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

Rikoti Tunnel Rehabilitation Works
ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT PLAN

September 2009

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List of Acronyms

EA	Environmental Assessment
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental Supervision Management Plan
HSE	Health, Safety, Environment
HS	Health and Safety
GIS	Geographic Information System
GoG	Government of Georgia
HS	Health and Safety
IBRD	International Bank for Reconstruction and Development
IPPC	Integrated Pollution Prevention and Control
KP	Kilometer Post
MCSPM	Ministry of Culture, Sports and Protection of Monuments
MED	Ministry of Economic Development of Georgia
MoE/MEPNR	Ministry of Environmental Protection and Natural Resources of Georgia
MLHSA	Ministry of Labour, Health and Social Affairs
NGO	Non-Governmental Organization
QC/QA	Quality Control and Quality Assurance
RAP	Resettlement Action Plan
RD	Road Department of the Ministry of Regional Development and Infrastructure of Georgia
MRDIG	Ministry of Regional Development and Infrastructure of Georgia
RBG	Red Book of Georgia Protected Species
SIA	Social Impact Assessment
TEM	Trans-European Motorway
ToR	Terms of Reference
TRRC	Transport Reform and Rehabilitation Center of Georgia
WB	The World Bank

EXECUTIVE SUMMARY

Introduction

Due to its geographical position Georgia acquired the status of an important corridor connecting Europe with Asia. Consequently, development of the transport infrastructure becomes a priority issue for the Government of Georgia. The Government of Georgia has requested the International Bank of Reconstruction and Development (IBRD) of the World Bank to support modernization of the East-West Transport Corridor.

This Environmental Impact Assessment (EIA) Report is an integral part of the detailed studies carried out in relation with the rehabilitation of existing road tunnel (so called "Rikoti Tunnel") located at KP-143 of the East-West Highway (E-60). The EIA determines the types of environmental impacts and provides respective mitigation measures.
The EIA Report, which includes an Environmental Management Plan, addresses the needs of applicable laws and regulations of Georgia and considers the relevant provisions of the World Bank Operational Manual.

Legal Context

The EIA was carried out in accordance with requirements of the current Georgian environmental legislation, as well as the World Bank's safeguard policies and the international good practice.

Public Consultation

Public consultation is an integral part of the EIA process. It contributes to early identification of problematic issues and due discussion of proposed mitigation measures. From the project outset stages, it is necessary to create a basis of mutual understanding with a view to establishing good, long-term relationships in future. Present EIA report was disclosed in-country and a consolation meeting with stakeholder communities was held.

Project Description

Study of the technical condition of Rikoti Tunnel located at Km-143 of Tbilisi-Leselidze Highway (E-60) revealed that the present state of this tunnel fails to comply with prevailing minimum safety standards and requires major rehabilitation. The Government applied to the World Bank for support in developing the detail design and securing finance for rehabilitation of existing highway tunnel located at km 143 of Tbilisi-Leselidze Highway.

The project foresees rehabilitation of the two-lane road tunnel according to the international standards. Total length of the tunnel under rehabilitation is 1,782 m. During rehabilitation works, the road traffic will be diverted using the existing bypass road, which was used by vehicles prior to construction of the tunnel, as well as currently during scheduled tunnel maintenance works.

The scope of tunnel rehabilitation works includes removal of the damaged section of tunnel lining and pavement, rehabilitation of the existing storm water system over its whole length, stabilization of the tunnel walls using the modern precast concrete structures, construction of the road with concrete pavement, installation of the tunnel ventilation and lighting systems aligned

with up-to-date requirements, and construction of the drainage facility for storm water exceeding the tunnel.

Tunnel Operation

One of the main goals of tunnel rehabilitation works is to minimize the need for intervention into its operation and maintenance. During operation the preference will be given to ensuring the road traffic safety and its environmental performance, which shall be carried out in full compliance with legal requirements and the best applicable industry practices.

The regular technical control over operational conditions of the tunnel will be exercised through supervision and inspection procedures.

A new mechanical ventilation system is designed with a separate fresh air duct and exhaust air duct for the fire case. An air monitoring system will be installed for measurement of carbon monoxide and visibility levels to form the basis of control for ventilation. The objective of the ventilation system is to dilute or remove harmful substances contained in exhaust gas from vehicles, in order to prevent the harmful substances from injuring the health of tunnel users and maintenance personnel and to maintain good visibility in tunnels. Due to the length of the tunnel and considering that the tunnel will be for indefinitely time used as bi-directional tube, semi-transverse ventilation systems are required in accordance to European safety standards to cope with the fire safety and smoke evacuation requirements.

To improve safety and to attain the minimum safety requirements for tunnels in the Trans-European Road Network, following measures are foreseen in accordance to the German Standard for tunnels (RABT 2006):

- Construction of emergency call niches
- Provision of hydrants near the portals and inside in niches
- Provision of state-of-the-art tunnel lighting, consisting of normal, safety and evacuation lighting
- Provision of traffic control, communications and information systems

A tunnel drainage system is designed for separate collection of ground water and surface water. The ground water will be collected in longitudinal drains along the sidewalls and discharged into the main ground water collector. The oil separator is provided to collect tanker spillages and tunnel wash down water.

Project Alternatives

Since the project scope aims only at rehabilitation of the existing Rikoti tunnel, there were no in-depth discussions held for an alternative alignment of the Rikoti Tunnel. The existing bypass road has been considered to be the only alternative. However, neither the parameters of the bypass road met the minimum required design standards nor required traffic safety conditions can be achieved.

As for ‘do nothing’ or ‘without project’ options, they may not be considered as genuine alternatives since the tunnel is in emergency condition and rehabilitation is required to keep the tunnel operational.

Overall 6 technical alternatives numbered A through D, D+ and D+optimized were considered:

Alternative A. The existing tunnel roof is strengthened by a new 25 cm thick reinforced shotcrete inner lining. The hollow spaces between the existing roof and the in-situ rock are filled in. The complete foundation and the drainage are renewed.

Alternative B. The existing tunnel lining is demolished and replaced by a new 35 cm thick reinforced in-situ concrete lining after the existing overhanging rock is made safe. The entire floor and drainage are renewed.

Above cost reduced alternatives are not in accordance with modern safety and design standards.

Alternative C. With this variation the inner shell is strengthened by a surface applied 15 cm thick reinforced layer of shotcrete after the demolition of the intermediate ceiling.

Alternative D. With this variation the inner shell is strengthened by a new 25 cm thick reinforced in-situ concrete inner shell, after demolishing the intermediate ceiling. Before building in the in-situ concrete shell the loose rendering is removed by high pressure washing and taken away. For the draining of the embrasure a layer of Enkadrain and the waterproofing system is built in around the entire area of the tunnel behind the in-situ concrete shell for collection through a mountain water drain.

Alternative D plus. In order to improve the earthquake resistance of the alternative D additional backfilling of the gap between the tunnel lining and the surrounding rock is envisaged. The sequence of the work is equivalent to alternative D with the exception that prior to demolition of the carriageway the existing hollow space shall be filled with cement mortar or rapid hardening in 1 meter steps from bottom to top alternatively behind the south tunnel wall or likewise the north tunnel wall.

Alternative D plus optimized. Due to the strong call for a ventilation system which ensure state-of-the-art controls of smoke in the event of fire and safety for tunnel user, an additional alternative with semi transverse ventilation system based on alternative D plus was developed. The semi transverse system comprises of a supply duct, whilst the whole traffic space acts as the exhaust duct, discharging to the tunnel portals. In the event of fire smoke will be discharged into the smoke exhaust air duct.

A multi-criteria analysis (MCA) was carried out to select the most favorable tunnel rehabilitation alternative, by identifying, weighting, scoring, mutually multiplying and summarizing products of weights and scores to derive rank points measuring assessment criteria against set project objectives as well as for correspondence of various alternatives with modern safety and tunnel standards. Weighting was applied to construction costs as well to account for budget constraints.

In view of the best technical and cost effective solution, alternative D-plus optimized was proposed as the highest ranked alternative while other lower cost alternatives were discarded primarily due to serious safety concerns in view of earthquake and fire safety.

The EIA takes therefore as the basis the tunnel rehabilitation alternative D plus optimized, which includes:

- demolishing of false ceiling (air duct), asphalt pavement and concrete tunnel base

- backfilling of gaps between lining and surrounding rock
- excavation in rock at tunnel base
- construction of new tunnel lining
- installation of waterproof membrane
- construction of new concrete pavement
- construction of semi-traverse ventilation system
- provision and installation of state-of-the art mechanical and electrical tunnel systems

Environmental Baseline

Prior to commencement of any project activities, it is important to identify the existing conditions of natural environment, known as the "baseline". The baseline environmental conditions have been considered in conjunction with the planned project works to determine potential impact types.

The natural environment prevailing along the proposed route is characterized by diverse physical conditions, although with lesser developed biodiversity.

During the process of assessment of the environment baseline the following components have been considered:

- Climate and meteorology;
- Geology and geomorphology;
- Seismicity;
- Hydrogeology;
- Hydrology and surface waters;
- Topsoil;
- Cultural and archaeological monuments;
- Flora and fauna;
- Noise;
- Ambient air.

Detailed information on the above issues is provided in the main part of the Report.

Impact Types and Mitigation Measures

The main approach adopted by Project regarding environmental impact aims at ensuring prevention, elimination or minimization of the impacts during design, construction and operation of the road tunnel.

The major documents of the EIA describe environmental impacts and mitigation measures for various project stages, including contractor's mobilization (construction of camps, access roads, vehicle parking sites, etc.), tunnel rehabilitation works and tunnel operation. Also, it is stated that no adverse social impact is expected during works progress as the distances to the nearest villages Chumateleti and Khevi located at the east and west of tunnel are about 2.5 and 5.0 kilometers respectively.

The mitigation measures have been developed and integrated into Project during design stage taking into account the variety, location and sensitivity of environmental receptors.

The mitigation measures applicable to potential impacts cover the reconstruction of the bypass road required for ensuring unrestricted flow of road traffic during tunnel rehabilitation stage, as well as the tunnel rehabilitation works. During developing the mitigation measures, high attention was paid to disposal of concrete waste removed from the damaged tunnel lining, and particularly to temporary storage of dismantled asbestos cement pipes (680 m of diameter 146 mm pipes) connected to 500 mm diameter metal central storm water main.

Another set of developed mitigation measures aimed at reduction of impacts generated due to establishing the temporary construction camp. In addition to above, the mitigation measures have been prepared to reduce adverse impacts on personnel safety, reinstatement of the areas used for construction activities and impacts caused by domestic wastes.

Key environmental impacts of the project during the *construction phase* are related to the need to:

TUNNEL:
- Safe dismantling and deposal of dia. 146 mm total 680 m asbestos-cement drain piping;
- Air pollution inside the tunnel during construction and impacts on health, safety, environment;
- Fire and smoke emergency and evacuation needs in case of accident;
- Potential increase in drainage while demolishing works with need in wastewater treatment;
- Concrete and rock disposal generated from tunnel demolishing works (ca. 20,000 cub. m);
- Impacts on soil from temporary stockpiling of inert construction waste;
- Spread of roadside lead pollution unless soil disturbance is contained within the site.
- Generation of non-hazardous household waste from temporary construction camp operation;
- Risk of releasing hazardous materials from temporary camp operation, refueling, maintenance;
- Disposal of wastewater from temporary construction camp operation (approx. 2 m^3 per day);
- Range of sanitary and hygiene as well as health and safety concerns for the workforce.

BYPASS:
- Need of cutting trees (estimated to 40 specimens)
- Surplus rock & soil generated at curvature cuts (estimated at 5,800. 4,200 m^3 for disposal);
- Rock fall, erosion, landslide and other hazard instigation risks at curvature widening works;
- Inadequate and insufficient drainage to divert surface waters from the road and ditches;
- Impacts from the operation of the mobile asphalt plant (depends on choices by contractor).

Impacts of the project during the *operation phase* are related to:

TUNNEL:
- Noise;
- Air quality inside the tunnel;
- Drainage waters;
- Serious concern is related to tunnel safety and emergency response in case of accident or fire.

BYPASS:
- As the bypass road is already existing and will have limited use after construction of tunnel rehabilitation works the operational phase impacts resulting from the bypass road are only minor and can be neglected, provided rock fall, erosion, landslide and other hazard risks are not instigated during construction and that adequate site stabilization is achieved.

Positive impacts of the tunnel rehabilitation are described further below.

Environmental Management Plan and RD Supervision Arrangements

Environmental Management Plan consists of two main components.

First component was developed within the Project framework and comprises the mitigation measures themselves as described in the Environmental Management and Monitoring Plan.

The second component consists of Capacity Development and Training Plan, as well as, specifies contents for the series of Environmental Management Plans for different issues (e.g. traffic management, reinstatement management, waste management and pollution prevention, sometimes referred to as "Procedures"). These Environmental Management Plans are not yet available to Roads Department and therefore cannot be developed prior to selection. One of the key recommendations of the Capacity Development and Training Plan is to call for development of roads infrastructure specific General EMPs for the RD operations in future. The contractors may have different capacities, different internal safety and environmental procedures, and different work plans applicable to tunnel rehabilitation works, therefore these plans would need to be submitted and cleared with the RD and project sponsors before site possession and initiation of works. In addition, it is recommended that the awarded contractor will work closely with the Roads Department during the mobilization period to develop detailed site-specific Environmental Management Plans further based on:

- Mitigation measures provided in the EIA;
- General Environmental Management Plans, which goals and objectives are outlined in the specific chapter of this EIA titled as "Contractor's Environmental and Social Management Plans";
- Contractor's own work plan and construction methods for specific contractual/road sections.

