosystems of the rivers/streams crossed by the highway, such as water pollution and increase of water turbidity will occur. Construction activities adjacent to unstable slopes may cause landslides and mudflow. Such events may entail further loss of vegetation through continuous loss of soil substrate, which again may negatively affect the river habitats.

The following measures for mitigation of impact on the fauna are suggested:

- Special attention should be given to the avian fauna in the spring-summer (April to July), the season most sensitive for birds;
- Construction in/near the riverbed should be avoided in the fish spawning season; impact on fish in artificial pond will be mitigated by arrangement of ‘passage’ allowing free migration of fish and water inflow in the lake - measure considered in design;
- Noise and vibration level should be reduced by means of securing proper technical maintenance of machinery/vehicles, adherence to no horn policy, strictly keeping to the stationing/operation ground during the construction and operation;
- Dust reduction measures should apply, such as covering materials, removed topsoil and waste to avoid wind erosion and spreading around; restriction of the speed of trucks delivering materials to the construction ground, covering friable material with tarpaulin during transportation, avoiding high dumping of materials during unloading. If required, the ground (machinery stationing, camp site) should be watered to avoid generation of dust;
- Special attention should be given to environmental safety during the construction near the riverbed. Hazard incurring operations (fuelling, servicing of cars/machinery) should be carried out in not least than 100m from the surface water body;
- Proper management of waste, including domestic, should be followed, waste dumping into the river or scattering around should be excluded. The site for temporary storage of waste should be selected in not least than 100m from the surface water body;
- The fuel/oil storage should be equipped with adequate secondary containment (impermeable cover of the area, and the containment of sufficient capacity to avoid pollution of soil/water outside the berm and/or washing it off by the runoff);
- Spills should be immediately cleaned up to avoid spreading of pollution;

- Trenches or pits, if made, should be fenced or protected to avoid entrapping and injuries of the fauna species. Bright coloured ribbons may be used for big animals (e.g. cattle), while metal plastic and other shields/fences may be used for small animals. If, despite of the mentioned precautions, small animals turn to be entrapped, upon completion of the shift, planks or medium size twigs must be made available for the animals to escape from the pits/trenches after the night. Pits and trenches must be checked prior to filling up.

The construction impact will be temporary. The scale of impact may be reduced by means of organizing the works with due consideration of environmental safety requirements and mitigation measures recommended above.

6.6.2 Flora and fauna impact assessment: road operation

No direct impact on flora is expected during operation of the highway. Indirect impact can be related to dust and exhaust emissions from traffic and contamination via contaminated runoff from the road.

Main impacts on fauna during operation in general may include:

- Death of animals caused by road mortality;
- Higher levels of disturbance and stress, including that related to noise;
- Barrier effect, filter effect to animal, including fish, movement (reduced connectivity);
- Modifications of food availability and diet composition (e.g. reduced food availability for bats due to the air temperature change along the road embankments at night);
- Modification of humidity conditions (e.g. lower moisture content in the air due to higher solar radiation, stagnant moisture on road shoulders due to soil compaction);
- Modification of light conditions;
- Modification of wind conditions;
- Indirect impact from dust, particles (abrasion from tyres and brake linings); oil, fuel, etc. (e.g. in case of traffic accidents)

As mentioned above, immediate impact related to operation of roads is noise from heavy traffic. In general animals may adapt to increased noise levels, and apparently resume normal activity. The birds and other wildlife that communicate by auditory signals may be particularly confused near roads.

Pollutants such as heavy metals, carbon dioxide, and carbon monoxide, emitted by vehicles, may all have serious cumulative effects. Combustion of petrol containing tetraethyl lead, and wear of tyres containing lead oxide, result in lead contamination of roadsides. Many studies documented increasing levels of lead in plants with proximity to roads, and with increases in traffic volume. Plant roots take up lead from the soil, and leaves take it up from contaminated

air or from particulate matter on the leaf surface. The lead then moves up the food chain, with sometimes toxic effects on animals, including reproductive impairment, renal abnormalities, and increased mortality rates.

The impacts of other heavy metals, such as zinc, cadmium, and nickel are less known. Motor oil and tyres contain zinc and cadmium; motor oil and gasoline contain nickel. These metals, like lead, were found to increase with proximity to roads, with increasing traffic volume and decreasing soil depth. Earthworms were found to accumulate all these metals, in concentrations high enough to kill earthworm-eating animals. These roadside contaminants may be carried far from roads by wind and water.

Impact of roadside litter is also to be mentioned. Poorly managed waste may attract and entrap small animals, while cigarette butts and filters are often mistaken for food by fish and birds.

Part of the new alignment will practically follow the existing one. The new Agara bypass section will run next to residential area, which enabled to assume that the fauna has already adapted to its presence of people and noise to some extend. Widening of the road will not affect the established balance significantly.

No significant habitats have been registered within the new alignment area. Fragmentation of habitats is not expected. For cattle passage, undercrossings will be installed. These structures may be used by other animal species as well.

The roadside vegetation will be re-established after completion of the construction, so within a few years animals/birds and bats may return to familiar surroundings.

Free movement of fish in the artificial lake will be ensured by ‘passage’ (concrete pipe running through the road embankment) arranged on construction stage. In case of discomfort or food base decrease, it will have the possibility to evade the impact. Cleaning the channel conecting the ponds with the river can be considered as additional mitigation.

Figure 6.7 *Area of artificial Tod crossing.*

The impact on biological environment is ranked as medium to low.

6.7 Impacts on geology

6.7.1 Geology impact assessment: road construction

Road is located in earthquake zone, no other geo-hazards known. Construction is related to a certain amount of earthworks (the construction of road embankments, underpasses, bridges and intersections), the probability of landslides and other mass movements in road cuts, erosion from fresh road cuts and fills, and sedimentation of natural drainage channels must be taken into account. Special attention should be given to the river crossing areas (bridges). The bypas is next to the floodplain of the River Mtkvari – must to be considered.

The principle impact that highway development projects have on the natural geologic erosion process includes temporary exposure of disturbed soils to precipitation and to surface runoff. The soil exposure and the resulting reshaping of the topography may create situations when detrimental erosion and sedimentation temporarily occur.

The two factors that have the greatest impact on the slope stability are the slope gradient and the groundwater. Generally, the greater is the slope gradient and the presence of the groundwater, the lower is the stability of a certain slope regardless of the geologic material or the soil type.

The erosion of embankments and river terrace slopes as a result of highway and bridge construction activity may have serious environmental impacts, including:

- pollution of surface water,

- damage to adjacent land, and
- degradation of streams and of the aquatic habitat.

In general the process may be controlled by:

- selection of a reasonable embankment height and stabilization of the slopes;
- use of wooden shields for pits if they are very deep to preserve stability, as the case may be during the bridge construction;
- establishment of temporary berms, slope drains, temporary pipes, contour ditches, ditch checks, diversions, sediment traps etc.

Culverts used in the road, bridge, and berm construction are to prevent flooding and washing out of roads. They also minimize erosion, build-up of standing water, and provide pathways for run-off.

Some of the problems and solutions are listed below:

Problem	**Solution**
When the runoff is allowed to flow down an excavated slope, the risk of erosion is high.	A combination of diversion ditches and slope blankets may be considered.
The outer surface of a fill is usually less compact than the rest of it. In wet weather, the moisture content of the outer layer will increase and the slope of adequate stability may fail in dry conditions.	Compaction, use of temporary shields
Bridge end fill slopes often suffer from the effects of concentrated flow, either running off the deck or from the deck drains.	Blocking the surface drains on the bridge temporarily, until vegetation becomes established, in the meantime collecting the water in a controlled manner at the end of the deck or placing water impact protection such as sufficiently large pads of rockfill under the drains.

Cut slopes will be stabilized by hydroseeding. According to the technical documentation the total area protected by hydroseeding amount to 26240 m^2. Information on hydrosesding is given in Technical specifications for Bidders Sections VI, Volume III - 3003 Grass Seeding, Wildflower Seeding, Turfing, Hydro-seeding and Planting Against Surface Erosion.

The construction impact may be mitigated by proper organisation of works.

6.7.2 Geology impact assessment: road operation

The operation impact is less likely to occur, as the design is developed based on results of extensive geotechnical and engineering geological surveys implemented under design stage of the project.

6.8 Impacts on soils

Evaluation of adverse impacts on soil and soil pollution was performed according to the Georgian laws and regulations (the law applicable to the largest extent is the Law on the Soil Protection, 1994 (amended in 1997 and 2002).

The road section from Ruisi to Agara West lies on the Gori Plain. Influenced by both, geologic and anthropogenic changes, the Gori Plain predominantly consists of arable land with little natural vegetation. The soils in this region are relatively fertile. Most of the land is subdivided into small plots, which are primarily individually-owned and occupied by orchards, vineyards, vegetable gardens, corn fields, hay and some overgrown secondary meadows.

For identification of the background quality of the soil along the road samples were collected with consideration of landform, vegetation, meteorological and hydrological conditions. Taking into account that the area is mostly rural and no significant sources of pollution, except for the road itself are available, four samples were collected.

The samples were collected from both sides of the road in 1-200m from the carriageway at the sampling depth of 0-10cm. The total amount of soil collected from one site is 1 kg. Prior to sampling, the sampling spots were cleared of grass and stones.

Samples were collected in plastic bags, labelled and delivered to the lab for testing. The samples are dried, averaged and sieved.

Method of soil analysis

Cu, Zn, Pb, Ni, Co, Co, Cd	ISO 11047, ISO 11466 - Aqua Regia extract Determination of Cu, Mn, Fe, Mn, Co, Pb, Cd, Ni, Zn, Cr, Ni. Al
As	ISO 2590 - General method for the determination of arsenic – Silver diethildithiocarbamate photometric method

The sample analysis revealed that concentration of all metals is below relevant maximum allowable concentrations adopted in the EU.

6.8.1 Soil impact assessment: road construction

Loss of the vegetative soil layer along the road section will inevitably occur, and soil properties will be changed to form sub-grades along the route, resulting in the loss of soil productivity.

The road construction impact on the soil will mainly relate to organizing and operating the camps, risk of fuel/oil spills from vehicles and/or fuel storage (if available on the camp site/building ground).