The above scheme needs to be supplemented by construction- and operation-period monitoring reports, which describe how mitigation measures have been implemented and how effective they are. The reports will be produced by the Roads Department commissioned environmental supervision and monitoring teams according to a prescribed format and will be submitted to the contract managers and to the regulatory agencies.

Organization chart for EMP implementation is proposed in the EIA for construction phase. Institutional setup and management measures for this project can be summarized as follows:

- Enhancement of the of Roads Department environmental, health and safety supervisory competency (by engagement of external environmental supervisory consultant, as well as by establishing the environmental supervision unit at the Roads Department) and by development of the environmental and HS supervision plan as part of the overall project supervision plan;
- Minimum two environmental inspectors/officers would be required in the team, reporting to designated Environmental Supervisor (latter directly reporting to RD Project Manager);
- Direct on-site instructions and direct issuance of Corrective and/or Preventive Action Requests would be the mechanisms for instructing the contractor and managing supervision;

- Supervision funds should come from RD budget or appraised as part of the IBRD project (including funds for personnel, their equipment and mobility);
- Assessment of contractor's HSE management capabilities before final selection is needed;
- Close supervision & training of contractor personnel if specific gaps are detected in capabilities and in understanding of environmental and HS requirements;
- Equivalent arrangements are required to manage HS supervision matters;
- Collision and Fire Accident Emergency Response Plan should be developed for the operation of the tunnel by the RD and related costs could be leveraged through donor funds.

Separate table is provided in the EMP with environmental mitigation and other measures (such as RD supervision) and related cost estimates for inclusion in the project s well as in the bidding document and in the construction contract.

In order to convey EMP provisions into construction contract following arrangements are proposed:

- Bidding Document should provide that for major infringements there will be a financial penalty up to 1% of the contract value in addition to the cost for restoration activities.
- Key mitigation items listed in the EMP shall be included in the Bill of Quantity.
- The mechanism is proposed to withhold 5% from due payments in case Corrective or Preventive Action Requests are opened and not acted upon within reasonable deadlines set.
- Subcontracting of the regular waste collection services should be required at bidding stage.
- Key personnel to include environmental & HS managers and to be interview at negotiations.
- Equipment should be checked against environmental & HS compliance before contact signing.

Conclusion

Based on results of environmental assessment, it may be stated that the majority of potential environmental impacts attributed to the proposed tunnel rehabilitation activities are likely to occur during rehabilitation works and mainly will be of temporary nature. Implementation of the proper mitigation measures during design and rehabilitation stages will ensure reduction of the adverse project impacts to acceptable levels. The project impact will be manageable if all proposed mitigation measures and monitoring activities are implemented properly.

Moreover, the tunnel rehabilitation measures will enhance traffic safety by:

- improvement of lightening system of the tunnel;
- installation of modern ventilation system, which lower pollution levels in the tunnel;
- waterproofing of the tunnel leading to dry tunnel and discharge of uncontaminated groundwater in the nearby streams;
- better tunnel monitoring will lead to quicker response time in case of accidents or mishaps;
- reducing travel time due to improved tunnel condition.

1. INTRODUCTION

Due to its geographical position Georgia acquired the status of an important corridor connecting Europe with Asia. Consequently, development of the transport infrastructure becomes a priority issue for the Government of Georgia. The Government of Georgia has requested the International Bank of Reconstruction and Development (IBRD) of the World Bank to support modernization of the East-West Transport Corridor.

Roads are one of the most important forms of transport infrastructure, since the motor transport plays an outstanding role in freight service. The increased demand on freight service put the necessity of reconstruction of the existing roads including structures belonging to it and construction of new safe sections where needed on the agenda.

The present Environmental Impact Assessment (EIA) report is a part of the detailed studies connected with the rehabilitation and upgrading of the so-called Rikoti Tunnel located at km 143 of the East-West (E-60) Highway, which is one of the main ways for vehicle traffic between East and West Georgia during winter months.

The project will include rehabilitation and upgrading of the existing Rikoti Tunnel to European safety standards. The project will also include improvement of the existing tunnel bypass road, which will be used as for traffic diversion during the works within the tunnel.

The objective of this Environmental Impact Assessment is to address the environmental impacts, mitigation measures and environmental management issues associated with the project. The EIA Report, which includes an Environmental Management Plan addresses the needs of applicable laws and regulations of Georgia and considers the relevant provisions of the World Bank Operational Manual.

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

2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1. Environmental Policy and Legislation of Georgia

According to the Georgian legislation during the planning and implementation process the investor/project proponent is obliged to take adequate measures for reduction or elimination of the probability of impact on the environment and human health. At present the requirements related to environmental permitting and public participation are being revised for the purpose of putting them in compliance with the international standards and environmental conventions.

The Law of Georgia on Environmental Protection is also called framework law (adopted on December 6, 1996) that regulates the legal relationship between the bodies of the state authority and the physical persons or legal entities in the scope of environmental protection and in the use of nature. It applies to all Georgia's territory including its territorial waters, airspace, continental shelf and special economic zone.

The Law discusses the aspects of environmental education, environmental management; describes the economic sanctions, licensing, standards, results of Environmental Impact Assessment; it also discusses the various aspects of protection of natural ecosystems, habitats to be protected, the issues of global and regional management, protection of the ozone layer, protection of biodiversity, protection of the Black Sea, and aspects of the regional cooperation.

On December 14, 2004 a number of changes have been introduced into this Law. According to Article 35, the term "environmental permit" has been changed to "environmental impact permit" and therefore the new version of the Article 37 of the Law says: Environmental Impact Assessment shall be carried out prior to issuing environmental impact permit for the proposed activity to prevent or minimize the harmful impact on the environment.

The Law of Georgia on Licensing and Permits (02.08.2005). The Law determined all the permits and licenses characteristic for the field and general procedure for issuing them. The law developed the procedures for the duration of permits and issues connected with the terms of decision-making.

The Law of Georgia on Environmental Impact Permits has been prepared on the basis of changes introduced into the Law of Georgia on Environmental Protection and is active since January 1, 2008. The Law establishes the procedure of obtaining environmental impact permits. In particular, the Article 4 deals with the activities subject to ecological expertise and bodies authorized for granting rights on implementation of the activities. The Article describes the procedure of obtaining environmental impact permits, including: public discussion of the EIA report; rules for documenting the results of public discussion of the EIA report; the list of documents required for obtaining permits; the rule of issuing permits; the EIA procedure and the requirements for the content of the EIA report; exemption of the activity from EIA; duties and responsibilities of the project proponent; duties and responsibilities of the permit issuing authority; etc.

Provision on Environmental Impact Assessment (was constituted on March 16, 2009). The provision determines the goals and objectives related with the Environmental Impact Assessment, its principles and methods. The document gives a detailed description of the

assessment process, the form of an EIA report necessary for obtaining the environmental impact permission and its structure. The provision specifies that an executor shall be responsible for financing organization of the environmental impact assessment process as well as the assessment works.

The Law of Georgia on Ecological Expertise (active since January 1, 2008) replaced the Law of Georgia on State Ecological Expertise. The Law defined the basic principles of ecological expertise; identifies organizations responsible for ecological expertise, determines their duties and responsibilities; establishes the rules for conducting ecological expertise; identifies independent experts; determines the conclusion of ecological expertise; establishes the duties and responsibilities of those involved in the process of ecological expertise, etc.

The Law of Georgia on Water (was constituted on January 1, 1997). The Law regulates issues of water consumption. It determines the rights and obligations of a consumer, establishes types of licenses and rules necessary for water consumption, considers conditions and rules for drawing up licensees, determines preventive aspects, temporary suspension, abolition, conditions for deprivation and cancellation. The law also regulates water costs.

The Law of Georgia on Ambient Air Protection (was constituted on June 22, 1999). The Law regulates issues connected with the ambient air protection from detrimental man's impact within the whole territory of Georgia (part I, chapter I, article 1.1). Detrimental man's impact implies impacts caused by human activities against the ambient air. It has or shall possibly have negative effects upon human health and environment (part II, chapter IV, article 11.1).

Table 2-1. Types of harmful impact (Part II, chapter IV, article 11.2).

Pollution of Ambient Air with hazardous substances
Impacts of radiation against ambient air
Pollution of ambient air with microorganisms and substances of microbial origin
Impacts of noise, vibration, electromagnetic fields and other physical impacts upon ambient air

Pollution of atmospheric air is the emission of any substances into the ambient air caused by human activities. The emissions shall possibly have negative effects against human health and natural environment (part II, chapter IV, article 12.1).

In connection with the present law, on January 1, 2008 was constituted the Law of Georgia on Correcting the Law of Georgia on the Ambient Air Protection. A whole number of issues was developed and formulated in the articles 30, 36, 45, 48 and 50.

The Provision on Impact Assessment Regime Violations. The provision is led into the Code of Administrative Violations of Georgia and in the criminal Procedure Code. In particular, in the Code of Administrative Violations of Georgia (chapter VIII) determines the responsibility for the agent if he has no corresponding permit for acting in the vicinity of sensitive environment and historical and cultural monuments.

According to the Criminal Code of Georgia (chapter 51-592, article 287, 360) in case of carrying out activities without having an environmental impact permit and illegal usage of natural resources, responsibility shall be imposed upon the agent.

Qualitative standards of the state of the environment determine the requirements for the qualitative state of the environment and define the maximal allowable concentrations of substances harmful for human health and the environment in water, air and soil.

2.2. Government Authorities Responsible for Assessing the Environmental Impact Conditions

The government agencies responsible for assessing the environmental impact conditions will be as follows:

Archaeological Research Center of the Ministry of Culture and Sports is responsible for supervise activities connected with construction works to protect the archaeological heritage of the state;

National Service Center for Food Safety, Veterinary and Plant Protection under the Ministry of Agriculture of Georgia. The Center is responsible for fulfilling sanitary protection connected with activities;

The Ministry of Environmental Protection and the Ministry of Internal Affairs. The Ministries are responsible for working out strategies and plans and carrying out them in cases of emergency.

2.3. World Bank Environmental Policies and Guidelines

The Project has been classified as a Category B project under the provisions of the World Bank's OP 4.01. The potential adverse impacts of Category B projects on human populations or environmentally important areas are considered less adverse than those of Category A projects. Such impacts are site-specific; few if any of them are irreversible; and in most cases mitigation measures can be designed more readily than for Category A projects. The scope of EA examines the project's potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate or compensate for adverse impacts and improve environmental performance.[1] An Environmental Management Plan detailing the mitigation measures, monitoring program, institutional strengthening and implementation schedule and costs are included in this EA. Table 2-2 provides checklist of safeguards triggered by this project.

Table 2-2. WB environmental and social safeguard guidelines checklist

The Safeguard Policies Triggered	YES	NO	TBD
Environmental Assessment (OP/BP 4.10)	X	O	O
Natural Habitats (OP/BP 4.04)	O	X	O
Forests (OP/BP 4.36)	O	X	O
Physical Cultural Property (OP/BP 4.11)	O	X	O
Involuntary Resettlement (OP/BP 4.12)	X	O	O
Policy on Disclosure of Information	X	O	O

[1] The World Bank Operational Manual: Operational Policies (OP) 4.01, January 1999 (as revised in August 2004).

The EA report will be presented to both the Government of Georgia and WB and shall serve as a background document for approval by the competent authority (MoE). The Government of Georgia (GoG) will have to make the draft EA Report available in Georgia at a public place accessible to project-affected groups and local NGOs in accordance with OP/BP 4.01, Environmental Assessment. The GoG must also officially transmit the EA report to the Bank before the Bank begins formal appraisal of the project. Once the EA report has been locally disclosed and officially received by the Bank, the Bank will also make it available to the public before it begins formal appraisal of the project.

The present EIA report has been disclosed both in Georgia and through the WB database. Public consultation was also conducted. Stakeholders received exhaustive responses to questions pertaining the EIA report and EMP. There were no comments calling for the revision of the EIA report.

3. EIA METHODOLOGY & APPROACH

The methodology used in this EIA study follows the provisions given in the TOR and relevant international principles as documented in different World Bank technical papers and in the European Union Council Directive 97/11/EC on the assessment of the effects of certain public and private projects on the environment. In addition the EIA addresses the needs of applicable laws and regulations of the Government of Georgia and considers the relevant provisions of the World Bank Operational Manual. Relevant provisions are laid down in the Operational Policies/Bank Procedures for Environmental Safeguard, Environmental Assessment, Natural Habitats, Forests, Pest Management and Physical Cultural Resources.

Based on the baseline information and the legal framework the EIA examines the project's potential negative and positive environmental impacts and recommends measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and to improve environmental performance.

Environmental Impact Assessment is one of the most important issues in the process of project development. The project proponent contractor is responsible for development of environmental assessment where all aspects of adverse impacts of construction and operation of the projected road section on natural environment and their management will be identified and mitigated. The contractor appointed to construct the road shall develop the environmental impact management plan following guidelines set out in the EIA report.

This Environmental assessment reflects and meets the requirements of the Georgian legislation and orders and instructions of the Georgian Government, as well as requirements established in the relevant World Bank documents. These include:

- Operational manual on environmental assessment (OP 4.01, January, 1999);
- Operational manual on natural habitats (OP/BP 4.04);
- Handbook on Management of Cultural Property in Bank-financed Projects (OPN 11.03, August, 1999);
- Handbook on Information Disclosure (December, 2002);
- and others.