To avoid impact on and/or loss of the topsoil it should be removed from the road embankment and temporarily stored separately in agreed locations within the RoW. To ensure stability, the soil piles shall not be higher than 2 metres. The piles must be placed so as to avoid erosion and washing off. Drainage trenches around the piles must be provided.

The topsoil removed from the new road alignment and from the area used for widening of the road may be handed over to the local municipality for soil quality improvement.

In order to avoid or mitigate impact (accidental fuel/oil spills, poor management of waste, polluted runoff.), the operation ground must be established with consideration of environmental safety measure, as presented below:

- Any temporary fuel tank shall be located within not less than 100 m from the riverbed. The tank shall be placed in a covered area with berms or dikes to contain any spills. Any spill shall be immediately contained and cleaned up with absorbent materials;
- Onsite repairs /maintenance activities shall be limited. Priority shall be given to offsite commercial facilities. If impossible, a designated area and/or secondary containment for the on-site repair or maintenance activities must be provided. These areas shall be located away from drainage channels and surface water bodies (the maintenance/fueling site shall be within not less than 100 m from the river);
- On-site vehicles and equipment shall be inspected regularly for leaks and all leaks shall be immediately repaired. Incoming vehicles and equipment shall be checked for leaks. Leaking vehicles/equipment shall not be allowed on-site;
- Secondary containment devices (drop cloths, drain pans) shall be used to catch leaks or spills while removing or changing fluids from vehicles or equipment. Drip pans or absorbent materials shall be provided. On small spills absorbent materials shall be used;
- Fuelling off-site shall be encouraged. If required, designated areas for on-site fuelling shall be located away from drainage courses and surface water bodies; (the maintenance/fueling site shall be within not less than 100 m from the river)
- Use off-site vehicle wash racks (commercial washing facilities) are preferable. If on-site cleaning is necessary, bermed wash areas for cleaning activities shall be established. The wash area may be sloped to facilitate collection of wash water and evaporative drying;

- Materials and waste shall be stockpiled so as to avoid erosion and washing off into the river. Drainage trenches shall be arranged to divert surface runoff from the site;
- Waste collection area must be sited so as not to receive a substantial amount of runoff from upland areas and not to drain directly to a water body;
- In case of the fuel/oil spills risk, an oil trap shall be additionally provided;
- To avoid loss of the productive soil layer, all suitable topsoil and other material shall be saved and stockpiled for the future recultivation of the area ;
- Soil compaction may be reduced by strictly keeping to temporary roads, camp/operation ground boundaries;
- Adequate training on environmental protection and safety shall be provided to the staff;
- No fly tipping policy shall be followed;
- Education/awareness raising of the community shall be provided.
- Only waste water cleaned up to established norms (TPH 0.3 mg/l and suspended particles 30 mg/l) can be discharged on the relief.

In the construction stage the responsibility for soil protection from pollution rests with the contractor.

6.8.2 Soil impact assessment: road operation

The road operation is usually related to soil pollution by heavy metals in a narrow band on either side of the road. Another impact – is pollution with litter.

The impact on soil during operation is more difficult to manage as the sources of impact in this stage are the “users” of the highway. Impacts may be partly mitigated by awareness raising and education of the community. The establishment of the rest/service facilities with consideration of environmental requirements may also contribute to the reduction of soil pollution with waste. .

6.9 Impacts on the landscape

The road will have impact on the local landscape. The new section will ‘deviate’ from existing alignment and bypass the residential areas (Agara). The new road corridor will cross some agricultural land and run along the Mtkvari river in about 750m from the riverbed with limited expected impact on flora

and fauna Construction works will require certain amount of clearing within the RoW. The impact may be rated a medium impact on the landscape.

The overall impact on the new road section on the landscape will be adverse and permanent, but not significant.

With due consideration of the background status and the view and prior to the development, the roadside revegetation options, wherever appropriate, should be provided to reduce the landscape impact.

Planting and landscaping of the roadsides is generally considered as an efficient way of restoring, sometimes improving aesthetic views of the area. At the same time plants along the roadside may act as windbreaks providing protection of farmland in the impact area. Planting with vegetation will also support wildlife by creating habitats. Planting with native plants is preferable.

To ensure adequate protection, the roadside zone must be defined. A typical roadside includes five zones that might occur on either side of the pavement (back slope or cut slope, swale or ditch zone, edge or border zone, approach or shoulder zone, front or fill slope).

The clear zone is an area for drivers of errant vehicles to regain control after running off the road. The clear zone defines the size of the clearance between the edge of the outermost travel lane and roadside obstacles such as large trees. A minimum allowable clear zone distance is measured laterally to the trunk of the tree. Special considerations will be given to provide additional clearance in potential vehicle accident recovery areas.

9 m may be considered a minimum clear zone distance for high volume, high speed highways. Clear zone distances larger than 9 m will be provided at other locations such as the outside of horizontal curves, near ramp intersections, at points of congestion or where evasive manoeuvres may be required.

A single tree with a trunk diameter larger than 0.1m is considered a fixed obstacle. Large trees may be planted within 9 m distance where they will not constitute a fixed object; for example, on cut slopes above a retaining wall, behind the existing barrier curbs (0.6m behind) or in areas behind the existing guardrails (0.4m behind). Trees may be planted behind barrier curbs if the road speed is sufficiently low so as to prevent cars from mounting the curbing. Design exceptions may include:

- locations where the cumulative loss of trees would result in a significant adverse change in character of the roadside landscape;
- landscape, park, recreation, horticultural, residential or similar areas where trees and other forms of vegetation provide significant functional and/or aesthetic value;
- where absence or removal of trees would adversely effect rare/endangered/threatened species (plant or animal), wetlands, water quality or result in serious erosion/sedimentation effects.

For planting trees closer along roadways, other considerations should include potential maintenance problems of roadway shading, leaf or other tree debris litter, etc. In areas of the right of way that are not impacted by limitations of the clear zone, naturalistic plant growth shall be encouraged.

Lines of sight - Plants should not interfere with the effective sight distance limits for stopping, passing or making manoeuvres at intersections. Low-growing plants of 5.5 m or lower may be planted in the sight line area as long as other requirements for sight distance are met. Taller growing plants are to be placed beyond these calculated sight line setbacks.

In the cases where an existing facility does not already provide adequate sight distance because of geometric restrictions, no further reduction will be allowed. Locations, such as the inside of curves, inside interchange loops and median shoulders shall be kept clear and the designed sight distance shall be kept.

Functions of roadside vegetation – Preservation of vegetation as far as feasible/revegetation,in addition to creating attractive groundcover, may serve various functions, such as:

- *Screen headlight glare*. Vegetation may shield headlight glare of oncoming traffic.

- *Buffer noise.* Vegetation may be used in combination with berms and barriers to block road noise from the surrounding environment. Very dense, wide and high plants will offer some noise reduction, but will not approach the sound blocking capacity of a built wall. Obscuring the source of the noise from view may often reduce awareness of the problem, providing some psychological benefit even though actual noise levels may not be affected..

- *Indicate change in direction.* From a distance, the trees will be viewed as a solid mass helping the driver to anticipate a turn in the road.

- *Control drifting snow*. Mass plantings of trees and/or shrubs are very effective for controlling drifting snow.

- *Integrate the roadside landscape into the surroundings.* Plants may mitigate the impression of the landscape disturbance.

- *Contribute to the health and diversity of the regional environment.* Plants may enrich the value of roadsides to the wildlife.

During the construction visual landscape impacts will be temporary and low.

Impact from permanent structure (road) during operation will have no impacty within the section where the road is being widened. In the new section the change can be ranked as low to medium.

6.10 Socio-economic impacts

6.10.1 Socio-economic impact assessment: road construction

Community health and security issues will be considered. Partial loss of cultivated plots/orchards during the construction will affect private property and income of the landowners. Increased traffic volumes and speed may result in a growing number of accidents and more serious injuries. Along with the affected land users, the roadside vendors will also be affected.

Road construction will have both, negative (such as dust, noise, loss of roadside businesses and land/harvest) and positive impact (temporary employment) from social-economic standpoint. Leisure zones along the route may support the development of local businesses and crafts.

According to the survey carried out by EPTISA, the impacts along these road sections will entail acquisition of 1,129,079 m^2 of land from 489 plots divided in terms of tenure type as follows:

- **Category 1.** 61 titled private land plots with full registration 175,228 sq.m;

- **Category 2.** 307 titled private land plots 269,264sq.m rightfully owned and requiring legalization through 1 stage process of registration in NAPR (legalizable land plots). These land plots have been transferred to the owners during the land reform but the formal procedures needed for registration in NAPR have not been completed.

- **Category 3.** 30 land plots of 42,412 sq.m non titled, but legalizable according to current legislation through 2 stage process (stage 1: recognition of ownership rights by PRRC; stage 2: Registration in NAPR). All of these mentioned 3 categories of land plots are subject for compensation.

- **Category 4.** 28 State Owned land plots of 19,276sq.m Illegally Occupied by Private Users and cultivated for agricultural needs.

- **Category 5.** 63 State owned land plots of 622,899 sqm not used by private users.

Given the magnitude of the impacts (there are 369 AHs, 212 severely affected APs and several relocated commercial facilities) the project under this LARP is classified as “A” for resettlement. Project impacts are summarized in Table 6.14 below.