As for the Environmental Impact Assessment, its purpose is to:

- examine the project's potential negative and positive environmental impacts and recommend any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and to improve environmental performance;
- propose technical information and recommendations for selection and designing of the best option from several alternatives;
- develop the Environmental Management Plan, which will include: mitigation programme, monitoring (self-monitoring) plan and technical assistance programme, as well as description of the institutional set-up.

During implementation of environmental activities the guidelines provided in the following documents shall be taken into account:

National standards:

See relevant Georgian Laws and Orders and Ordinances of the Georgian Government above.

Applicable international standards (World Bank Safeguard Policies) & guidance:

- General introduction into the World Bank Safeguard Policies.
  Permanent weblink: http://go.worldbank.org/WTA1ODE7T0

- OP/BP 4.10 Environmental Assessment.
  Permanent weblink: http://go.worldbank.org/K7F3DCUDD0

- Sourcebook on Environmental Assessment.
  Permanent weblink: http://go.worldbank.org/D10M0X2V10

- OP/BP 4.12 Involuntary Resettlement.
  Permanent weblink: http://go.worldbank.org/GM0OEIY580

- OP/BP 4.04 Natural Habitats.
  Permanent weblink: http://go.worldbank.org/PS1EF2UHY0

- OPN 4.11 Physical Cultural Resources.
  Permanent weblink: http://go.worldbank.org/UBUBZD7NA0

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- The World Bank Policy on Disclosure of Information.
  Permanent weblink: http://go.worldbank.org/GI2KQOD6X0

Other project related guidelines and manuals of the World Bank:

- The World Bank Handbook on Information Disclosure.
  Permanent weblink:

- Good Practice Note: Asbestos: Occupational and Community Health Issues.
  http://siteresources.worldbank.org/EXTPOPS/Resources/AsbestosGuidanceNoteFinal.pdf

- Handbook on Roads and Environment.
  Permanent weblink: http://go.worldbank.org/7989W6YLJ1

During the assessment the project's medium and long-term, permanent and temporary, positive and negative impacts are considered.

In accordance with the policy of international donors, both national and international standards are used in assessment of the level of impacts and development of relevant mitigation measures.

4. PROJECT DESCRIPTION

4.1 Background

The Rikoti Highway Tunnel is approximately 1,782 m long and was built in 1982 under rather complicated geological conditions. The existing tunnel profile is horseshoe-shaped with a tunnel width between 9.84 m and 10.40 m. In many places the tunnel walls are not vertical and inclined towards the roadway, which causes additional reduction of the tunnel clearance.

The lining of the Rikoti tunnel is of concrete and at the portal parts of reinforced concrete, which is partly covered with sprayed concrete. The thickness of the concrete varies between 0.55 m and 1.35 m. The quality of the concrete is low and inhomogeneous. The tested average concrete strength corresponds to the concrete class B15.

Geotechnical investigations revealed that for large parts of the tunnel gaps between the tunnel lining and rock mass exist. Based on the existing information, injection activities intended for filling these gaps ware occasionally done from 1996 to 2004.

Tunnel is ventilated by means of four very old soviet BOD-21M type fans (two operating, two spare) located in ventilation duct of the arch. The tunnel is lighted by РКУ-250 type lighting fixtures composed of DPL-400 type cold lighting lamps being rather obsolete at present.

Currently, the Tunnel is in emergency condition, because rehabilitation works have not been practically undertaken since it was built.

The Rikoti tunnel crosses the Likhi Range (1 180 m from the sea level). which is a watershed between eastern and western parts of Georgia. The eastern tunnel face is situated at the 143-km mark of the Tbilisi-Leselidze Highway Its coordinates are:

- North 40^0 03' 09"
- East 43^0 29' 49"

The area over the tunnel as well as both sides along the construction are covered with broad-leaved forest.

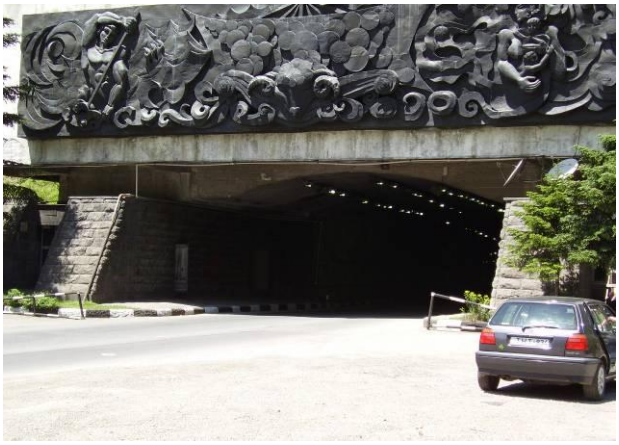


Figure 4-1:
Eastern tunnel face of the Rikoti Tunnel.

Figure 4-2:
Western tunnel face of the Rikoti Tunnel

The environment and landscape around and above the tunnel area belongs to well-known Surami Ridge, which represents "natural bridge" between the Greater and Lesser Caucasus and which is substantially contributing into biodiversity of Caucasus by essentially connecting and providing natural transition gradient between these quite different mountain ecosystems. The area is dominated by forests under relatively low human pressure, represented by mixed foliage trees like chestnut, beech, alder, hornbeam, lime-tree, ash-tree, Georgian oak. Tunnel construction and operation contributes significantly to restoration of the fragmentation of these forest habitats disconnecting by bypass road construction in the period before tunnel was put in place.

The eastern part of the tunnel goes into Khashuri Region and the western part goes into Kharagauli Region. The nearest village from the eastern part of the tunnel is Chumateleti. It is situated about 2.5 km from the tunnel. Chumateleti is the popular stopping place for both heavy load and light vehicles moving in east-west in both directions as it provides convenient place to for passengers to take lunch. Local economy is heavily dependent on these roadside services. Surami is the next settlement and is popular locally in Georgia with its excellent air quality and recreation beloved by families with small kids – pine trees proving natural air filtration for children with lung and other health problems. Surami is regarded as popular local tourist destination in Georgia, primarily due to relative proximity to Tbilisi. As for the western part, the nearest village called Khevi is located in a distance of about 5 km from the tunnel.

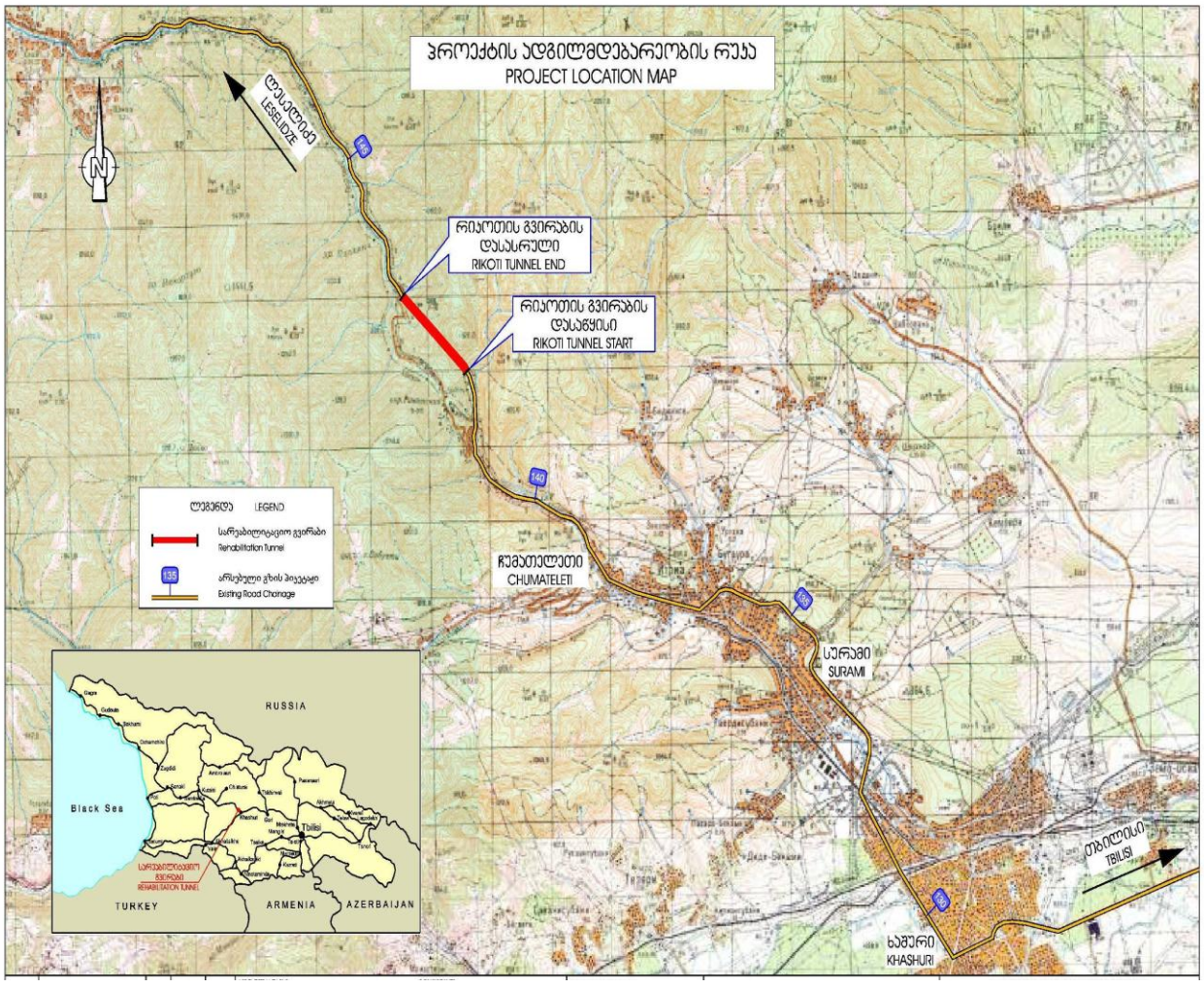


Figure 4-3 Tunnel location map

4.2 Traffic Volume

Traffic surveys were carried out to obtain information regarding traffic intensity and types of the vehicles using the tunnel on May 24-25 and May 25-26 of 2009.

Information about the present and forecasted traffic is given in Tables 4-1 and 4-2. Vehicles were classified and counted in order to evaluate the intensiveness of the road twice. The observations were carried out along the existing road at the eastern portal of the Rikoti Tunnel. However, the presented data take not into account the seasonal variability and reflects not adjusted daily traffic counts.

Table 4-1: Traffic intensiveness changes during 24 hours at the Rikoti Tunnel (May 24-25, 2009).

#	time, hr	Traffic intensiveness, vehicle/hr					
		Passenger car	Minibus, Pick-up	Bus, Truck	Trailer (longer than 14 meters)	Other	Sum
1.	07-08	131	10	12	37	36	226
2.	08-09	145	23	8	19	34	229
3.	09-10	188	30	6	33	28	285
4.	10-11	213	41	12	15	35	316
5.	11-12	193	36	9	12	40	290
6.	12-13	195	44	9	13	26	287
7.	13-14	178	26	9	19	52	284
8.	14-15	221	41	9	6	48	325
9.	15-16	217	28	4	0	49	298
10.	16-17	198	35	8	2	46	289
11.	17-18	179	38	6	0	33	256
12.	18-19	157	22	6	0	34	219
13.	19-20	151	28	9	0	19	197
14.	20-21	90	18	5	0	16	129
15.	21-22	61	11	4	1	6	83
16.	22-23	45	8	3	0	10	66
17.	23-00	26	3	4	1	4	38
18.	00-01	18	7	3	2	2	32
19.	01-02	23	3	4	5	2	37
20.	02-03	18	1	3	4	7	33
21.	03-04	16	5	12	10	7	50
22.	04-05	42	14	11	32	26	125
23.	05-06	65	13	15	37	44	174
24.	06-07	85	16	3	37	28	169
	Total	2855	501	174	285	632	4437

Table 4-2: Traffic intensiveness changes during 24 hours at the Rikoti Tunnel (May 25-26, 2009)

#	Time, hr	Traffic intensiveness, vehicle/hr					
		Passenger car	Micro bus, Pick-up	Bus, Truck	Trailer (longer than 14 meters)	Other	Sum
1.	07-08	185	25	9	15	31	265
2.	08-09	198	35	4	12	25	274
3.	09-10	230	41	7	14	20	312
4.	10-11	185	36	22	38	21	302
5.	11-12	199	39	16	36	29	319
6.	12-13	186	45	22	42	27	322
7.	13-14	209	33	11	31	34	318
8.	14-15	220	31	15	14	25	305
9.	15-16	235	48	11	19	33	346
10.	16-17	225	31	19	11	42	328
11.	17-18	193	30	12	28	32	295
12.	18-19	166	17	23	22	28	256
13.	19-20	114	27	12	30	14	197
14.	20-21	88	18	14	27	19	166
15.	21-22	81	16	12	25	11	145
16.	22-23	53	14	10	11	12	100
17.	23-00	32	11	5	13	5	66
18.	00-01	31	10	7	10	2	60
19.	01-02	23	6	7	11	4	51
20.	02-03	33	12	15	14	8	82
21.	03-04	33	9	5	4	0	51
22.	04-05	37	10	5	3	6	61
23.	05-06	95	12	7	17	14	145
24.	06-07	163	24	10	16	28	241
	Total	3214	580	280	463	470	5007

Table 4-3 below gives an annual average daily traffic for the tunnel section.

Table 4.3: Current and forecasted traffic at the tunnel.