Table 6.14 *Summary Impact on Land Acquisition and Resettlement*

No.	Impacts	Unit	
Land Tenure Patterns			
1	Total Land parcels affected	No.	489 plots
2	Total land Area to be acquired	Sqm	1,129,079
3	Category 1. Private Registered Plots	No.	61
		sq.m	175,228
4	Category 2. Private (Rightfully owned) Legalizable through NAPR (1 stage legalization)	No.	307
		sq.m	269,264
5	Category 3. Private (Nonrightfully owned) Legalizable through PRRC+ NAPR (2 stage legalization)	No.	30
		sq.m	42,412
6	Category 4. State Owned Illegally Occupied by Private Users (non legalizable)	No.	28
		Sqm	19,276
7	Category 5. State Owned Not Used by Private Users	No.	63
		Sqm	622,899
Land Use and Compensation Categories			
8	Type 1; Private agricultural (remote from the existing section of highway) (3 Gel/sq.m)	No.	154
		sq.m	108,058
9	Type 2; Private agricultural (located along the existing section of highway) (4 Gel/sq.m)	No.	237
		sq.m	361,074
10	Type 3; Private non-agricultural land used for commercial needs(5 Gel sq.m)	No.	7
		sq.m	17,773

11	Type 4; State Owned agricultural land (Illegally used by Private Users); not compensable	No.	28
		Sqm	19,276
12	Type 5; Non-agricultural State Owned (not used by private users); not compensable	No.	63 public
		Sqm	622,899
Agricultural Patterns			
13	Area under wheat cultivation	sq.m	145,889
14	Area under maize cultivation	sq.m	62,886
15	Area under beans cultivation	sq.m	16,971
16	Area under vegetables cultivation	sq.m	112,734
17	Area under hay/grass cultivation	sq.m	106,835
18	Area under potatoes cultivation	sq.m	9452
19	Area under strawberry cultivation	sq.m	22116
20	Affected Trees	No	2764
Affected Structures			
21	Fuelling Stations	No.	4
22	Flower - Shop	No.	1
23	Fencing	No.	45
		m	3405
24	Wells	No.	17
25	Toilet	No.	1
26	Irrigation system	No.	1
27	Pool	No.	1
28	Ancillary buildings (Shed)	No.	3

			10
Affected Businesses			
29	Operated Fuelling Station (operation income)	No.	1
30	Leased not operated Fuelling Station (leasing income)	No.	1
Affected Households			
31	Severely affected Households	No.	212
32	Vulnerable Households	No	82
33	Resettled households	No.	0
34	AH with registered plots	No.	51
35	AH with legalizable plots (rightful owners, 1 stage registration through NAPR)	No.	282[1]
36	AH with legalizable plots (non-rightful owners, 2 stage registration through PRRC + NAPR)	No	29[1]
37	AH illegally using State owned land (non-legalizable)	No	27[1]
38	AH with agricultural land plots	No	343
39	AH with non-agricultural (commercial) land plots	No.	7[2]
40	Total AH	No	369
41	Total Affected Persons	No	1439

The project impact extends to 1439 people comprising 53% male and 47% female (763 male and 676 female). Further, 19 of the 369 AHs are headed by women. Special attention will be given to the impact of resettlement on women and other vulnerable groups during monitoring and evaluation of the LARP-I.

The project will have a positive impact on gender, and civil works contracts will include provisions to encourage employment of women during the implementation. Additionally, women headed households are considered vulnerable and special assistance is provided in the LARP entitlements.

The legal and policy framework of the project on land acquisition and resettlement was adopted to assist the APs and/or households for their lost land and assets, income and livelihood resources. Expropriation of land through eminent domain will not be applied unless approach of acquisition through negotiated settlement fails. .

The APs entitled for compensation or at least rehabilitation assistance under the Project are the following:

(i) all persons losing land irrespective of their title;
(ii) tenants and sharecroppers irrespective of formal registration;
(iii) owners of buildings, crops, plants, or other objects attached to the land; and
(iv) persons losing business, income, and salaries.

However, the LARP identified no impact on tenants, sharecroppers, businesses, income or salaries. A summary entitlements matrix is included in Table 6.15.

Table 6.15 *Summary entitlements matrix*

Type of Loss	Application	Definition of APs	Compensation Entitlements
Land			
Permanent loss of agricultural land	AF losing agricultural land regardless of impact severity	Owner with full registration	Cash compensation in cash at full replacement cost or replacement land of same value of land lost and at location acceptable to APs where feasible. The option selected for the Program is cash compensation. If residual plots becomes unusable the project will acquire it in full if so the AP desires.
		Legalizable Owner	These AP will be legalized and provided with cash compensation at full replacement cost.
		Informal Settlers/ APs with no registration/valid documentation	One time self-relocation allowance in cash equal to 12 months at minimum subsistence income (312 GEL x 12 =3744 GEL x AH).
Non-Agricultural Land	AF losing their commercial/ residential land	Owner with full registration	Cash compensation at full replacement cost or replacement land of same value of land lost and at location acceptable to APs where feasible.
		Legalizable Owner	APs will be legalized and provided with cash compensation at full replacement cost..
		Renter/Leaseholder	Rental allowances in cash for 3 months.
		Informal Settlers/ APs with no registration/valid documentation	One time self-relocation allowance in cash equal to 1 year at minimum subsistence income (312 GEL x 12 =3744 GEL x AH).
Buildings and Structures			
Residential and non residential structures/assets.		All AFs regardless of legal ownership/ registration status (including legalizable and Informal Settlers).	All impacts will be considered as full impacts disregarding the actual impact percentage. Impacts will be compensated in cash at full replacement costs free of depreciation and transaction costs..
Loss Of Community Infrastructure/Common Property Resources			
Loss of common property resources	Community/Public Assets	Community/Government	Reconstruction of the lost structure in consultation with community and restoration of their functions

Type of Loss	Application	Definition of APs	Compensation Entitlements
Loss of Income and Livelihood			
Crops	Standing crops affected or loss of planned crop incomes**	All AFs regardless of legal status (including legalizable and Informal Settlers)	Crop compensation in cash at gross market value of actual or expected harvest. Compensation for this item will be provided by default both if the crops was harvested or not at time of impact
Trees	Trees affected	All AFs regardless of legal status (including legalizable and Informal Settlers)	Cash compensation at market rate on the basis of type, age and productive value of the trees.
Business/Employment	Business/employment loss	All AFs regardless of legal status (including legalizable and Informal Settlers)	Owner: (i). (permanent impact) cash indemnity of 1 year net income; (ii) (temporary impact) cash indemnity of net income for months of business stoppage. Assessment to be based on tax declaration or, in its absence, minimum subsistence income. Permanent worker/employees: indemnity for lost wages equal to 3 months of minimum subsistence income.
Allowances			
Severe Impacts	>10% incomeloss	All severely affected AFs including informal settlers	Agricultural income: 2 additional crop compensation covering 1 year yield from affected land. Other income: 1 additional compensation for 3 months of minimum subsistence income. (312 GEL x 3 =936 GEL per AH)
Relocation/Shifting	Transport/transition costs	All AFs to be relocated	Provision of allowance covering transport expenses and a livelihood expenses for the transitional period for 3 months equal to 3 months of minimum subsistence income. 200 GEL as vehicle hire charge + 312GEL as minimum subsistence income x 3 months = 1,136 GEL per AH
Vulnerable People Allowances		AFs below poverty line, headed by Women, disabled or elderly	Allowance equivalent to 3 months of minimum subsistence income* and employment priority in project-related jobs 312 GEL as minimum subsistence income per month for 31 months= 936 GEL per AH)
Temporary Loss			
Temporary impact during construction		All AFs	Due compensation will be assessed and paid based on this RPF during construction. All land required for temporary use is to be obtained by the civil works Contractor through volun-

Type of Loss	Application	Definition of APs	Compensation Entitlements
			tary negotiations (e.g., willing buyer-willing seller basis). The maximum period for temporary use is defined as 2 years. Compensation rates to be paid should not be less than compensation at current market rates for the gross value of 4 year's harvest of crops on the affected lands. It is also required that lands (or other assets) be fully cleared and restored following use
Unforeseen resettlement impacts, if any			Roads Department and the construction contractor will address and mitigate/compensate unforeseen resettlement impact during project

* Minimum subsistence income to be calculated based on a 5 people family, 316 GEL and the monthly-updated benchmarks indicated by the National Statistics Office of Georgia at time of RAP approval

** Income expected from crops on affected agricultural land permanently used for crop cultivation during the recent years. In case if the land was permanently used for crop cultivation, but for the year, when the inventory of losses was conducted, no crops have been planted (due to need of rest to this land or illness of the farmer or any justifiable reason), the land parcel still will be considered as designed for crop cultivation and relevant compensations will be paid

A grievance mechanism will be available to allow an AP appealing any disagreeable decision, practice or activity arising from land or other assets compensation. Consultation with likely APs in the project affected areas was conducted during the feasibility study of the Project (tranche 1) and preparation of draft LARP for section 1 in 2009. People were consulted through individual contact during the census survey under the feasibility study for identification of APs. At the preparation of LARP-I in the detail design stage, all likely APs (available on site) were consulted through community level meetings and through individual contact at the time of census, socioeconomic survey and detail measurement survey.

All issues related to land acquisition and compensation issues are described in the land acquisition plan.

6.10.2 Socio-economic impact assessment: road operation

Road operation will have both, negative (such as dust, noise) and positive impact (an improved infrastructure) from social-economic standpoint. Leisure zones along the route may support the development of local businesses and crafts.

6.11 Historical-cultural impacts

In 0.5-1 km from the road, Urbnisi is situated on the left bank of the Mtkvari river . Archaeological studies demonstrated that the place was inhabited in the 3rd millennium BC. Ruins of a fortress, rich baths, pagan sanctuaries and even a Jewish temple suggest the importance of the city. In 2010, during the construction of the highway about 20 sarcophagues dated by 4-5 AD were unearthed. To the west of the site, Eneolyth-Bronze age settlement and burial moulds were found. There are no architectural/cultural monuments in the direct impact zone.

Despite the fact that no signs of archaeological heritage were revealed during the survey implemented under the EA from Ruisi to the Prone River, long history of the area allows for possible future findings. The works in the area should be supervised by an archaeologist. Particular attention shall be given to the section from the right bank of the West Prone to the right bank of the Ptsa, the area within the second terrace of the Mtkvari.

In the event of unexpected discovery of archaeological objects during construction the Contractor shall immediately inform the Employer who will notify the Ministry of Culture and Monument Protection and obtain their further instructions. In this case construction works would be stopped until the Ministry has given clearance for the continuation of operations. Works would resume only after measures have been taken as requested by the Ministry and confirmation has been received that works may continue.

There is no risk of operation impacts.

6.12 Protected territories

There are no protected areas in the project impact zone. This issue are not considered in the EIA.