Types of vehicles	**Traffic intensiveness of the tunnel at the present moment**		**Traffic intensiveness of the tunnel in case of rehabilitation**	
Years	2009	2010*	Years	2009
Total quantity of cars	5505	5664	Total quantity of cars	5505

4.3 Project Components and Implementation Schedule

The project consists of two parts. The first part consist of the tunnel rehabilitation works, whereas the second part of the project foresees partial improvement of the tunnel bypass road between km 141+900 and km 144+850.

During tunnel rehabilitation works closure of the tunnel at least for certain periods are necessary. Therefore the improvement of the tunnel bypass road is an important factor during tunnel rehabilitation to maintain uninterrupted traffic. It should be pointed out that improvement of the bypass road shall be carried out before tunnel rehabilitation works commenced.

Tunnel rehabilitation works are planned to commence by the end of February 2010 and to complete by the end of the year 2011.

4.4 Tunnel Rehabilitation Measures

Tunnel degradation has advanced to a point where repairing of the tunnel is urgent required. The whole length of the tunnel to be rehabilitation is about 1,750 m. The project foresees rehabilitation of the two-lane road tunnel according to the international standards. During the rehabilitation works traffic shall be diverted to the existing bypass road that was used before the tunnel was constructed.

The number of traffic lanes will be maintained inside and outside the tunnel. The dimensions of the tunnel will be as follows:

Vertical clearance:	4.50 m
Lane width:	3.50 m plus 0.25 m hard shoulder

In order to improve the earthquake resistance backfilling of the existing gap between the tunnel lining and the surrounding rock is envisaged. The gap shall be filled with cement mortar in 1.5 meter steps from bottom to top alternatively behind the south tunnel wall or likewise the north tunnel wall.

Rehabilitation works includes removal of tunnel base and false ceiling of the air duct, rehabilitation of drainage and mountainous water collecting systems, installation of a waterproof membrane to protect the tunnel from water infiltration, strengthening the tunnel walls by means of reinforced concrete linings, construction of concrete pavement, installation of ventilation and lighting systems, provision of traffic control, communications and information systems meeting European safety requirements.

To improve safety and to attain the minimum safety requirements for tunnels in the Trans-European Road Network, following measures are foreseen in accordance to the German Standard for tunnels (RABT 2006):

- Construction of emergency call niches
- Provision of hydrants near the portals and inside in niches
- Provision of state-of-the-art tunnel lighting, consisting of normal, safety and evacuation lighting
- Provision of traffic control, communications and information systems

A new mechanical ventilation system is designed with a separate fresh air duct and exhaust air duct for the fire case. An air monitoring system will be installed for measurement of carbon monoxide and visibility levels to form the basis of control for ventilation.

The aim of the tunnel ventilation is to reduce the occurrence of noxious gases and harmful particles like CO, HC, NOx, etc. to the admissible nonhazardous level. Besides, the ventilation

project shall favor the improvement of the visibility requirements in the tunnel. Heavy-tonnage vehicles produce many exhausts like black smoke and soot restricting visibility conditions for drivers.

Table 4.4: Objective of the ventilation design

Object of Ventilation	Design Objective
CO Concentration	100 ppm
Visibility Reduction	50% for 100 m

A tunnel drainage system is designed for separate collection of ground water and surface water. Although the tunnel surrounding soils are low water bearing, at localized places ground water flow is expected. The design water flow of 30 – 40 m3/hour is expected with a maximum of 300 m3/hour. Since the inner, existing, lining, will stay in place lower flow rates are anticipated. The ground water will be collected in longitudinal drains along the sidewalls and discharged every 70 m into the main ground water collector. A oil separator will be provided to collect tanker spillages and tunnel wash down water.

The supply for the fire main is provided by separate water tanks to ensure security of supply. In order to achieve the required capacity of 70 m3 an additional tank will be installed besides the existing 25 m3 tank.

The selected tunnel rehabilitation scheme is shown in the Figure below

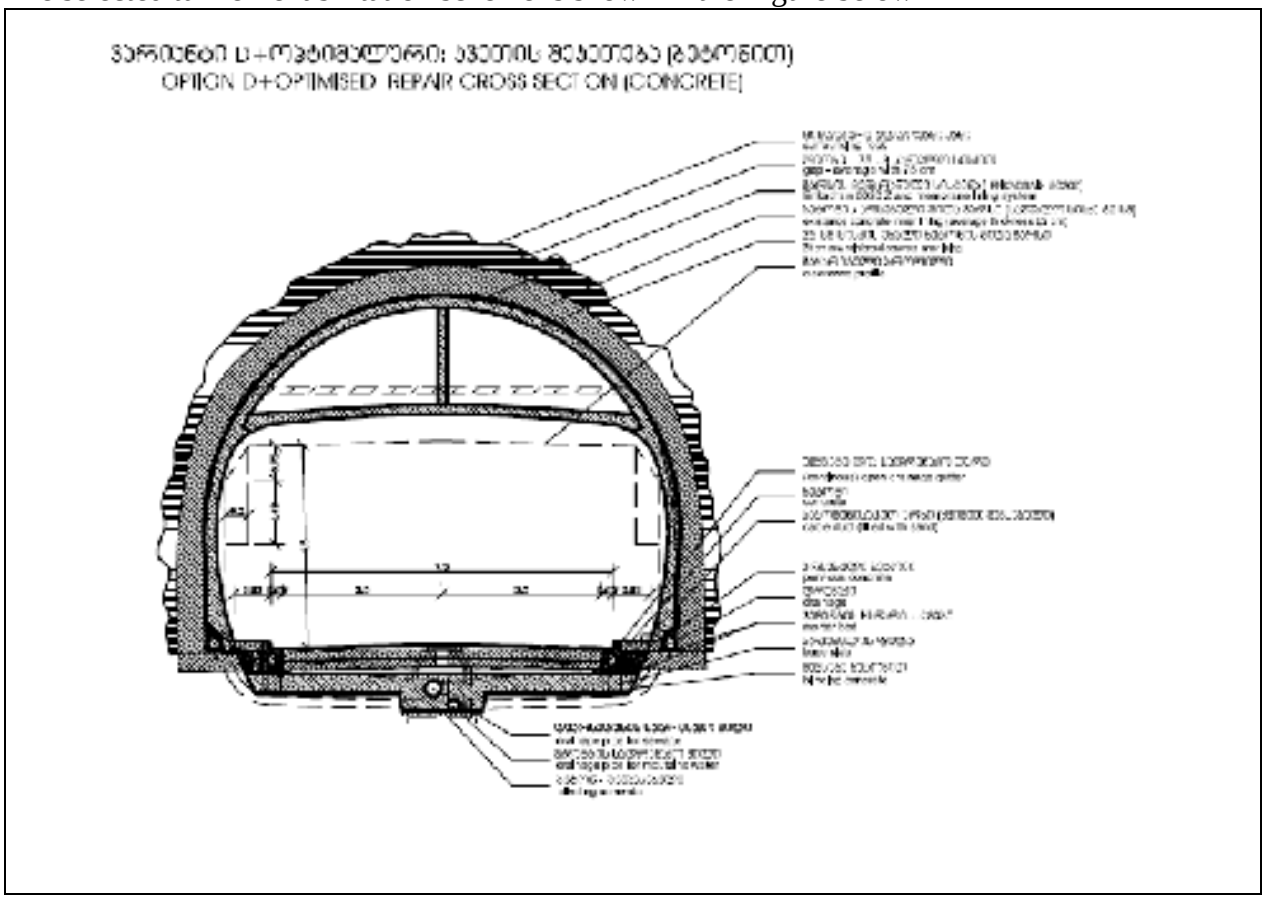


Figure 4-4 Tunnel rehabilitation cross section

The estimated quantities of major civil works components are as follows:

Demolition of concrete false ceiling and tunnel base	10,000	m3
Excavation in rock at tunnel base	10,000	m3
Backfilling of gaps between lining and surrounding rock by injection	31,700	m3
Shotcrete for tunnel lining	9,350	m3
Concrete for tunnel base	7,140	m3
Concrete for false ceiling (air duct)	3,280	m3
Reinforcement for inner lining, base and false ceiling for air ducts	1,900	ton
Waterproof membrane	37,600	m2
Concrete pavement slab, 280 mm thick	12,735	m2

Although the demolished concrete and excavated rock material from the tunnel in the amount of 20,000 m3 could be recycled and reused, within the frame of the tunnel rehabilitation project there is no possibility for reuse and the material needs to be disposed for future use in other projects.

4.5 Pre-construction Activities

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

- improvement of the existing tunnel bypass road which will be used as traffic diversion during tunnel rehabilitation
- preparation of temporary camp sites in the vicinity of the road bed at the eastern and western portals of the tunnel in accordance with environmental requirements
- selection of temporary disposal sites for construction debris of the tunnel and surplus material of the tunnel bypass road.

a) By pass road

Improvement of the tunnel bypass road shall be completed before commencement of the tunnel rehabilitation works foreseen in the project design. Measures should be undertaken to ensure traffic safety during periods where the tunnel is closed for public traffic and the bypass road is used as traffic diversion.

The existing Rikoti tunnel bypass road branch from the Tbilisi-Senaki-Leselidze Highway (E-60) starts at km 141+900 and joins the main highway (E-60) at km 144+850. As it was mentioned above, before rehabilitation of the existing Rikoti tunnel, the existing bypass road has been considered the only alternative. Total length for by-pass is 4.5 km. The road runs through difficult terrain, especially because of two serpentines with small radii and steep slopes.

The most part of carriageway width of the by-pass road varies in the frame of 7-10 m. However, there are some places, especially sharp turnings, where the width of existing road cannot ensure safety traffic of heavy trucks and trailers. In such kind of places, carriageways need to be widened.

Especially important is to widen three turnings to increase traffic safety. Risks of accidents here are quite real, especially for trailers having the length of 14 meters and more.

Widening in the sharp turnings should be to the mountainous side with the length of 300 m and from the left side of the road 900 m. In these sections of the road, average widening width varies between 3-3.5m. Widening should be on the account of shoulders, which is possible with considering of existing relief. Widened carriageways will ensure traffic safety at most and can have minimum impact on existing landscape.

Besides, the speed shall be restricted to its minimum to improve also traffic safety. The above-mentioned restrictions are directly connected with human safety as well as environmental issues for road accidents can cause pollution with hazardous substances and materials like petroleum derivatives, hazardous chemical substances, etc.

It is also important to mention, that widening works of the by-pass does not require land acquisition, as works should be carried out in the frame of existing right of way zone.

Figure 4-5 Turning that needs to be improved

As for the widening of the turnings (on the mountainous side) is required cutting of rock soils in the amount of approximately 5,800 cubic meters of which 1,600 cubic meter are used within the project and the remaining 4,200 cubic meters should be disposed of (final disposal location is described in chapter 8.8.1 in mitigation measure No. 1.4 and shown on Map 8-1 and Fig. 8-1). Additionally approximately, 40 trees need, to be cut. Information about the plants is given in the list of impact reducing measures.

Figure 4-6 Turnings that needs to be improved.

To seal and strengthen the existing asphalt surface and improve the skid resistance of the road, an asphalt overlay (50 mm thick) will be applied.

The rehabilitation scheme is shown in the Figures below.

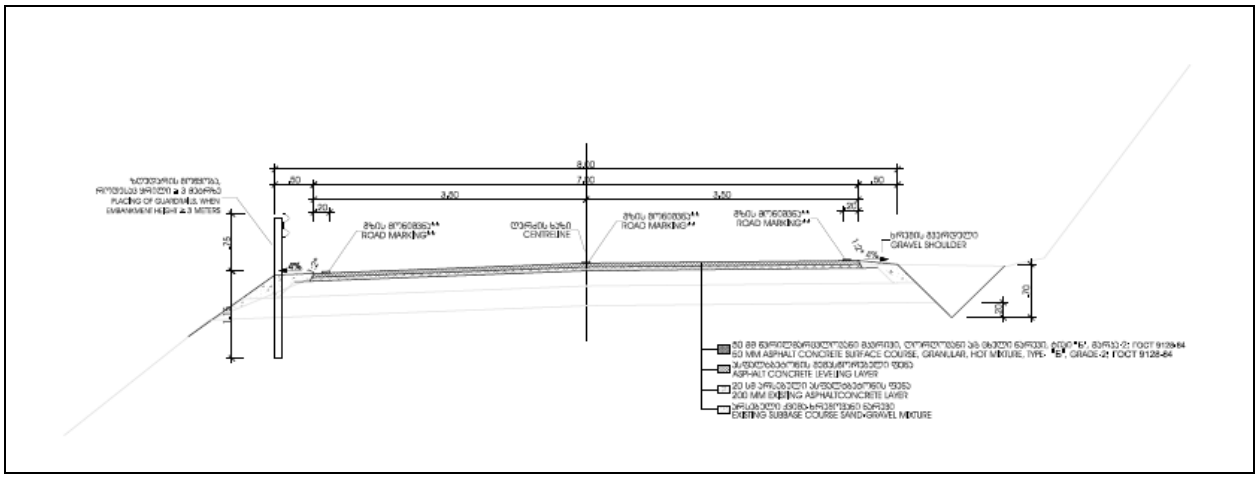


Figure 4-7 Typical cross section of rehabilitated road

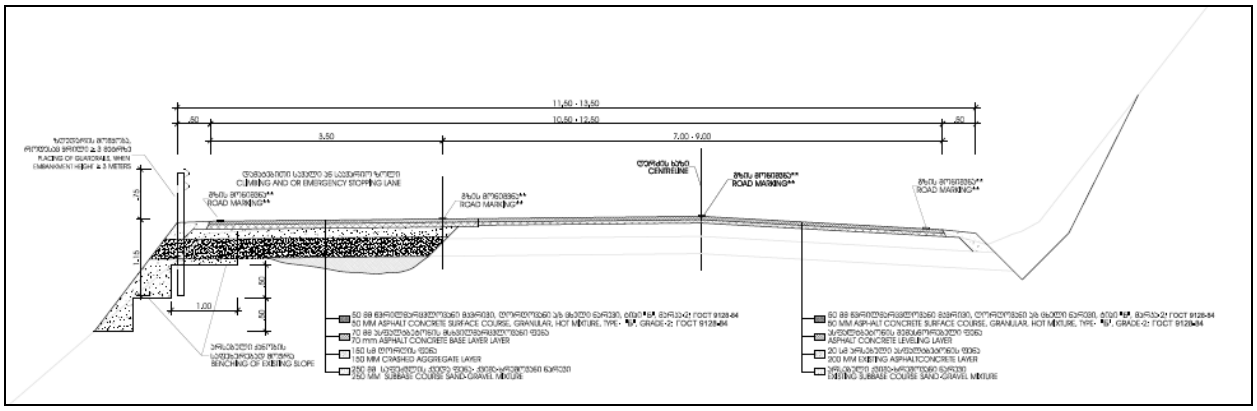


Figure 4-8 Typical cross section of widened, improved cross section

The existing drainage system consists of side drains and pipe culverts. It is envisaged to keep the existing drainage system with minor repair and construction works were parts are broken or the

system is incomplete. Side drains will be constructed where necessary for controlled discharge of surface water and erosion control of slopes.

Traffic safety features such as road signs, road marking and road furniture, including appropriate road safety barriers (guardrails) will be implemented, taking into account that the bypass road will be used also in future in case of tunnel closure or simply for drivers which do not want to use the tunnel.

Aggregates and other granular construction material, as well as asphalt will be supplied from the existing Gzamsheni-5 construction materials and asphalt plant. plant (18 km distance from the bypass). This is not the exclusive supplier for the project, but closest to tunnel and by-pass location and all calculations are based on the availability of this closest option. However, Contractors are free to select alternative sources of sand, gravel, asphalt and other construction materials.

The rehabilitation works will entail minimal earthworks particularly for partial widening of the road width. Certain spots need to be cut to improve curves and conform to the necessary width. The amount of cut is around 5,800 m3 while the fill will be around 1,800 m3. Surplus material in the order of 4,200 m3 is considered for final disposal. Final disposal is described in chapter 8.8.1 as mitigation measure.

b) Temporary camp sites / Contractor's yard

The establishment of contractor's work camp may cause adverse impacts if various aspects such as liquid and solid waste disposal, equipment maintenance, materials storage, and provision of safe drinking water supply are not addressed properly.

An area situated on the left side of the Tbilisi-Leselidze Highway in the vicinity of the eastern portal of the tunnel might possibly be used for arranging the work camp of the Contractor. The land was already used as a construction camp during the construction of the highway. The location of the proposed site for the Contractor's work camp is shown in Annex A. There is a two-storied non-functional building in the area (Figure 4-9), which might be used for site offices during tunnel rehabilitation.

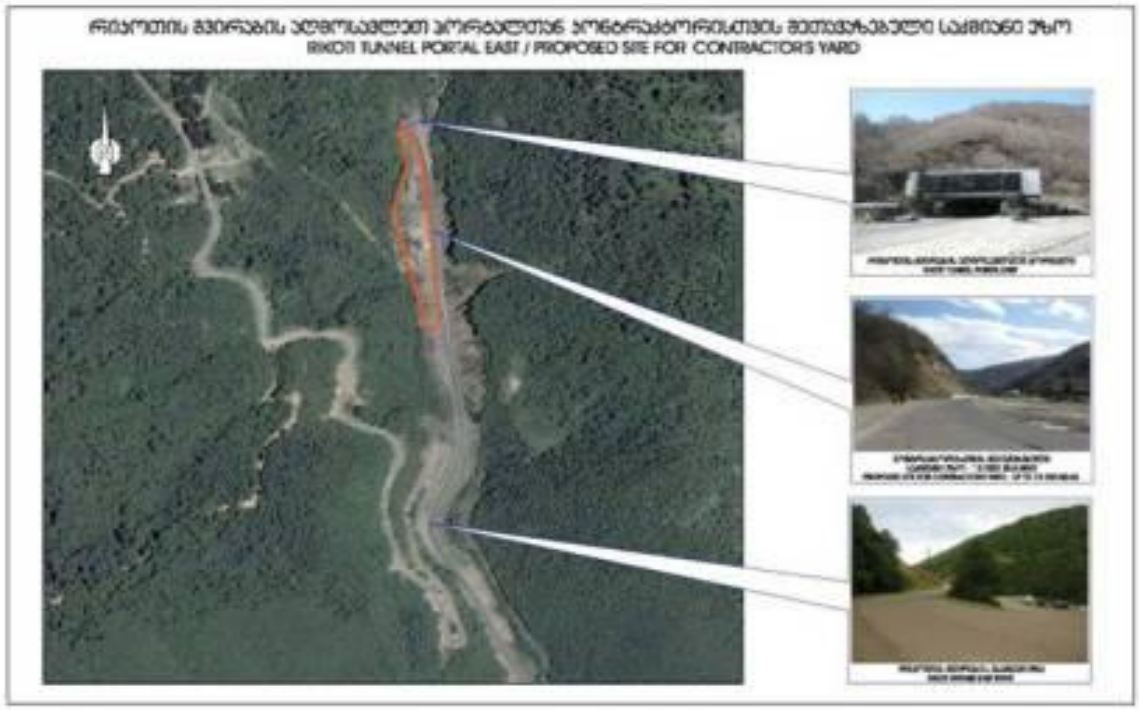
Figure 4-9 The building in the vicinity of the tunnel.

The building is equipped with a sewerage system connected to a concrete pit for collecting polluted water. As for the areas in the vicinity of the building, they can be used for placing building equipment necessary for rehabilitation works and temporary storage of the building refuse taken out of the tunnel.

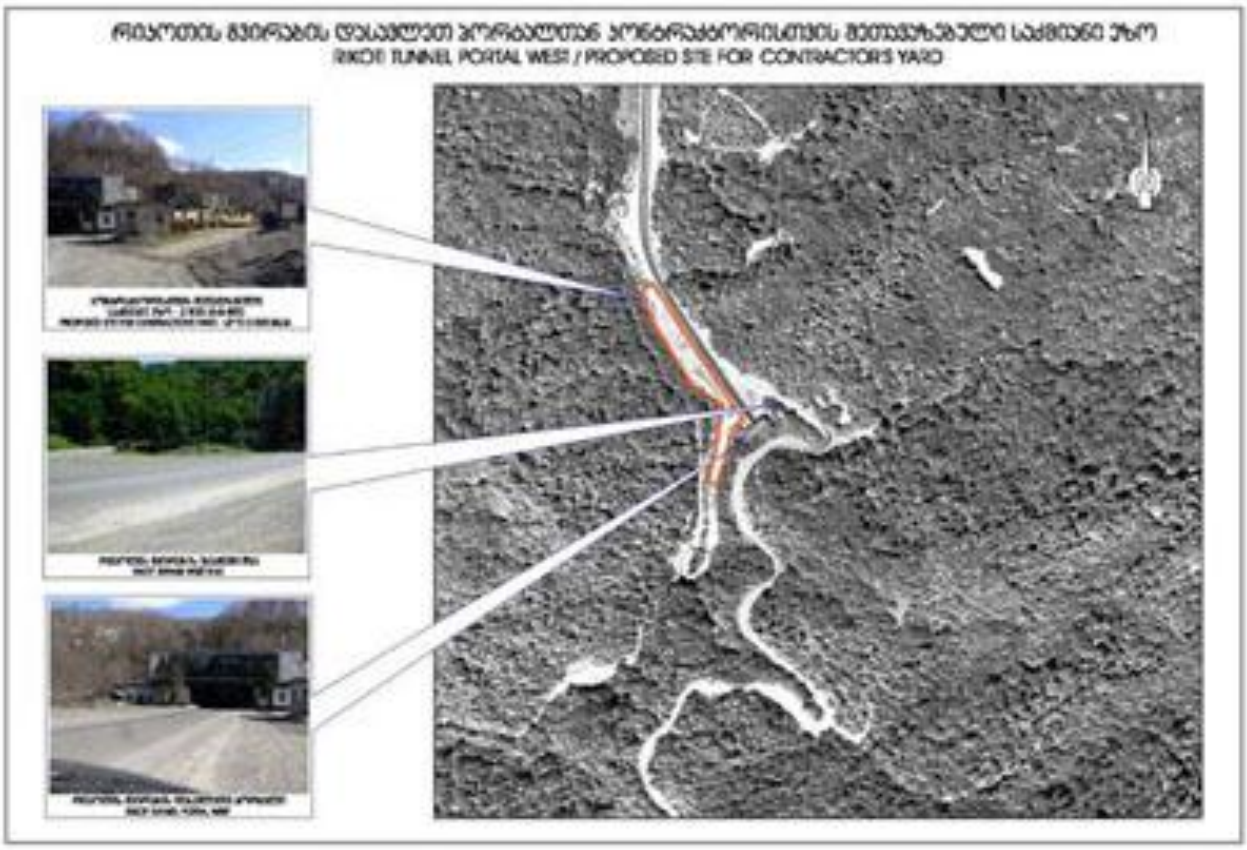
On the left side of the eastern portal the area of the land makes about 5000 square meters, the area of the land on the opposite side is about 3000 square meters. The area of the highway itself is not meant in any of the areas.

The building and area can be used as a shelter for the personnel, administration, canteen and block for sanitary needs. Certain repair works have to be carried out at the building. Inside the enclosure a reservoir for fuel necessary for the machinery can be arranged. In whole, before launching the works any land used for the tunnel rehabilitation works shall be planned vertically so as to let the run-off caused by the precipitation drain into a single system. Areas near the western portal can be used or the temporary storage of the building refuse, as well as four smaller areas on the left side of the western road direction. A picture of one of the temporary storage is given below in figure 4-10.

The location of the proposed contractor's work camp is shown on the maps below.



Map 4-1: Proposed site for contractor's yard at east portal



Map 4-2: Proposed site for contractor's yard at west portal

c) Temporary disposal sites

It is foreseen for the rehabilitation works to be carried out simultaneously from the eastern and western portals. Correspondingly, it shall be necessary to organize temporary storage of the building refuse resulting from the rehabilitation works with prompt haulage to disposal site before accumulation of large stockpiles. As for the service and rest places for the personnel, it is foreseen to organize a construction camp.

Figure 4-10 Potential location for not hazardous demolition material.

The areas at the western portal that shall be possibly used for the temporary storage of the demolition material.

1. 100 x 15 = 1500 m2, 900 meters from the tunnel portal;
2. 80 x 15 = 1200 m2, 700 meters from the tunnel portal;
3. 170 x 15 = 2550 m2, 300 meters from the tunnel portal.

5. ALTERNATIVES

5.1 Project Alternatives

The existing bypass road has been considered as the only alternative in respect to the Rikoti tunnel. Total length for by-pass is 4.5 km. The most part of the road runs through difficult, hilly terrain. The existing diversion road to bypass the Rikoti tunnel is a category IV road according to SNIP Standard with about 7.00 m paved carriageway. The alignment of the diversion consists of steep slopes and sharp curves, which makes it difficult for large trucks to use the diversion.
The detailed information related to the by-pass is described in Chapter 4.5.

It is important to mention, that the by-pass was part of the main road network before 1980, when the tunnel was constructed. During that time the Tbilisi – Senaki - Leselidze road had no transit function, and served as a regional connection. The main transport means were cars, medium sized trucks and mini buses. After the highway obtained transit function, the number of large, high loaded trucks and trailers has increased significantly. However, the by-pass cannot ensure traffic safety conditions, does not meet minimum international requirements and standards, as a permanent connection.

As for the alternatives like “do nothing” or “without project, they cannot be regarded as project alternatives, because the project aims to achieve international standards for the existing tunnel. This means that without improvements to the lightening system, installation of better ventilation system, construction of a high quality road pavement (that lessen accidents risk), negative impacts will increase, particularly with increased traffic intensity.

5.2 Tunnel Rehabilitation Alternatives

Before commencement of the detailed tunnel rehabilitation design several tunnel rehabilitation alternatives have been discussed with Road Department. Detailed information for each tunnel rehabilitation alternative is described below.

Alternative A
The existing roof is strengthened by a new 25 cm thick reinforced shotcrete inner lining. The hollow spaces between the existing roof and the in-situ rock are filled in. The complete foundation and the drainage are renewed.

In a spacing of 70 m the mountain water drains are led to the mountain water collector pipe under the carriageway. The existing carriageway and foundation are renewed and deepened. The carriageway is served by slot channels for drainage which are sealed off every 50 m and likewise every 50 m there are plunge shafts in the slot channels to take the water from the carriageway to collector pipes. Under the emergency sidewalks there are cable ducts and water pressure hose lines for supplying water to quench fires.

Alternative B
The existing lining is demolished and replaced by a new 35 cm thick reinforced in-situ concrete lining after the existing overhanging rock is made safe. The entire floor and drainage are renewed.