7 Mitigation measures

Mitigation measures and residual impacts are listed in the EMP (see Section 9) for the impacts ranked as medium and high. Each environmental theme is addressed regarding the phases of road upgrading: preconstruction, construction and operation. Mitigation measures according to the recipient environment are presented above in the relevant sections of the document and Subsection 9.4 of this document.

8Comparative evaluation of alternatives and identification of the environmentally preferred option

Intheframe of theFS and EIA various alternativeswere compared and a preferable option was chosen.The following options/alternatives were dealt with (Figure 8.1):

- ***Wideningthe existing road***(Ruisi-Agara section)
- ***Aradeti realignment***. (Ruisi-Agara section)
- ***Agara Bypass North***.
- ***Gomi-Agara Bypass South 1***(Agara Area)
- ***Gomi-Agara Bypass South 2***(Agara Area)

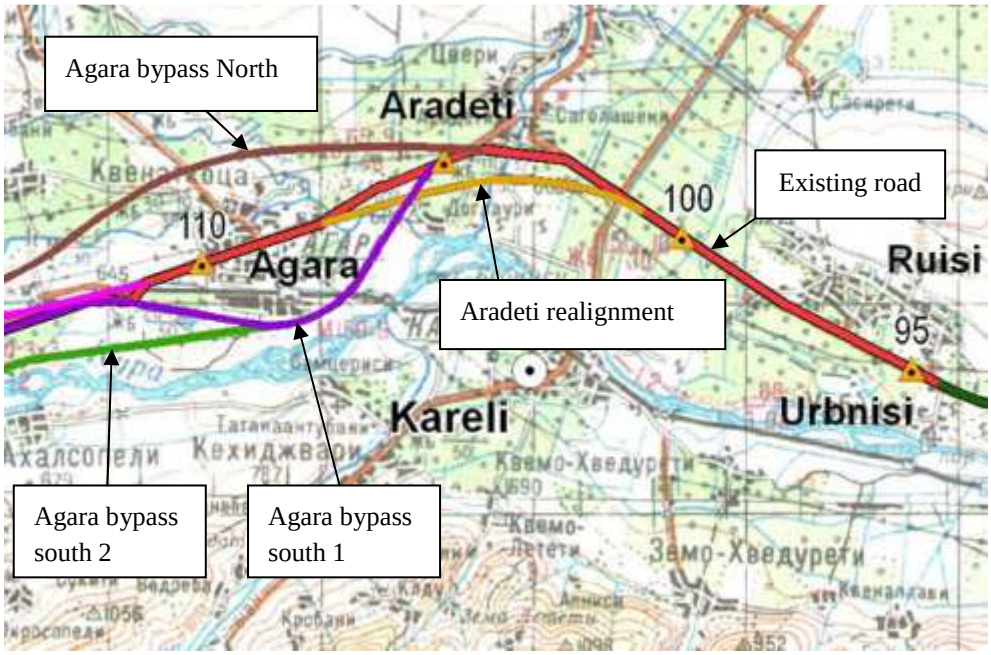


Figure 8.1 *Alternatives - Ruisi to Agara West of E-60 Highway.*

Agara Bypass North would start at km 104. The proposed bypass would make a large loop north of Agara and would continue westwards between the villages Mokhisi and Agara before joining the Khasuri bypass alternatives north of Gomi. Considering the impact of the northern alternative on the agricultural (private) land and the negative attitude of the regional stakeholders on land needs of the most productive soils, the Feasibility study ***recommended to exclude*** this alternative from further evaluation.

*A Gomi/Agara Bypass South 1*alternative*(Agara Area)* to bypass Agara and Gomi was developed to avoid impacts on the agricultural land north of the existing road. The southern alternative would branch off the Aradeti village and make a loop around Agara. Alternatively the Agara south bypass branch off at about km 106 from the existing road. At km 111.5 the bypass will join again the existing road. The proposed alignment would avoid demolishing of buildings, but cross partly private land parcels.

Gomi-Agara Bypass South 2 alternative (Agara Area) was developed in order to straighten the south alternatives for bypassing Agara and Gomi by connecting directly the proposed southern bypass of Agara with the proposed southern bypass of Gomi. This alternative would shorten the south alternatives by about 0.5 km and would minimise land acquisition, since most part of the alignment is located within the Mtkvari river basin. Gomi-Agara bypass south 2 alternatives are located within the Mtkvari River basin and would require additional measures to protect the road from flooding. This option performs more poorly than the other southern alternative and therefore ***is not recommended for further evaluation***.

Aradeti realignment - for smoothening of the road alignment and locating the road away from the village of Aradeti, an alignment improvement was considered between km 101 and km 108. The proposed alignment would shift the existing road approximately 600 m to the south in order to reduce noise and pollution levels for the population of Aradeti. The proposed realignment would reduce the road length by about 430 m. At the same time it would require a substantial acquisition of land including the loss of some agricultural land. The new alignment would make an adverse impact on archaeologically vulnerable area and would be more unfavourable from an environmental point of view than the widening of the existing road. The advantages of the alignment alternative are mainly related to a smoother alignment and reduction of the route length. Though an important step in the improvement of traffic safety in the Aradeti alignment alternative is seen by the regional stakeholders as unfavouravle, the Aradeti alignment alternative is ***not recommended for further investigations*** and evaluations due to the need of extra land and the potential of an adverse impact on a significant archaeological site.

Based on the mentioned above upgrading of the existing road to a four-lane standard and bypassing Agara to the south meet the initial evaluation criteria and therefore have been recommended for further study (Figure 8.1).

Table 8.1(a) *Comparison of alternatives – Ruisi-Agara section*

EvaluationCriteria	Upgrading Existin-gRoute(Alternative -A0)	Alignmentimprove-mentArade-ti(Alternative – A11)	PreferredAl-ternative
Efficiencyoftravel,safetyandaccessibility			
Lengthofroadconnection betweenbeginningan-dend ofby-pass/realignment -Lengthofnewroad	6.6km -	6.1km 6.1km	A1

Trafficefficiencyduring-construction	Impairmentoftrafficduring-construction	Trafficwilluseexistin-groad,nointerferencewith construction	A1
Designandengineering			
Geotechnicalrisks	Roadlocatedinearthquake-zone,noothergeo-hazards known	Roadlocatedinearthquake-zone,noothergeo-hazards known	-
Potentialfloodingrisk	Nofloodingcasesregistered-tilltoday	Nofloodingcasesregiste-redtilltoday	-
Useofexistin-groad infra-structure	The existing roadwill be ful-lyutilized.	Existing road will be used forlocaltraffic	A0
Magnitudeofearthworks	Wideningto4lanes requires-lessearthworkthannewcon-struction	Newroadconstructionof4 lane road requires large-rearthworkthanwidening	A0
Socio-economic andfinancial			
Impactsonagricultural opportuni-tiesand businesses	Limitedimpactonagricultural landduetoroad widening	AcquisitionoftheRoWfor-thenewroadalignment will leadtosubstantial im-pacts onagriculturalop-portunities	A0
Roadconstructioncost	Utilising the existing road andconstructionof2 Addi-tionallaneswill minimise-constructioncosts	Newconstructionofthe-full roadwidthwillresul-tin higherconstruction-costs andlandacquisi-tioncosts	A0
Landacquisitionanddis-placementimpacts	Minor land acquisition for-roadwideningrequired	Substantiallandacquisitio-nrequiredfortheRoWofthe newroad	A0
Environment			
Naturalandbuild environment	Wideningofroadminimize impactontheenvironment	Roadconstructiononane-walignmentgenerategrea-ter impactthanroadwiden-ing	A0
Impactonpotentialar-chaeologicalsensitive areas	Within the RoW of theex-isting road,no archaeologi-calsitesknown, nosignifican-timpacts	IV-III millennium BCsettlement andbron-zeage burialmounds ha-vebeen partiallyexca-vated. Further archaeo-logical sitesare antic-ipated withinthe propo-sedcorridor.	A0

Note: green cells - favourable,red cells – unfavourable, unshaded - neutral,

Table 8.1(b) *Comparison of alternatives –Agara bypass section*

EvaluationCriteria	Upgrading Existing Route (Alternative-Alt 0)	Agara Bypass North(Alternative -Alt1)	Agara Bypass South(Alternative - Alt 2)	Agara Sub-alternative Bypass South new (Alternative _Alt2-1)	Preferred Alterna-tive
Efficiencyoftravel, safety andaccessibility					
Lengthofroadconnectionbetweenbe-ginning andendofbypass/realignment section -Lengthofnewroad	12.9k m-	16.6km	13.8km	13.5km	Alt.0
Trafficefficiencyduringconstruction	Impairmentoftraffic duringconstruction	Trafficwill useexisting road,no interferen-cewith construction	Trafficwill useexisting road, butlimited im-pairmentof traffic en-visagedbetween Agara andGomiduetowiden-	Trafficwill useexisting road,no interferen-cewith construction	Alt.1and Alt.2-1
Designandengineering					
Geotechnicalrisks	Roadlocated in earthquake zone, no othergeo-hazardsknown	Roadlocated in earthquakezone. Active landslidearea northof Kvenadotsawill be bypassed	Roadlocated in earthquake zone, no othergeo-hazardsknown		-
Potentialfloodingrisk	Nofloodingcases registeredtilltoday		The Agarabypass is-partly located in theMtkvaririverbasin. Measuresagainst over flooding of the roads needstobeimple-mented.	The new alignmentis locatedformostof the length within the Mtkvaririverbasinand measures against over floodingof the-roadsneedsto be implemented.	Alt.0and Alt.1
Useofexistingroadinfrastructure	The existing road will be fullyutilized.	Existingroadwillbeused forlocaltraffic	Betweenthe Agaraand Gomibypassthe exis-tingroad willbewide-nedto4 lane standard	Existingroadwillbeused forlocaltraffic	Alt.0
Magnitudeofearthworks	Wideningto4 lanes requiresless earth-work thannewcon-	Thealternativefollowsthe existing terrain with limitedearthworks			Alt.0
Socio-economicandfinancial					

Impacts on agricultural opportunities and businesses	Impactson agricultural lands and opportunities are not significant,but wideningof theroadwill require demolishingof roadside businessesin	Impactonmost productive agricultural lands northof Kvenadkotsa.	Limitedimpact on agriculturallandsatAgara bypass and widening of theroad	Limitedimpact on agricultural lands, since theroadis locatedin the Mtkvaririverbasin	Alt.2and Alt.2-1
Roadconstructioncost	Utilisingthe existingroad will reduceconstruction costs	Newconstructionofthefullroadwidthwillresultin higherconstructioncosts andlandacquisitioncosts	Partlyutilisingtheexisting roadbetweenAgaraand Gomiwillreduce constructionandland aqquisitioncosts	Newconstructionofthefullroadwidthwillresultin higherconstructioncosts andlandacquisitioncosts	Alt.0
Landacquisitionanddisplacementimpacts	Wideningof theexisting road in Agara will result in loss of roadside businesswithin thesevillages.	The northernalternative cross a large area of private agriculturallands, which isthemain source of incomeof thelocal populationinthisarea.	The southernbypass minimisethe impacton privateland. No displacementimpacts are anticipated.		Alt-2and Alt.2-1
Environment					
Naturalandbuildenvironment	Wideningof theexisting road minimise impact on the environment,but will dividethe townintoparts and havenegativeimpact on the connectivitywithin	The new road corridor cross mainlyagricultural land with limitedexpected impactonfloraandfauna	The new road corrdor crosssome agricultural landandthe Mtkvaririver basin withlimited expectedimpacton flora andfauna	The newroadcorridoris locatedin theMtkvaririver basin withlimited expectedimpacton flora andfauna	-
Impact on potential archaeological sensitive areas	WithintheRoWof the existingroad no archaeological sites known,no significant impacts				-

Note: green cells - favourable,red cells – unfavourable, unshaded - neutral,

Relying on the information given above EIA report includs analysis and comparison of:

- *The "**zero" alternative** - assuming that the project was not implemented;*
- *Upgrading of the existing road to a four-lane standard, without changing present road alignment - **Project alternative 1**;*
- *Gomi-Agara Bypass South 1 alternative including two bypasses to the south of Gomi and Agara, and widening the existing road between Gomi and Urbnisi - **Project alternative 2**.*

Taking into account the mentioned above and allowing for the mitigation measures suggested, widening of the road on Ruisi-Aradeti section and construction of the section bypassing Agara from the south (Agara bypass south 1) were considered as preferable alternative.

9 Environmental Management Plan (EMP)

Information included in the EMP is synthesized from the main findings outlined in every chapter of the EIA report, i.e., all proposed mitigation and monitoring actions set to a timeline, specific responsibility assigned and follow up actions defined.

The EMP for the preferred alternative is presented in a table format and divided into three main parts, dealing with the physical environment, with the biological environment, and with the socio-economic and cultural environment. Each part is organized by development stages, i.e. pre-construction, construction and road operation.

The overall objective of the EMP is to bring the project into compliance with national environmental and social requirements and environmental and social policies of the lender.

The EMP links the mitigation measures into a comprehensive implementation scheme, designed to ensure action. It describes institutional responsibilities, compliance monitoring and reporting requirements, and cost for implementing the EMP, all in order to answer the “who?”, “how?” and “how much?” questions.

A set of mitigation measures, monitoring indicators and estimated costs of main mitigation activities is listed in Section 9.4 of this document.

The EIA and EMP will be made available for the bidders so that they can consider and incorporate their environmental responsibilities into their bid proposals.

9.1 Environmental management framework and policy

The Georgian environmental impact assessment (EIA) system is based on environmental legislation of Georgia. The laws Environmental Impact Permit and Ecological Expertise provide the framework for EIA in Georgia. The process is similar to that in European Union and on the whole meets requirements set in the International Financial Institutions’ (EBRD, World Bank, IFC) environmental and social safeguards.

Environmental impact permit is issued by the Ministry of Environmental Protection (MoE) following to consideration of application for an Environmental Impact Permit (EIP) submitted by the proponent. According to the national regulations the application includes Environmental Impact Assessment report, technical summary and other information. The application is subjected to review by experts. Conclusion of the review forms the basis of the permit deci-

sion.

World Bank Environmental Assessment policy (OP/BP 4.01) incorporates environmental impact assessment of projects, strategic environmental assessment of plans and policies, etc. The process involves screening to define the type and level of study/assessment and specifies approach. The OP4.01 is "supported" by other guidance given in variety of the guidelines.

The guiding principles on the environmental safeguards applicable to every stage of a project include: commitment to comply with all applicable environmental laws and regulations; commitment to the sustainable management/use of natural resources; commitment to manage the business activities so that any adverse effects on the local environment is avoided, remedied or mitigated.

9.2 Institutional framework and environmental administration

Roads Department of the Ministry of Regional Development and Infrastructure of Georgia (RD) is responsible for general oversight on environmental compliance of works through ensuring quality performance of the technical supervisor and of the contractor. In order to achieve this objective the RD liaises with the World Bank, ensures availability of environmental information, and facilitates environmental supervision of the Project by the World Bank.

Supervisor of works commissioned by RD is charged with responsibility to establish strong field presence in the project area and supervise the works. Along with ensuring consistency with the design and quality of works, the supervisor is mandated to track implementation of EMP by the contractor, reveal any deviations from the prescribed actions, and identify any environmental issues should they emerge at any stage of works.

Construction contractor is obligated to follow the EMP and good construction practice. Contractor must have one environmental specialist in the team in order to ensure compliance with the EMP, who is able to fully understand recommendations and professionally apply prescribed mitigation measures to the contractor’s daily operations.

The Contractor shall comply with the requirements of the Environmental Management Plan, the Health and Safety Plan, and the Traffic Management Plan developed by him for the Contract. After the contract is awarded, the Contractor is required to use the mobilization period to finalize in detail all his EMPs based on a detailed preconstruction survey and the EIA documents handed to him by the Employer. The EMPs have to be in accordance with the Contractor’s finalized work/method statements and schedules.

According to the Technical Specifications, before commencement of works the Contractor shall develop and submit for approval by the Engineer a range of documents:

1. Dust management plan
2. Sewage management plan
3. Waste management plan

4. Soil Management Plan

5. Emergency response plan (in case of spills, accidents, fires and the like) prior to operation of the asphalt plant

6. Grievances mechanism

7. Method statement or plan for the execution of bridge construction works

8. Health and Safety Plan

The simplified chart given herewith shows reporting structure, the levels of management and the chain of communication in the project.

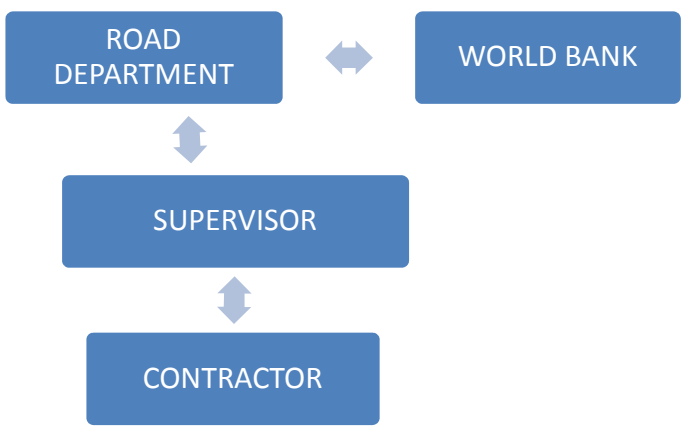


Figure 9.1 *Environmental administration flowchart*

9.3 Summary of anticipated environmental impacts

Issues to be considered on design and pre-construction phase

#	Description	Comments
1	Route selection	Risks/impacts related to geohazards prone sites; sensitive ecosystems; archaeology; landuse can be avoided by proper selection of the route.
2	Siting alternatives for borrow pits, waste disposal areas, asphalt and concrete mixing sites, fueling sites, camps, storage places and equipment yards.	Impact on air/water and landscape depends on proper siting of the sites and facilities. This is to be considered by constructing contractor at the mobilization stage.
3	Interchanges and interception sites	Are considered in design in order to avoid interference on local transportation and access; and ensure safety of traffic.
4	Compliance with international design standards	Safety; efficiency of operations and maintenance
5	Nuisance	Noise and emissions related to traffic are tangible only in densely populated areas where the residential houses are located close to the road.

6	Protection of fish in the artificial lake crossed by the Agara bypass	Consideration of 'pasage' to allow free migration of fish and water flow.
6	Bridges, viaducts and flood protection installations; drainage facilities, anti-erosion measures	Proper design ensures safety and reduces the risks of road destruction related to flooding, landslides, rockfalls etc. Implementation of drainage systems is important for the maintenance and safety Temporary and permanent drainage systems, retaining walls, berms and embankments, design of anti-erosion engineering measures and reinstatement plan areimportant for minimizing erosion and secondary impacts: landscape degradation and increased sedimentation of watercourses, slow destruction of the highway pavement
8	Infrastructure elements.	At the design stage it is important to consider protection and reinstatement of this infrastructure (electric power transmission systems, water supply and irrigation pipilne systems and channels).