In a spacing of 70 m the mountain water drains are led to the mountain water collector pipe under the carriageway. The existing carriageway and sub base are renewed and deepened. The carriageway is served by slot channels for drainage which are sealed off every 50 m and likewise every 50 m there are plunge shafts in the slot channels to take the water from the carriageway to collection pipes. Under the emergency pathways there are cable pull pipes and water pressure hose lines for supplying water to quench fires.

Improvement of the new tunnel profile:
It is apparent from the contract specification that the existing tunnel, between the roof concrete and the surrounding rock mass, shows a hollow space of up to 2 m. Due to the stipulation that the tunnel should be strengthened for an earthquake magnitude of 9 on the Richter scale, the hollow space has to be backfilled. In order to appraise the cost effectiveness of an overhaul in comparison to a renewal, several different variations have to be broken down in regards to the variable costs of a tunnel cross section and the necessary filling and cutting back of rock. Basis for the calculation of the backfilling area are the results of the Technical State Survey for Rikoti Motor Tunnel. From this ensues an average value for concrete strength of 62.4 cm and for the hollow space a medium depth to the in-situ rock of 75.2 cm. These average values were taken as a basis for the economic investigation.

General information about variations C and D:
These cost reduced alternatives are not in accordance with the European standard. The intermediate ceiling must be demolished for safety reasons, because of the high presence of rust and the unknown fire safety. The renewal of the intermediate ceiling is to be foregone by reasons of cost. The ventilation of the tunnel is ensured by stream ventilators. In the case of fire a systematic extraction of smoke is not possible. Therefore in the case of fire there is no comprehensive protection for people.

The structural installations in the tunnel are designed to a minimum standard. Breakdown bays and the insets for emergency exits to the future 2nd tunnel are omitted. Also the ground water protection basins (catastrophe basins) for the carriageway wastewater won't be constructed until the construction of the 2nd tunnel. Whereby, during the building of the 2nd tunnel limitations will occur for the operation of the existing tunnel.

The backfilling of the hollow space between the existing inner shell and the in-situ rock is inapplicable by reason of the high costs. For this reason the demanded earthquake safety stipulations cannot be adhered to in the base alternative C or D.

Alternative C
With this variation the inner shell is strengthened by a surface applied 15 cm thick reinforced layer of shotcrete after the demolition of the intermediate ceiling.

In a spacing of 70 m the mountain water drains are led to the mountain water collector pipe under the carriageway. The existing carriageway and foundation are renewed and deepened. The

carriageway is served by slot channels for drainage which are sealed off every 50 m and likewise every 50 m there are plunge shafts in the slot channels to take the water from the carriageway to collection pipes. Under the emergency pathways there are cable pull pipes and water pressure hose lines for supplying water to quench fires.

Alternative D
With this variation the inner shell is strengthened by a new 25 cm thick reinforced in-situ concrete inner shell, after demolishing the intermediate ceiling. Before building in the in-situ concrete shell the loose rendering is removed by high pressure washing and taken away. For the draining of the embrasure a layer of Enkadrain and the waterproofing system is built in around the entire area of the tunnel behind the in-situ concrete shell for collection through a mountain water drain.

In a spacing of 70 m the mountain water drains are led to the mountain water collector pipe under the carriageway. The existing carriageway and foundation are renewed and deepened. The carriageway is served by slot channels for drainage which are sealed off every 50 m and likewise every 50 m there are plunge shafts in the slot channels to take the water from the carriageway to collection pipes. Under the emergency pathways there are cable pull pipes and water pressure hose lines for supplying water to quench fires.

Alternative D plus
In order to improve the earthquake resistance of the alternative D additional backfilling of the gap between the tunnel lining and the surrounding rock is envisaged. The sequence of the work is equivalent to alternative D with the exception that prior to demolition of the carriageway the existing hollow space shall be filled with cement mortar or rapid hardening in 1 meter steps from bottom to top alternatively behind the south tunnel wall or likewise the north tunnel wall. For this all 10 borings are carried out through the inner shell.

Alternative D plus optimized
Due to the strong call for a ventilation system which ensure state-of-the-art controls of smoke in the event of fire and safety for tunnel user, an additional alternative with semi transverse ventilation system based on alternative D plus was developed. The semi transverse system comprises of a supply duct, whilst the whole traffic space acts as the exhaust duct, discharging to the tunnel portals. In the event of fire smoke will be discharged into the smoke exhaust air duct.

5.3 Evaluation of investigated alternatives

The main differences between the tunnel rehabilitation alternatives are summarized in the following table.

Table: Summary of rehabilitation alternative comparison

Rehabilitation Alternative	**A**	**B**	**C**	**D**	**D plus**	**D plus Optimized**
Shell construction cost including pavement	17.3 Mio. €	24.1 Mio €	8.34 Mio. €	9.19 Mio. €	15.31 Mio. €	17.18 Mio. €
Rehabilitation according to European standard	yes	yes	no	no	no	yes

Construction duration in months	16	18	14	14	16	16
Inner lining type	shotcrete	in-situ reinforced concrete	shotcrete	in-situ reinforced concrete	in-situ reinforced concrete	in-situ reinforced concrete
Soffit drainage	every 2 m	extensive	every 2 m	extensive	extensive	extensive
Assurance of dryness of the tunnel construction	no	yes	no	yes	yes	yes
Earthquake proof	yes	yes	no	no	yes	yes
Ventilation system	semi transverse ventilation	semi transverse ventilation	longitudinal ventilation	longitudinal ventilation	longitudinal ventilation	semi transverse ventilation
Smoke evacuation system	yes	yes	no	no	no	yes
Emergency lay-bays	2	2	no	no	no	no
Emergency call niches	11	11	11	11	11	11
Fire hydrant niches	11	11	11	11	11	11
Preparation of emergency exists in anticipation of the second tunnel tube	yes (5)	yes (5)	no	no	no	no
Waste water tank (for accident case)	2	2	no	no	no	2
50 m³ Fire water reservoir	yes	yes	yes	yes	yes	yes

A multi-criteria analysis (MCA) was carried out to identify the most favorable tunnel rehabilitation alternative. Multi-criteria analysis is a method for evaluating alternative options against several criteria, and combining the separate evaluations into an overall evaluation. It was used to identify a single most preferred option. The steps in a multi-criteria analysis are as follow:

1. Identify assessment criteria to measure key consequences of proposed alternative options based on the relevant objectives or on their likely impacts.

2. Analyze relative importance of criteria (weighting) to determine relative weights of each criteria in the decision making.

3. Analyze performance (scoring).

4. Multiply weights and scores for each of the options. Each option's performance on a criterion is multiplied by the weight of the respective criterion. The sum yields the overall relative score for the given option.

Criteria were developed and used to evaluate the different rehabilitation alternatives in view of their correspondence to European safety and tunnel standards, durability and construction period. Since budget constrains exist a high weighting was applied to construction costs.

The weighted score for each tunnel rehabilitation alternative is presented in the following table.

Table: Multi-Criteria Analysis of Rehabilitation Alternatives with Disproportional Consideration of Construction Costs

Criteria	**Alternatives**						**Alternatives**						**Max. score**
	A	**B**	**C**	**D**	**Dplus**	**Dplus opt**	**A**	**B**	**C**	**D**	**Dplus**	**Dplus opt**	
Horizontal and vertical clearance	yes	yes	yes	yes	yes	yes	10	10	10	10	10	10	10
Fire resistance of the tunnel construction	yes	yes	yes	yes	yes	yes	10	10	10	10	10	10	10
Earthquake safety of the tunnel construction in the mining section of the tunnel for earthquake intensity 9	yes	yes	no	no	yes	yes	20	20	0	0	20	20	20
Personal protection	yes	yes	no	no	no	yes	30	30	0	0	0	30	30
Dryness of the tunnel construction	no	yes	no	yes	yes	yes	5	10	5	10	10	10	10
Environmental Protection (lakes and rivers)	yes	yes	no	no	no	yes	5	5	0	0	0	5	5
Design life and durability	50 years	100 years	50 years	100 years	100 years	100 years	10	15	10	15	15	15	15
Construction period	16 months	18 months	14 months	14 months	16 months	16 months	10	5	20	20	10	10	20
Technical Score							**100**	**105**	**55**	**65**	**75**	**110**	**120**
Structural construction costs	17.3 Mio. €	24.1 Mio €	8.34 Mio. €	9.19 Mio. €	15.31 Mio. €	17.18 Mio. €	29	21	60	55	33	30	60
Total Score							**129**	**126**	**115**	**120**	**108**	**140**	**180**

Alternative A, B and D plus optimized are the technical best alternative, corresponding to state-of-the art tunnel construction techniques and are therefore from the technical point the recommended alternatives.

In view of the limited budget available budget, alternative C and D are the rehabilitation alternative with the lowest rehabilitation costs, although serious safety concerns in view of earthquake and fire safety exists, and absolute dryness cannot be assured.

In view of the best technical and cost effective solution, Alternative D-plus optimized is the highest ranked alternative and was therefore recommended for implementation.

The EIA takes therefore as the basis the tunnel rehabilitation alternative D plus optimized, which includes:

- demolishing of false ceiling (air duct), asphalt pavement and concrete tunnel base
- backfilling of gaps between lining and surrounding rock
- excavation in rock at tunnel base
- construction of new tunnel lining
- installation of waterproof membrane
- construction of new concrete pavement
- construction of semi-traverse ventilation system
- provision and installation of state-of-the art mechanical and electrical tunnel systems

6. BASELINE DATA

The aim of the field works was to specify the current environmental conditions within the design highway. The operations were necessary to determine expected impact of environmental issues that shall occur during the rehabilitation works of the Rikoti Tunnel.

The field surveys works were held in May-June, 2009. The information given below describes the background state of the environment in the vicinity of the tunnel.

6.1 Climate and Meteorology

Climatic conditions make one of the principle components of the studies planned to determine the background state of the environment in the design area. The area is situated in the vicinity of the Likhi Range 9 (1180 m above the sea level) watershed between the eastern and western parts of Georgia. Its coordinates are:

- North 40^0 03' 09"
- East 43^0 29' 49"

The area is characterized by cold winter and normal warm summer. In August the maximum average air temperature reach up to $+26.5^0$C. In February the temperature gets down to its minimum and makes -2.4^0C. Average annual atmospheric precipitation is 565 mm. The number of snowy days varies from 55 to 60 and the thickness of the snow cover at the tunnel often is 0.5-0.7 meters. The temperature of soil as well as the air temperature goes down to its lowest point in December-January. The relative humidity corresponds to the level of precipitation and its average annual rate is within 75%. More detailed meteorological and climatic data based upon the information submitted by the Surami and Rikoti Stations under the Hydrometeorology Service of Georgia are given in Annex B.

6.2 Geomorphology and Geology at Rikoti Tunnel

Areas in the vicinity of the Rikoti Tunnel belong to the eastern part of the River Dzirula massif. The massif itself represents the geomorphologic district of the Transcaucasian intermountain area. There are three types of relief on the structural storeys of Precambrian, Middle Jurassic and Upper Cretaceous-Middle Sarmatian periods. The relief types are:

- allochthonous - denudation;
- allochthonous - structural;
- autochthonous - erosive.

The eastern part of the River Dzirula massifs is especially important in regards to the Rikoti Tunnel site. It is mainly represented by the third structural unit made of Paleozoic and Proterozoic crystal rocks. The rocks are bare in the eastern and southern parts. They are characterized with low-mountainous and middle-mountainous division. The plateau part of the massifis complicated by relic gorges, karstic forms/caves and Neocene volcanic structures. In the river gorges there are terraces and landslides.

The geologic development of the Dzirula massif starts with the period preceding the Mesozoic era. In the period developed sediments that turned into phyllites and crystal slabs. Quartz diorites and pink granites developed from the magmatic formations. As for serpentinites and rocks, they developed from intrusive rocks.

Among the Mesozoic and Cenozoic formations the Lias shales consisting of sandstones and lime stones are the most important ones. As for the Middle Jurassic sediments, they are represented by Biosis porphyrine layer.

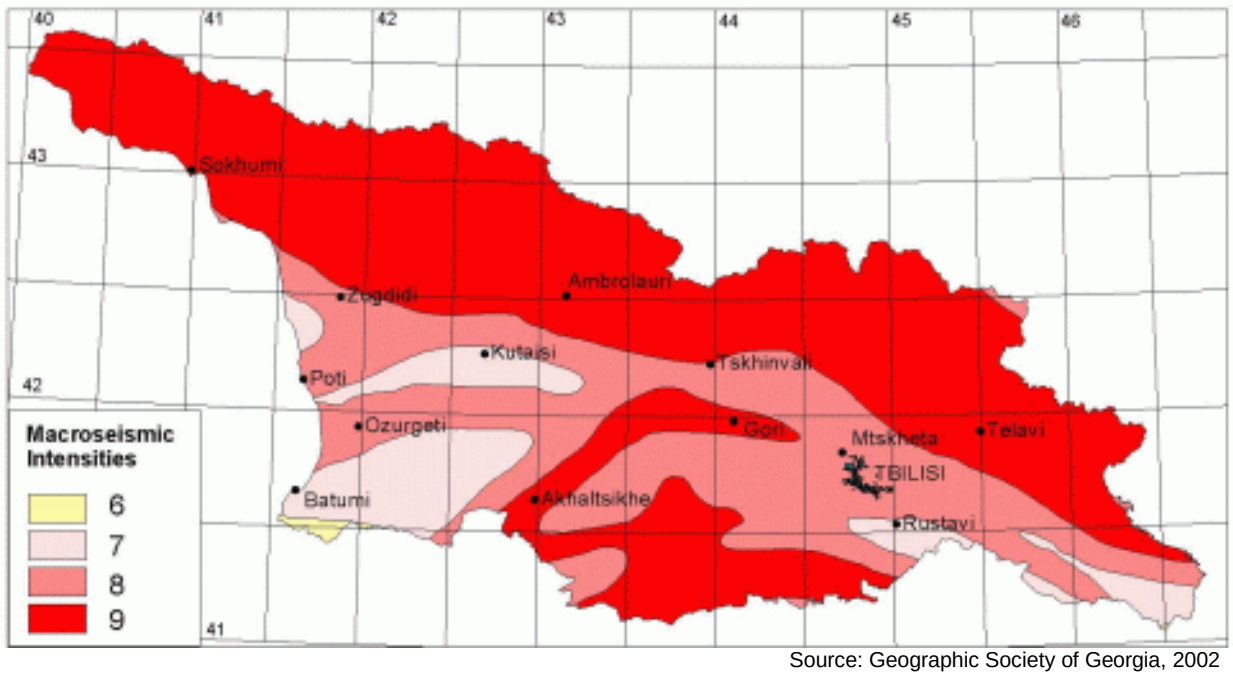
A layer of younger chalk sediments characterized with hard lime-stones transgressively overlaps the sediments of the Jurassic Era.