Environmental impacts - construction

#	Potential Impacts	Severity	Sites
1	Destruction of natural landscape (relief, soil cover, vegetation, eco-systems, habitats and wildlife) in the right-of-way occupied by the highway.	Minor to medium	Whole alignment
2	Destruction of natural landscape (relief, soil cover, vegetation, eco-systems, habitats and wildlife) on the access roads, in the borrow pit sites, waste dumps, construction camps and equipment yards.	Medium	Borrow pit sites Waste dumps, Construction camps Equipment yards – to be defined at the preconstruction stage by the constructing contractor.
3	Erosion stimulated from fresh road cuts and fills and temporary sedimentation of natural drainage ways. Erosion of lands below the road bed receiving concentrated outflow from covered or open drains.	Minor	Part of alignment, which passes hilly and mountainous landscape
4	Increased suspended sediment in streams affected by erosion at construction sites and fresh road cuts, fills and waste dumps. Declined water quality and increased sedimentation	Medium	Bridge construction area, road section next to the river
5	Impact of construction activities on aquatic ecosystems of the rivers and streams crossed by the highway	Minor to medium	Rivers: Prone, Ptsa, Mkvari, artificial lake
6	Soil and water contamination during construction – spilled oil, grease, fuel, paint.	Minor	Water – rivers Prone, Ptsa, Mtkvari , lake Soil – along the whole alignment; camps, equipment yards/concrete mixing sites

7	Poor sanitation/solid waste disposal in construction camps and work sites (sewerage, sanitation, waste management)	Minor to medium	Location to be defined by constructing contractor.
8	Construction wastes alongside the RoW, spoil and roadside litter.	Medium	Along alignment; at work-sites
9	Air pollution from vehicle operations, dust.	Minor/ Medium	Near the settlements: Ruisis, Aradeti, Sagolasheni, Agara
10	Air pollution from asphalt/concrete plants.	Medium	Supplier site
11	Noise from machinery/vehicle – traffic, local	Minor	Near the settlements
12	Poaching by construction workers	No to very minor	Rivers, along the route
13	Creation of stagnant water bodies in borrows pits, quarries, etc. suited to mosquito breeding and other disease vectors.	Minor	Borrow pits, quarries
14	Recontamination by infectious biological materials during earth works near the pest holes (i.e. not registered Anthrax sites)	No to very minor	Whole the new alignments,alignment
15	Health hazards by noise, air emissions/dust (vechicles, construction works)	Medium	Near the settlements
16	Impacts on archaeological sites	Minor to medium	Aradeti-Sagolasheni adjacent area
17	Hazardous driving conditions where construction interferes with existing roads.	Minor	Whole alignment Near the settlements
18	Impact on existing infrastructure	Medium	Near the settlements
19	Traffic related accident risks	Minor	Whole alignment; Most sensitive sites are near the settlements.
20	Economical displacement of people living on the right of way	Medium	Compensation

Environmental Impacts - Operation

#	Potential impacts	Severity	Sites
20	Impact on landscape	Medium	Whole alignment
21	Impact on the access roads, borrow pit sites, waste dumps	Minor	During repair
22	Roadside litter	Minor	Along alignment, landfills
23	Erosion from road cuts and fills and temporary sedimentation of natural drainage ways. Erosion of lands below the road bed receiving concentrated outflow from covered or open drains.	Medium	Within the RoW. Most part of alignment,
24	Alteration of land/subsoil drainage patterns	No impact	The existing culverts and drainage systems are rehabilitated

25	Increased suspended sediment in streams affected by erosion, fresh road cuts, fills and waste dumps. declined water quality and increased sedimenta-tion	Minor	Along alignment near the rivers
26	Soil and water contamination by oil, grease, fuel and paint alongside the highway	Minor	Most part of alignment
27	Air pollution from machinery during maintenance works.	Minor	Most part of alignment
28	Air pollution from traffic	Minor	Near the settlements, Most part of alignment
29	Noise pollution from traffic	High	Near the settlements, Most part of alignment
30	Roadside litter.	Medium	Most part of alignment
31	Creation of a transmission corridor for pests, weeds, etc	Medium	Most part of alignment
32	Health hazards by relad to dust and ex-haust emissions	Minor	Near the settlements:
33	Obstruction of routes from homes to farms, etc, increasing travel time.	Minor	Near the settlements
34	Impairment of non-motored transporta-tion in the highway corridor due to re-duced or impeded rights-of-way.	No	No
#	**Emergency Related Impacts**	**Severity**	
35	Accident risks associated with traffic that may result in spills injuries or loss of life	Medium	Near the settlements Most part of alignment

Impact matrix - Construction Stage

Activity	Impact	Character of impact							
		Direct	Indirect	Positive	Negative	Reversible	Irreversible	Temporary	Residual
Land clearance and grading in the RoW	Impact on landscape, flo-ra/fauna, habitats	+			+		+		+
	Erosion	+			+		+		
	Emissions	+			+	+		+	
	Noise, vibration	+			+	+		+	
	Soil pollution		+		+	+		+	
	Waste generation		+		+	+		+	
	Ground and surface water pol-lution		+		+	+		+	
Construction; pavement	Emissions	+			+	+		+	
	Noise, vibration	+			+	+		+	
	Soil pollution		+		+	+		+	
	Waste generation		+		+	+		+	
	Ground and surface water pol-lution		+		+	+		+	

Exploration of borrow pits	Impact on landscape, flo-ra/fauna, habitats	+			+		+		+
	Erosion	+			+		+		+
	Emissions	+			+	+		+	
	Noise, vibration	+			+	+		+	
	Soil pollution		+		+	+		+	
	Waste generation		+		+	+		+	
	Ground and surface water pollution	+			+	+		+	
Transportation of material from borrow pits.	Emissions	+			+	+		+	
	Noise, vibration	+			+	+		+	
	Soil pollution		+		+	+		+	
	Waste generation		+		+	+		+	
	Ground and surface water pollution		+		+	+		+	
Demolition of part of the road-side structures and part of ex-isting pavement	Emissions	+			+	+		+	
	Noise, vibration	+			+	+		+	
	Soil pollution		+		+	+		+	
	Waste generation		+		+	+		+	
	Ground and surface water pollution		+		+	+		+	
Disposal of spoil and wastes	Impact on landscape, habi-tats	+			+	+		+	
	Emissions	+			+	+		+	
	Noise, vibration	+			+	+		+	
	Soil pollution		+		+	+		+	
	Waste generation		+		+	+		+	
	Ground and surface water pollution		+		+	+		+	

Character of Main of the Anticipated Impacts - Operation Stage

Activity/ Factor	Impact	Character of impact							
		Direct	Indirect	Positive	Negative	Reversible	Irreversible	Temporary	Residual/long-term
Physical existence	Impact on landscape	+					+		+
Traffic	Impact on landscape, flo-ra/fauna, habitats	+	+		+				
	Emissions	+			+				+
	Noise, vibration	+			+				+
	Soil pollution		+		+	+		+	
	Waste generation		+		+	+		+	
	Ground and surface water pollu-tion		+		+	+		+	
Maintenance works	Impact on landscape, flo-ra/fauna, habitats	+		+					
	Erosion	+		+	+			+	

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Gamma

	Emissions	+			+				+
	Noise, vibration	+			+				+
	Soil pollution		+		+	+		+	
	Waste generation		+		+	+		+	
	Ground and surface water pollution		+		+	+		+	
Accidents	Impact on landscape, flora/fauna, habitats		+		+	+		+	
	Erosion								
	Emissions		+		+	+		+	
	Noise, vibration								
	Soil pollution		+		+	+		+	
	Waste generation		+		+	+		+	
	Ground and surface water pollution		+		+	+		+	

9.4 Environmental management and monitoring

A. Design phase

Environmental Issue	Measures taken or to be taken	Implementing Organization	Responsible Organization - supervisor
Dust/air pollution	• Placement of earth borrowing sites, waste disposal sites and concrete mixing sites is identified with consideration of environmental issues (to avoid negative impacts on humans and wildlife).	EPTISA/Contractor	RD
Noise	• Planning of auxiliary and haulage routes away from densely settled areas avoiding increased noise levels.	EPTISA/Contractor	RD
Surface water pollution	• Identification of the need for arrangement of drainage system. Identification of surface water protection measures for facilities/works near or in the riverbed	EPTISA	RD
Fish in artificial fish pond	• Free movement of fish in artificial lake will be ensured by 'passage' (concrete pipe running through the road embankment).	EPTISA	RD
Loss of land/harvest Loss of a source of income/busines	• Development and implementation of Land acuisition plan • Compensation	EPTISA	RD

B. Construction phase

Activity	Location	Environmental Issue	Mitigation measure	Responsible authority	Approx. Cost (GEL)	Monitoring			
						Monitoring measure	Frequency	Approx. Cost (GEL)	Responsible agency
Site clearance	RoW, support infrastructure	Cutting of grass and other herbaceous vegetation, cutting and removal of shrubs and tree felling activities.	• Identification of trees to be cut or replanted. During the construction of the bridges special attention shall be paid to the protection of theplant species along rivers. • Avoidance of cutting and damaging of the trees without any special need. Preservation of vegetation as far as feasible. • Each removed tree shall be compensated by planting and maintaining 3 trees of the same species nearby or after completion of works and recultivation of temporarily used sites .	Contractor	The cost will be determined on case by case basis with consideration of the type of the plant species removed. In total around 349 trees will be cut.of them 235 coniferous.	Inspection	Permanent monitoring during construction After completion of recovery works	No cost	Contractor, supervision by RD
Offsite traffic	Access roads	Impact on vegetation and soil	• Strict keeping to the boundaries of the traffic route to avoid 'extra' damage of vegetation (if any) and soil ramming	Contractor	No cost	Inspection	Ocassionally	No cost	Contractor, supervision by RD

Establishment and operation of contractor's work camps, equipment yard	Camps, equipment yard	Impact on vegetation and inadequate use of land resources	• Keeping to the boundaries of plots allocated for the project. • After completing the works rehabilitation measures shall be taken to restore the access roads and other units (construction camps, storage territories, etc) to the state that they were in before launching the project. By approbation of the local authorities the temporary roads can be left for the use of the local communities.	Contractor	Cost of revegetation – will depend on location of site allocated for the camp and auxiliary facilities. The cost for planting and maintenace of a tree is estimated as 7$ per unit	Inspection during the whole phase of construction process.	Once a week.during construction. Monitoring of implementation/ efficiancy of recovery plan	No extra costs	Contractor, supervision by RD