Tertiary Miocene formations overlap the above-mentioned formations with a vivid discordance. The tertiary formations are usually represented by breccias conglomerates, clays, sandstones and limestone sandstones. Within the massif the rocks are wrinkled and almost horizontally overlap chalk sediments.

6.3 Seismic Conditions

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 neighboring Eurasian and Afro-Arabic rocks. The seismic activity map is given in the source "Geographic Society of Georgia – 2002".

The project is located in the high intensiveness seismic zone - the Richter scale (IX). The intensity of tectonic zones are calculated for 2 % probability (expectation time twice in 1000 years) according to the Richter scale.



Source: Geographic Society of Georgia, 2002

Figure 6-1 Seismic intensiveness map of Georgia

6.4 Top Soil of the land around the Rikoti Tunnel

Within the eastern part of the Dzirula Gorge where the design tunnel is located there are soil formations of three types:

- Grey soils;
- Yellow grey soils;
- Humus grey soils.

Grey soils represent one of the most widespread soil type in the Caucasus. Their formation in connected with the climatological conditions when precipitations prevail the expulsion and create a special soil and landscape belt.

Within the Dzirula massif including the areas adjoining the tunnel , the structure of the grey soil changes. Podzolic grey and carbonate soils are formed. Pozdolic grey soils mainly appear on the intensively exhausted clay soils and clays. Their profiles are characterized with thin underlying formation followed by 3-5-cm humus horizon and 15-20-cm obviously faded podzolic horizon. The profiles end with alluvial-metamorphic hardened straw-colored and yellow or reddish-yellow horizon turning into the main rock. The humus content is low and the reaction is the acid one.

Yellow grey soils belong to the type of yellow soils. The soils as well as grey soils are spread in the surface zones of the Dzirula massif, where there is a residual type of soil. They are mainly spread on terrace formations and piedmont plains. The humus soil is represented by a granular soil layer (19-15 cm). Deeper there is a illuvial-metamorhic horizon that gradually turns into the main soil-forming rock. The content of the humus horizon in this type of soil makes 6-10%, and the level of acids prevails higher than the level of base materials.

Humus-calcareous soils are developed under the growth, main calcareous rocks. These are lime-stones, dolomites and their fission products. Their area is characterized with damp climatic conditions. The high carbonate contents of the soil-former contributes to the formation of calcareous and humus-calcareous floor profile. Their upper part has dark grey color and fades lower. Then it goes into the base rock. In the upper part of the profile the reaction is neutral. As for the lower part, the reaction is an alkaline one. The lower part of the profile is enriched with carbonate. The concentration of humus in the upper part of the horizon is 6-10%. The soil types are mainly spread in the limestone rock zones characteristic for the Chalk era rocks along the Caucasus.

6.5 Flora and Vegetation

The rehabilitation works will have no impact on the areas covered with forests. That is why the floristic characteristics given below have an character of concise information just to make the Environmental Impact Assessment more precise and complete.

The growth within the areas in the vicinity of the tunnel are included in the Upper Imereti Plateau. Notwithstanding the fact that the rehabilitation works have no direct impacts on the forest, a specialist from the Georgian Institute of Botany made an assessments of the areas over

the tunnel as well as of those that are situated in its vicinity. The assessments were carried out for the zone located 1000-1100 m above the sea level. The average length of the zone is 100 meters.

According to the assessments, the growth in the zone is the poorest one among the Kolkheti vegetation types. Though, the total amount of the relict Kolkheti species is quite significant within the area, their phytocenosis positions are comparatively modest, i.e., there are almost no typical Kolkheti species like cherry-laurel (*Laurocerasus officinalis*), Pontic Rhododendron (*Rhododendron ponticum*), azalea (*Rhododendron luteum*), box-tree (*Buxus colchica*), etc.

The land adjoining the tunnel is mainly represented by the forest belt only. The growth there has been more preserved than near the villages situated westwards from the tunnel. The picture below demonstrates that the land around the tunnel is covered with woodlands.

Figure 6-2 **Area around the tunnel that is covered with forests.**
(two soil sampling points are indicated with pink symbols as well as the area for batch plant and camp where soil disturbance should be minimized and no spoil should leave the site to avoid cross-contamination – no other eastern portal areas should be disturbed

The growth is mainly represented by mixed foliage trees like chestnut (*Castenea sativa*), beech (*Fagus orientalis*), alder (*Alnus barbata*), hornbeam (*Carpinus caucasica*), lime-tree *(Tilia caucasica)*, ash-tree (*Fraxinus excelsior*), Georgian oak (*Quercus iberica*). At the forest edges there are mountain shrill (*Festuca montana*), wood-rove (*Asperula odorata*), filices, ferny (*Dryopterix filix mas*) and grass growth.

6.6 Fauna

The geographic characteristics of Georgia cause the climatic diversity of the country and consequently the diversity of the local flora and fauna. At the present moment many species are endangered and all the possible measures has to be taken to maintain the present unique nature at least.

The land connected with the rehabilitation of the tunnel that starts at the 143rd km mark of the Tbilisi-Leselidze Highway and the local fauna make a part of the geobotanical region of Imereti Plateau. The region to be assessed includes areas of broad-leaved forest. Though, it is not foreseen to use areas other than those belonging to the right-of-way corridor, a specialist from the Georgian Institute of Zoology assessed the local fauna, to make the format of the Environmental Impact Assessment report more precise. During the field works attention was paid to droppings, signs and dens of wild animals. As for the ornythofauna, due assessment were made according to visual observations and nests. The existing printed materials were obtained and studied too. The researches together with the corresponding literature made it possible to draw certain conclusions.

It was taken into consideration that according to the researches carried out in the forests it is difficult to make full-scale assessment of the fauna, nevertheless certain conclusions were drawn. The tables below give the list of vertebrate and invertebrate animals.

MAMMALS

Table 6-1: Mammals in the project area forests

Species	In Latin	Biotype
Roe Deer	*Capreolus capreolus*	Forest
Sow (wild)	*Sus scrofa*	Forests - shrubs
Black bear	*Ursus arctos*	Forest
Wolf	*Canis lupus*	Forest
Jackal	*Canis aureus*	Forests - shrubs
Fox	*Vulpes vulpes*	Forests - shrubs
Lynx	*Lynx lynx*	Forest
Jungle-cat	*Felis chaus*	Forests
Marten	*Martes spp*	Forests - shrubs
Caucasian squirrel	*Sciurus anomalus*	Forest
White-toothed shrew	*Crocidura russula*	Forest
Badger	*Meles meles*	Shrubs
Common shrew	*Sorex araneus*	Forest

Note: The black bear **(Ursus arctos)** is included in the Red List of Georgia.

AVIFAUNA

Table 6-2: Avifauna species recorded in the project area

Species in Georgian	Species in English	Biotype
Hawk	Accipiter gentilis	Forests
Pigeon	Columba palumbus	Forests
Forest owl	Strix aluco	Forests
Cuckoo	Cuculus canorus	Forests

Green woodpecker	Picus viridis	Forests
Dunnock	Prunela modularis	Forest edges
Blackbird	Turdus merula	Forests and steppes
Titmouse	Parus caeruleus	Forests and steppes
Jay	Garrulus glandarius	Forests
Finch	Fringilla coelebs	Forests
Goldfinch	Carduelis carduelis	Forest edges

6.7 Cultural and Archaeological Monuments

None of the historical and archaeological monuments situated in the region of the designed tunnel are included in the area foreseen for the rehabilitation works, except barreliefs decorating the faces of the both tunnel portals, which should be preserved and protected against damage during the construction, cleaned and enhanced with rehabilitation of adjacent structure surfaces. Defaced structures and debris should be removed from the site of visibility around both portals.

6.8 Environmental Conditions

6.8.1 Surface water quality

Studies of the surface water quality were carried out for the Environmental Impact Assessment in June, 2009. The aim of the research was to study small rivers on both sides of the tunnel and the quality of water pollution in the Rivers Suramula and Rikotula. The analysis of the waters include: a full-scale nitrate analysis (TN), polyphosphate analysis (TP) and analysis for the evidence of the oil hydrocarbons (TPH). The assessment of the surface waters aimed at determining the possible pollution level of the operating highways.

The physicochemical parameters of both rivers like temperature, pH, opacity and electro-conductivity are given in Table 6-3. Table 6.4 presents the chemical characteristics of the river water.

Table 6-5 demonstrates that the quality of the water is good in general and water from both rivers can be used for the construction works as well as drinking water (after treatment).

Table 6-3: Physical characteristics of the river water

No	Rivers	RateC	pH	Opacity, FTU	EC mS/cm
1	Riv. Suramula	19.7	7.18	0,34	0.079
2	Riv. Rikotula	18.5	7.9	0.29	0.085

Source: Caucasian Institute of Minerals, KIMS 2009

Table 6-4: . Chemical characteristics of the river water

No	Rivers	mg/l								
		Cl	HCO3	SO4	Ca	Mg	Na	K	DO	TDS
1	Riv. Suramula	5.1	41,5	9.6	12.8	3.8	4,6	0,4	7.8	74
2	Riv. Rikotula	5.0	37.8	7.4	9.0	4.1	6,0	0.4	9.7	79

Source: Caucasian Institute of Minerals, KIMS 2008

Table 6-5: Nitrate, poliposphate and oil hydrocarbons in river waters

No	Rivers	TN (mg/dm^3)	TP (mg/dm^3)	TPH (mg/l)
1	Riv. Suramula	8	Was not revealed	<0.2
2	Riv. Rikotula	10	Was not revealed	0.2
	Standard			**0.03-0.5**

Source: Water Quality Monitoring, Environmental protection Ministry, 2009.

6.8.2 Ground water quality

For the purpose of determining the quality of the ground water three samples were taken in the inner part of the tunnel. The measure is important for assessing the impacts occurring against the tunnel walls made of reinforced concrete. Samples were taken in those parts of the tunnel where the tracks of the groundwater impacts were obvious (corrosive parts of the reinforced concrete). The samples were taken to assess aggressiveness of the leaked water.

The first sample was taken 100 meters far from the eastern tunnel portal (143+100 km mark). The second sample was taken in the middle part of the tunnel (143+900 km mark) and the third one was taken at the western portal of the tunnel (144+700 km mark). Analyses of the samples were carried out at the certified laboratory under the Caucasian Institute of Minerals. The results of the analyses are given in the following table:

Table 6-6: Result of chemical water analysis

Sample	**pH**	**SO_4 2-, mg/l**	**Cl^- mg/l**	**Rustiness mgO^2/l**	**Solute salts mg/l**	**HCO^3 mg/l**	**After contacting with HCO^3 - $CaCO^3$**	**C_0**	**CO_2 mg/l**	Soluted **$CaCO^3$ mg/l**
1	7,5	30,4	2,5	1,5	232	198,2	275,2	0,72	27,9	63,5
2	7,7	7,3	2,8	2,7	130	128,1	129,3	0,99	0,4	1,0
3	7,0	9,1	3,5	3,6	210	179,9	220,8	0,81	14,7	33,5

Co = initial alkalinity / alkalinity after contacting with $CaCO^3$.

According to the current Georgian norms if **Co** equals 1, water is considered to be stable, if Co is lower, than water is regarded as aggressive to concrete.

6.8.3 Noise

Within the scope of the Environmental Impact Assessment noise levels were studied at two points (at the eastern and western tunnel faces). The distance between the two measurement

points and the central line of the outer lane was 7.5 m. First class integrating noise meters of the 00026 type were used for measuring the noise levels. The results of the measurements are shown in the table below. Measurements of the equivalent sound levels represent the noise characteristics of the current traffic flow (L_{Aeq}=68dbA).

Figure 6-3 Noise Measurement Process.

In the period of time when there was no traffic along the highway, the noise produced by the ventilation system at the measurement point was 67 dbA.

In the table below are given normative acts specified by the by-law of Georgia on Qualitative Norms of the State of Environment (Sanitary Norms 2.2.4/2.1.8. 000-00).