Establishment and operation of contractor's work camps	Camps, equipment yard	Water and soil pollution, uncontrolled spillage of the waste water and waters polluted with mineral oils.	• Control the waste water of the temporary construction units to avoid their possible impacts upon the surface water. The waste water shall be collected in the septic tanks/pits. The tanks/pits emptied – waste disposed under agreement of local municipality. • Fuel/oil tanks shall be ricked around with watertight material (it is possible to use clay for the purpose). Storage site arranged at least 100 m distance from the riverbed. The area under the reservoirs/inside the ricks shall also be covered with waterproof material. Any spill should be immediately isolated and cleaned up with absorbent materials. • Onsite fuelling must be avoided. If onsite fuelling is required, this is to be done in the area arranged according to the requirements of pollution prevention plan. The designated areas for on-site fuelling must be located away from drainage channels. • Regularly checking of vehicles/machinery for leaks.All leaks shall be immediately repaired. Incoming vehicles and equipment shall be checked for leaks. Leaking vehicles/ equipment shall not be allowed on-site. • Secondary containment devices drip pans or absorbent materials shall be provided. On small spills absorbent materials must be used. • Materials and waste must be stockpiled so as to avoid erosion and washing off into the river. Drainage trenches must be established to divert surface runoff from the site. • Waste collection area must be sited in order to avoid substantial amount of runoff from upland areas without draining directly to a water body. • If there is a risk of fuel/oil spills, an oil trap should be additionally provided. • To prevent runoff contamination, paving should be performed only in dry weather. • Staff should be briefed in sound material/fuel/waste management	Contractor	The costs will be estimated by contractor identified through tendering.	Inspection during construction Monitoring of compliance with requirements of "Plan of avoidance of accidental spills and spills responce"	Permanent monitoring during construction works	No extra cost	Contractor, supervision by RD

Earthworks and various construction activities	Road alignment	Soil stability and quality degradation, deterioration of the soil structure and reducing its productivity.	• Removal of topsoil prior to construction • Maintaining the humus topsoil deposited along the RoW corridor in a stable state prior to reuse. • Strict keeping to the boudaries of the access roads and operation grounds to avoid pollution, ramming of soil. • Preservation of vegetation as far as feasible to avoid the risk of erosion • Avoidance of fuel/oil spills • Briefing staff in good practice • Hydroseeding	Contractor	No extra costs required. Will be done within the budget of construction works.	Inspection Periodical checkup with the purpose of estimation of state of the soil storage layer.	Once a weekl during construction Monitoring after completion of works	No extra costs	Contractor, supervision by RD
Establishment and operation of contractor's work camps and various construction activities	Camp, operation ground	Safety of workers, operators and drivers.	• Providing detailed information to the personnel about the activities foreseen in the project. • Holding trainings upon the safety of activities carried out by specialists in different fields • Briefing of new staff • Safety briefing prior to the shift start • Providing the personnel with personal protective equipment. • Checking the safety skills of the technical staff (drivers, etc.). • Preparation of a health and safety plan governing all activities on site.	Contractor	No extra costs required. Will be done within the budget of construction works	Incident records Training recordsSafety briefing records	Inspection	No extra costs	Contractor, supervision by RD

Bridge and culvert construction	Bridge and culver construction sites	Possible deterioration of water quality, impacts upon water habitats caused by the works carried out in the river-beds. Impacts on the banks caused by activating erosion processes	• Earthworks necessary for the construction of the bridge piers and abutments shall be kept to the minimum practicable according to the design in order to avoid erosion. • Building temporary access roads having taken into consideration existing extent of erosion. • Examining the river banks and their neighbouring slopes for potential sliding of soils. The aim of the examination is to rehabilitate and consolidate the banks in time. • Reducing the time necessary for the construction of the bridge piers and abutments to its optimal minimum. • Avoidance of stockpiling the material removed from the trenches into the river-beds. • Prohibition of vehicle/car maintenance, on-site fuelling near the riverbed. • Proper management of waste • Stabilisation of slopes • Timing construction works in the riverbed with consideration of periods sensitive for aquatic life. Construction works in the rivers shall not coincide with the spawning season (preferably in autumn). • Prohibition of direct discharge of waste water into the rivers. • Arranging water-ways and canals for fish-passes during temporary shifts of the natural river-beds necessary for the construction works carried out in the river-beds. • Briefing staff in good practice	Contractor	No extra costs required	Inspection Briefing records	During construction Daily	No extra costs required	Contractor, supervision by RD

Operation of equipment maintenance and fuel storage areas	Workshops fuelling area	Deterioration of water/soil quality in the rivers caused by possible spillage of polluted waters, mineral oils or other contaminants.	• Establishing control to avoid re-fuelling the vehicles and technical equipment in the riverbeds, on the terraces and in their immediate vicinity and hence uncontrolled emergency spillage. • Constrol of the proper status of technical maintenance of vehicles/building machinery (pipes for hydraulic fluid, fuel tanks, etc shall be daily checked before the machinery comes into the rivers). • Usage of off-site vehicle wash racks or commercial washing facilities is preferable. If on-site cleaning is required, bermed wash areas for cleaning activities must be established. The wash area may be sloped to facilitate collection of wash water and evaporative drying. • Onsite repairs /maintenance activities should be limited. Priority should be given to offsite commercial facilities. If impossible, a designated area and/or a secondary containment for possible spills for on-site repair or maintenance activities must be provided. These areas shall be located away from drainage channels. • Machinery/vehicles must not be fuelled or maintained near the riverbed (distance between the maintenance site and the river should be at least 100 m). • Briefing staff in good practice	Contractor	No extra costs required. The costs for arrangement of wash area (as appropriate) will be estimated by contractor	Inspection during construction Daily control of technical status of vehicles/machinery records. Briefing records	During construction Daily	No extra costs required.	Contractor, supervision by RD
Earthworks and various construction activities	Construction ground	Landscape disturbance.	• Before launching the works with regard to possible changes of the landscape a landscape harmonization plan shall be worked out and approved by Employer.	Contractor	No extra costs required.	Monitoring of implementation of the plan - records	During construction	No extra costs required.	Contractor, supervision by RD

Earthworks and various construction activities	Construction ground	Archaeological chance finds	• Supervision by an archaeologist to avoid impact • In the event of unexpected discovery of archaeological objects during construction operations the Contractor shall immediately inform the Employer who will notify the Ministry of Culture and Monument Protection and obtain their further instructions. In this case construction works would be stopped until the Ministry has given clearance for the continuation of operations. • Works would resume only after measures have been taken as requested by the Ministry and confirmation has been received that works may continue. • Briefing staff in good practice	Contractor	Cost of archaeological examination	Availability of chance find procedure Control records	During construction	No extra costs required.	Contractor, supervision by RD
Earthworks and various construction activities	RoW and adiacent	Air pollution from improper maintenance of equipment	• Maintain construction equipment to good standard; improper functioning machinery that causes excessive pollution will be banned from the construction sites. • Speed limit for offsite traffic	Contractor	No extra costs required	Permanent control	During construction	No extra costs required.	Contractor, supervision by RD
Reinforced concrete mixing	Concrete mixing unit area	Dust/air pollution from concrete mixing	• Mixing equipment should be well sealed; vibrating equipment should be equipped with dust-remove device. Keep at least 300 m distance from residences windward wind direction to reinforced concrete production plants.	Contractor	No extra costs required.	Permanent control	During construction	No extra costs required.	Contractor, supervision by RD
Earthworks, storage and transportation of soil or other fine-grained materials (cement, sand, etc.), vehicles moving across unpaved or dusty surfaces.	Storage, roads	Dust/air pollution	• Spray all unpaved roads and significant areas of uncovered soil with water every four hours on working days, during dry and windy weather; • Provide a wheel-washing facility and ensure that it is used by all vehicles before leaving all sites. • Cover all loose material with tarpaulins when transported off-site on trucks; • Cover all material stockpiled on site with securely-held tarpaulins at all times;	Contractor	The costs for arrangement of wheel-washing facility will be estimated by Contractor. No other costs required.	Permanent control	During construction	No extra costs required	Contractor, supervision by RD

Earthworks and various construction activities	Settlements	Impacts upon the human beings and natural receptors caused by increased noise levels.	• In the vicinity of settlements material transport and working hours will be restricted to between 07 to 21 hours within a 500 m distance of the adjoining settlements. • Speed limit set for the offsite traffic. • Implementation of regular technical check-ups of mobile and stationary devices.	Contractor	No extra costs required.	Permanent control,	During construction	No extra costs required	Contractor, supervision by RD
Construction of the road, bridges and demolition of the roadside structures/buildings	Waste dumping area	Non-hazardous waste production from construction and demolition	• Development and implementation of waste management plan • For temporary disposal of inert waste the site within the camp/operation ground must be selected. The waste must be placed so as not to interfere with free movement of machinery and staff, away from surface water (within at least 100 m). Waste must be source-separated in order to ensure efficient management and enable reuse. • Any waste materials that may be used for the project must be reused on the site, or for the needs of muncipality based on agrrement, the rest should be disposed at the nearest landfill, as the case may be, under agrrement of local authorities. • Briefing staff in good practice	Contractor	No extra costs other than that related to removal of the waste from the site by waste removal service (under the contract) - required.	Monitoring of compliance with the waste management plan - records	During construction	No extra costs required	Contractor, supervision by RD

Operation of equipment maintenance, fuel storage areas, various construction activities	Operation ground	Hazardous waste production from accidental spills, maintenance of the machinery, etc. (oils, solvents, oily rugs, used filters, etc.)	• Development and implementation of waste management plan • As Georgia has no hazardous waste landfill yet, the hazardous waste will be disposed off under agreement with local authorities. However, the site for temporary disposal of hazardous waste must follow stricter requirements, namely, hazardous waste containers shall have secondary containment and the waste shall not be mixed with recyclable inert material. • Temporary disposal site must be agreed with relevant authorities • Waste oil to be carried to the closes recycling facility unnder the contract • The staff involved in waste handling, in particular in hazardous waste management, should receive adequate training in waste management and safety. • Used tires can be transferred to Heidelberg Cement enterprise, for use as fuel, based on agreement with the company's leadership	Contractor	No extra costs other than that related to removal of the waste from the site by waste removal service (under the contract) - required.	Monitoring of compliance with the waste management plan- records	During construction	No extra costs required	Contractor, supervision by RD
Establishment and operation of construction sites/camps	Camp	Production of non-hazardous domestic waste (food waste, packaging, plastic bottles, etc.)	• Development and implementation of waste management plan • Waste must be collected in waste containers fitted with lids to prevent scattering by wind, odour pollution and attraction of scavengers. The lid will also protect the waste from rain/snow. The containers should be located in a predefined area, remote from water bodies and away from traffic. • Briefing staff in good practice	Contractor	No extra costs other than that related to removal of the waste from the site by waste removal service (under the contract) - required.	Monitoring of compliance with the waste management plan - records	During construction	No extra costs required	Contractor, supervision by RD

Various construction activities	Along the RoW	Impacts on fauna (accidental deaths, reduction, loss or isolation of habitats, etc.)	• Trenches or pits, if made, should be fenced or protected to avoid entrapping and injuries of the fauna species. Bright coloured ribbons (for big animals - e.g. cattle); metal plastic and other shields/fences (for small animals) may be used. If, despite of the mentioned precautions, small animals turn to be entrapped, upon completion of the shift, planks or medium size twigs must be made available for the animals to escape from the pits/trenches after the night. Pits and trenches must be checked prior to filling up; • Special attention should be given to the avian fauna in the spring-summer (April to July), the season most sensitive for birds; • Construction in/near the riverbed should be avoided in the fish spawning season.(mainly autumn) • Monitoring of fauna on the new road section construction site. • Briefing staff in good practice	Contractor	No extra costs required	Monitoring of impact – casualties report	During construction	No extra costs required	Contractor, supervision by RD
Earthworks and various construction activities	Along alignmenr	, erosion, etc.	• Selection of a reasonable embankment height and stabilization of the slopes by hydroseeding; • Use of wooden shields for pits if they are very deep to preserve stability, as the case may be during the bridge construction; • Establishment of temporary berms, slope drains, temporary pipes, contour ditches, ditch checks, diversions, sediment traps etc. • Hydroseeding • Briefing staff in good practice	Contractor	No extra costs required. Will be covered by construction works budget.	Visual mnitoring	During construction	No extra costs required	Contractor, supervision by RD

C. Operation phase

Activity	Location	Environmental Issue	Mitigation measure	Responsible authority	Approx. Cost (GEL)	Monitoring			
						Monitoring measure	Frequency	Approx. Cost (GEL)	Responsible agency
Accidental fuel/oil spill and/or road-side litter washed off/blown off into the river	Surace water	Water pollution	• More frequent surface sweeping and the development of better cleaning methods; • Better control over truck traffic to minimize spills; • Culverts must be cleaned routinely, and repaired as far as required.	Contractor, supervision by RD	No extra costs – covered by maintenance budget	Visual Instrumental measuring – TSP and oil in water samples	12 months after commissioning (quarterly)	Cost of analysis by authorised laboratory	Contractor supervised by RD
Road/bridge resurfacing	Road/bridge	Water bodies pollution by heavy metals, hydrocarbons and debris	• Maintenance paving should be performed only in dry weather to prevent runoff contamination. • Proper staging techniques should be used to reduce the spread of paving materials during the repair of potholes and worn pavement. These can include covering storm drain inlets and manholes during paving operations, using erosion and sediment controls to decrease runoff from repair sites, and using drip pans, absorbent materials and other pollution prevention materials to limit leaks of paving materials and fluids from paving machines. • Resurfacing operations could include porous asphalt for potholes and shoulder repair to reduce the amount of storm water runoff from road systems.	Contractor, supervision by RD	No extra costs	Instrumental measuring Inspection Keeping records	During maintnance	No extra costs	Contractor supervised by RD

Transport emissions	RoW, settlements	Air pollution by transport emissions	• To keep greenery near settled areas;	Contractor, supervision by RD		Visual observation of the status og greenery	Quarterly instrumental measuring	Low cost	Contractor supervised by RD
Noise	Residential area	Impacts upon the human beings and natural receptors caused by increased noise levels.	• To protect residents along the 95 km to 114 km road section (mostly applies to the settlements of Ruisi, Aradeti and Agara.) from negative noise impacts noise mitigation measures should be applied-traffic velocity decrease in those sections where the noise limits are exceeded (see EIA report)	Contractor, supervision by RD	No extra cost	Instrumental measuring - day and night times (Within 750 m from the highway)	12 months after commissioning (quarterly) - Quarterly instrumental measuring of noise levels by day and night time	Low cost	Contractor supervised by RD
Littering	Alongthenew road	Possible negative impact on wildlife, water pollution	• Ensure that the community is aware of the range of ways to dispose of their waste correctly; • Inform the community of the level of fines that littering incurs; • Signage may be an element of a roadside litter prevention program, educating the community that littering is illegal, fines apply and behaviours are monitored. The signs may be suitable for placement in a series of two to four signs at 10 km intervals to repeat the message in different ways. • Cleanin up	Contractor, supervision by RD	No extra costs, the costs will be set in the terms of the contract agreement with the relative company	Visual	Throughout the year	No extra costs	Contractor supervised by RD

Condition of green buffers	Alongthenew road	Impact on vegetation Road kills of animals	• Removal of faded plants and re-plating. • Status of plants • Keep records of accidents. • Ifaccident hotspotswithlarge mammalsare identified, appropriate protectivemeasures shallbeelaborated (e.g.reflectors/localfencing, warningsigns, speedreduction etc.)	Contractor, supervision by RD	No extra costs – covered by maintenance budget	Visual observation Keep records of accidents.	Throughout the year Monthly drive through the highway section	No extra costs required	Contractor supervised by RD
Traffic	Alongallroad sections	Incidenceofaccidents dueto wintertypical hazards(snow,ice, fog)	Installation of warnimg signs Informing	Contractor, supervision by RD	Low cost	Keep records of accidents.	Winter period	No extra costs	Contractor supervised by RD

9.5 Monitoring, implementation

Objective of the monitoring is to control the impacts estimated during environmental assessment; evaluate efficiency of mitigation measures set in the EIA statement; detect unpredicted impacts and define measures to minimize, avoid or mitigate them.

Monitoring shall be done by supervisor. Construction and operation stages of the project - covered. The monitoring shall be provided at sensitive receptors. The monitoring data shall be submitted to the Roads Department. Any impact or failure of mitigation measures shall be identified, relevant remedial actions defined.

Monitoring shall include visual observation and measurements as appropriate. Field testers and hand-held equipment shall be used to monitor short- term impact. Calibrated equipment and approved methods of monitoring must be used. Calibration must be done requlary, all calibration records and monitoring results, along with the copies of the site resords, certificates, permits and documents - submitted and kept by the Roads Department.

The list of records must include:

- Work program and schedule;
- Environmental permits and licences;
- List of equipment;
- List of mitigation measures;
- Route/program of construction material transportation;
- Inspection records – noise, water quality monitoring data;
- Copies of correspondence related to environmental issues;
- Site drainage plan;
- Records of maintenance and cleaning schedules for sediment and oil/grease traps;
- Records of sewage disposal;
- Records of quantity of discharged wastewater and concentration of pollutants;
- Waste disposal records
- Written designation of waste disposal sites and instructions for waste transportation from local authorities;
- Air quality monitoring results;
- Log of material inventories and consumption;
- Chance find records (if any);
- Complaints register;
- Incidence register (environmental limits excedence forms, injuries records, etc);
- Records on remedial actions taken;
- Equipment control and maintenance log;

- Corrective and preventive action request records;
- Training records.

The preset frequency of monitoring can be revised based on reults of the observation data. In case of non-compliance with environmental quality performance criteria additional monitoring must be carried out.

9.6 Reporting

Contractor shall prepare monthly EMP status reports for submission to supervisor/ Roads Department. Based on the contractor's reports the supervisor prepares monthly reports on the status of EMP implementation and environmental performance of the contractor. Technical supervisor assess accuracy of information given in the contractor's reports, identifies gaps, evaluates adequacy of mitigation measures applied by contractor; highlights incompliance with EMPs, inform on any acute issues, and proposes corrective actions.

The reports must be handed over to environmental specialists of the Roads Department. Environmental specilaist of the RD every six months reports to the World Bank on the status of environmental compliance. The reports contain information on any violations and relevant corrective actions taken. The Roads Department is responsible to inform the World Bank on any major environmental issues at any time, independently from the schedule of regular reporting.

9.7 Remedies for EMP violation

Any violations identified through monitoring shall be remediated. Responsibility for enforcement of compliance and adherence of contractor to the EMP rests with Roads Department of the Ministry of Regional Development and Infrastructure. For minor infringements, the contractor will be given 48 hours to remedy the problem. In case restoration fails RD will arrange for another contractor to do provide restoration. The cost of works will be deduced from the offending contractor's payment. For infringements causing a long-term/irreversible damage financial penalty up to 1% of the contract value in addition to the cost for restoration activities will be set.

10 Stakeholders' consultation and disclosure

Stakeholder's consultation and disclosure will be conducted according to the World Bank policy, the Georgian laws and reasonable international practice. The framework for the EIA in Georgia is established by the legislation (see Chapter 2). The specific requirements are prescribed by three statutory acts: *On Environmental Impact Assessment (2009),On Carrying Out Ecological Expertise (2008),* and *Rules for Special Council ofEnvironmental Impact of the Ministry of Environment Protection (2008)*.

Two series of the meetings with community were held:

- *at the beginning of projectduring the EIA scoping process* to inform stakeholders about the project and seek their input in determining the scope of the EIA and design studies; The meetings were held on 22 of August and 15th of February in Kareli and on 9th of december in Agara
- at the*Draft Final Report stage*, to inform people about the likely impacts of the project and the way in which they will be mitigated, and to obtain their support to the measures as far as possible.Under the request from the World Bank, a meeting with community and other stakeholders was held on the 18th of January, 2012. Another meeting with community was scheduled and held in July 18, 2012.

During the EIA process, the RoadsDepartment was responsible for arrangement of the meetings including invitation to the participants, the venue and presentation equipment. Representatives from the Roads Department were participating in the the meetins and discussions.

The consultant (COWI Lietuva and GAMMA) was responsible for the development of a presentation in Georgian at each meeting; writing up leaflets in Georgian to be distributed at each meeting; preparation of the minutes of each meeting; incorporation of an account of the consultation process in the EIA report, identifying how each point was addressed in the EIA and/or engineering design, and providing valid reasons why any points were not addressed.

This report was prepared taking into account the commentaries and remarks received from the stakeholders. Minutes of the meetings and responses to the comments received from the Ministry of Environment of Georgia in enclosed (see Annex 3).

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