Table 6-7: Allowable sound (noise) levels in residential areas

Area Type	Time Period	Equivalent Sound Levels DBA	Maximum Sound Level DBA
The areas bordering residential houses, polyclinics, schools and buildings for other institutions.	From 7 AM to 11 PM	55	70
	from 11 PM to 7 AM	45	60
The areas bordering (immediate adjacent to) hotels and dormitories	from 7 AM to 11 PM	60	75
	from 11 PM to 7 AM	50	65

Table 6-8: Results of the equivalent and maximum sound level measurements at the Rikoti Tunnel

Place of measurement	Equivalent sound level, dbA	Maximum sound level, dbA	Traffic intensiveness vehicle/hr	Percentage quantity of trucks, %
At the eastern portal (when the ventilation system works)	71	82	360	11
At the eastern portal (when the ventilation system is stopped)	68	81	348	11,5
At the western portal (when the ventilation system is stopped)	68	81	354	16

Note: The data of 24-hour and seasonal changes in traffic intensity are obtained.

Information. The distance from the western portal of the Rikoti Tunnel and the nearest village (Khevi) is 5.0 km. Chumateleti, the nearest village from the eastern portal is located in 2.5 km distance. Respectively there will be no impact caused by the noise on the objects indicated in Table 6-7.

6.8.4 Topsoil Quality

The necessity to identify whether there are heavy metals in the soil depends upon the fact that during about the whole exploitation period (up to the year 2000) ethylated fuel containing lead was used by the majority of vehicles. Greater part of the exhaust precipitated right on the soils adjoining the highway.

It is anticipated that after upgrading of the Tbilisi - Leselidze Highway the traffic flow and correspondingly the air pollution level shall be significantly increased. The pollution level within the right-of-way corridor can be determined by means of comparing the data necessary for determining the background conditions of the environment (the data are obtained through the research foreseen in the present documentation) with the results of the monitoring studies of the increased traffic.

The soil samples were taken in about 10 meters from the road pavement. In total four samples were taken.

Two of the samples were taken at the eastern tunnel portal (on the right and on the left sides of the roads). The third and the fourth samples were taken at the western portal (right and left sides of the road). Location of the points where the samples were taken are given in Table 6-10.

Methodology of taking and studying the soil and water samples is based upon the current international norms determined in special literature: SOIL - Inspection of Quality and Geological Safety According to International Standards (1997);

Points where the samples were taken are described in Table 6.10 below.

The samples underwent due laboratory research in Tbilisi, at the certified laboratory "GEOEXPERT" (Caucasian Institute of Minerals).

The results of the research carried out to determine availability of heavy metals in the samples taken along the Rikoti Tunnel were summarized and compared with the international standards.

Studies of literature make it obvious that high concentration of lead along motorways is directly connected with vehicle emissions. As active Georgian standards were accepted in Soviet times, maximum allowable concentrations of heavy metals in soils are determined in accordance with international standards. These indices are given in the Table below:

Table 6-9: Concentration of heavy metals in the soil (mg/kg)

Symbol of chemical element	Metal	Background concentration of heavy metals in soils (international standards 2000)
Cu	Copper	2 – 50
Zn	Tin	10 – 300
Pb	Lead	0.1 – 20
Ni	Nickel	1 – 100
Co	Cobalt	1 – 50
Cd	Cadmium	0.01 – 1.0
As	Arsenic	1 – 50

Source: Caucasian Institute of Minerals , KIMS 2008

Table 6.10: Test results of soil samples in the project area

N#	Coordinates (degree, min, sec)						Heavy Metals (mg/kg)				
	North			East			Cu	Pb	Zn	Cob	Ni
1	42	03	92	43	29	42	40	70	170	40	30
2	42	03	12	43	29	47	45	70	180	30	30
3	42	03	55	43	29	36	50	80	160	30	30
4	42	03	54	43	29	55	40	90	150	30	30

Source: Caucasian Institute of Minerals , KIMS 2008

As it is evident in the Table above, besides the fact of availability of lead (Pb) in the soil layer, the concentration of other elements meet the requirements of international standards.

Conclusion: The field and laboratory researches carried out for the right-of-way corridor of the Tbilisi-Leselidze Highway (E-60) at the 143 km mark revealed that there are three types of soil in the section

- Grey soils;

- Yellow grey soils;
- Humus grey soils.

The chemical studies revealed that besides lead (Pb) availability of other heavy metals mostly meets the requirements of Dutch and international standards. The analyses of the samples were carried out by the Caucasian Institute of Minerals at the stage of fulfilling tasks for the EIA (2008).

High lead concentrations in the soil are recorded not only around the area adjacent to the tunnel, but along the whole road length due to the use of ethylated (lead containing) petrol during decades. Lead is included in the group of heavy metals, it is not soluble and is subject to accumulation in the environment. The sampling points together with respective areas are indicated in the maps attached.

Since no widening of the main roadway, adjacent to the tunnel, is planned the contaminated areas will not be disturbed beyond the demarcated areas. No mitigation measures are proposed for these areas, except for the sites, related to the tunnel rehabilitation, i.e. construction camp preparation work and installation and operation of the temporary batch plant.

6.8.5 Ambient Air Quality

Before the year 1991 the ambient air quality monitoring was carried out in the large cities of Georgia only. As for the areas located in the vicinity of the Rikoti Tunnel, settled areas are quite remote from the tunnel (the village of Chumateleti – 2.5 km, the village of Khevi – 5 km) and that is why assessments of the ambient air have not been carried out so far.

The present ambient quality data are necessary in order to make a full scale assessment of all the possible impacts upon the ambient air that shall be caused by the air pollution in the area of the motor highway passing in the immediate vicinity of the Rikoti Tunnel. In the vicinity of the Rikoti Tunnel there has been no stationary point for observing the ambient air quality and that is why methodological instructions ("Background Concentrations for Towns and Settled Areas where no Ambient Air Quality Observations are Held") are to be used. Possible concentrations of harmful substances calculated in connection of the population is given in the following table.

Table 6.11: Background concentration rate

Population quantity in thousands	Background Concentration Rate, mg/m^3			
	Nitrogen dioxide	Sulphur dioxide	Carbone dioxide	Dust
250-125	0,03	0,05	1,5	0,2
125-50	0,015	0,05	0,8	0,15
50-10	0,008	0,02	0,4	0,1
<10	0	0	0	0

As far as there are no settled areas along both tunnel faces (eastern and western portals) the background data can be regarded as vanishing.

7. ENVIRONMENTAL IMPACTS

This chapter discusses the expected environmental impact for different stages of the project. This includes: the stage of contractor mobilization (creating temporary camps, temporary roads, car parks etc.) and the stages of construction works and tunnel operation.

Mitigation measures are also discussed which are important for elimination of potential impacts. If such impact is not eliminated completely such an impact is discussed as a residual.

7.1 Potential Impacts During Construction Phase

7.1.1 Tunnel Construction Phase

Potential Impacts due to Construction Phase

According to the Law of Georgia on Environmental Protection, the types, amount and possible disposal places shall be determined as well as measures aiming at reducing and processing construction waste.

During the course of the rehabilitation works along the Rikoti Tunnel the remains will mainly consist of the concrete waste removed from the tunnel bottom and walls, and rubble from water channels along the tunnel sides. In addition, small dia. 146 mm asbestos-cement pipes connecting with the central dia. 500 mm intercepting steel sewer will need to be disposed (total length of the asbestos-cement pipes is about 680 m). Additionally, the domestic waste from the temporary construction camp will need to be disposed off.

According to the project, the rehabilitation time is estimated up to 16 months. The estimated number of personal staying at the camp simultaneously is 25.

Some 20,000 m3 concrete waste and rock surplus material will be generated from demolition works in the tunnel.

Waste disposal arrangements are described as various mitigations in sections 8.8.1. and 8.8.2.

Potential Impacts on Water Resources

The area serving as a main base for the Rikoti Rehabilitation Works is situated in the vicinity of the eastern tunnel portal (left side of the Tbilisi-Leselidze highway). During the initial tunnel construction works the area was used as a construction camp. There is a non-functional two-storied building. The building is fenced and its inner area is 2 000 $m^{2.}$

According to the project, the average duration of the works is 16 months. Simultaneously there can be 25 persons.

Drinking water is usually brought from a source situated not far from the house. Water for other purposes shall be taken from the Suramula river.

Waste water

The number of the workers staying at the construction camp simultaneously is 25. According to norms and the data from municipalities, the amount of water for each person is determined as follows: household expenditures – 25 l, shower – 40 l, toilet needs – 20 l. Correspondingly , the daily expenses shall be:

- Household expenditures – 625 l;
- Use of shower – 25x40 = 1000 l;
- Toilet – 25x20 =500 l.

The volume of wastewater shall be 2,125 liters (2.12 m^3) each day.

It is foreseen for the household wastewaters to be collected in a special concrete pit arranged at the base area for collecting sanitary sewage. The volume of the pit is 75 m3 (6 x5 x 2,5). The full pit shall be emptied by means of special vehicles. Afterwards they shall be let into the operating sewage system of Khashuri.

Potential Impacts on Ambient Air (Design Stage)

One of the important objectives of the Rikoti Tunnel rehabilitation works is to bring the ventilation system of the tunnel into a state-of-the-art system in accordance with the modern requirements. As for the determination of what are the impacts caused by the polluted air pumped out of the tunnel upon the quality of air outside, it is important to avoid further expansion of the nearest villages towards the polluted ambient air zone. The program method „Ecolog-3“ was used to determine the level of the impacts caused upon the ambient air by the emission of harmful substances. The method makes it possible to determine the volume of emitted contaminous substances, i.e., it determines emissions of harmful substances at the tunnel portals. The calculation is presented in Annex C.

In the existing circumstances and taking into account the further prospects, emission scores and their dispersion parameters are considered to be the initial data.

The meteorological characteristics and figures determining the conditions for dispersion of harmful substances in the ambient air are described in the table 7-1.

Table 7-1: Meteorological characteristics determining the conditions for dispersion of harmful substances

#	**Meteorological characteristic figure**	**Values**
1	2	3
1.	temperature stratification of atmosphere	200
2.	topographic effect figure	1
3.	Average maximum air temperature of the hottest month, ^oC	26.4
4.	Average air temperature of the coldest month, ^oC	-2.4
5.	Average annual wind directions,	%
	_ north	2
	_ North-east	10
	_ west	28
	_ south-east	1

	_ South	1
	_ South-west	3
	_ West	48
	_ north-west	7
6.	The wind over speed with the periodicity of 5% (based upon long-term observations)	9.1

According to the requirements of norms of Georgian Law about "Ambient Air", the maximum allowable concentrations of substances in the ambient air are given in Table 7-2 below.

Table 7-2 Maximum Allowable Concentrations of substances

Substance	MAC (mg/m^3)	
	One-time maximum	24-hours average
Nitrogen dioxide	0.2*	0.04
Nitrogen oxide	0.4	0.06
Soot	0.15	0.05
Sulfur oxides	0.5	0.05
Carbonic acid	5.0	3.0
Dust	0.5	0.05
Hydrocarbons (petrol)	5.0	1.5
Hydrocarbons (oil fraction)	1.2	-
Phormaldehyde	0.035	0.003
Benzapyrene	-	0.0000001

* Note – MACs are calculated based on recommendations of the World Heath Organization.

The level of impact of concentrations of substances in the ambient from the tunnel has been calculated by the software method of "Ecology 3", which gives possibility to establish contaminant emissions sizes in g/sec, so determines contaminant emissions from tunnel portals.

Table 7-3: Pollutants and emissions from tunnel in g/sec.

Substance	Code	Emission (g/sec)
Carbonic acid (CO)	337	1.6995825
Nitrogen oxides (NOx)	3000	2.307987
Nitrogen dioxide (NO_2)	301	1.8463896
Nitrogen oxide (NO)	304	0.30003831
Hydrocarbons (petrol)	2704	0.0438372
Hydrocarbons (Oil fraction)	2732	0.5549445
Soot	328	0.03677157
Sulphur dioxide	330	0.014325795
Formaldehyde	1325	0.002746211
Benzapyrene	703	2.1888E-07

Potential Impacts on Ambient Air during Construction

Tunnel is basically an enclosed space with a complex structure and often crowded with vehicles and people during rehabilitation and when in operation.

The major source for air pollution during the construction phase in the tunnel will be the exhaust fumes from operational equipment. In order to ensure safety of workers in the applicable Standard 12.1.005-88 titled as "Sanitary-Hygienic Requirements of Ambient Air in the Work Zone", which establishes the following allowable optimal temperature, relative humidity and air velocity values assuming 8-hour long work time (41 hours in the week) should be followed. Following parameter of this standard should not be violated:

Work Category:	Hard
Temperature in Non-Permanent Work Zone:	
- Minimum Allowable Limit -	13 ^{0}C
- Maximum Allowable Limit -	28 ^{0}C
Allowable Relative Humidity:	70-75%
Air Flow Speed:	0.2-0.6 m/s

Maximum Allowable Concentrations of Hazardous Substances in Air:

- Carbon Oxide (CO) -	20 mg/m^3
- Nitrogen Oxide (NOx) -	0.2 mg/m^3.

The minimum air quantity per person during construction period is 24 m^3 daily or 1 m^3 per hour.

During operations If there is an accident causing fire, there will be difficulty to communicate, to allow access by emergency vehicles and personnel and for the people to escape, resulting possibly in disastrous consequences. The high temperature and smoke can sometimes cause much more damages to people than the fire itself. All tunnels therefore must have emergency plans for traffic accidents and other disasters caused by traffic accidents to prompt control of any damages, minimizing the injuries and loss to life and property. Specialists in health care and fire safety fields will be invited prior to commissioning of the tunnel for evaluation of emergency and fire preparedness. Based on assessments performed and recommendations given by these specialists, the tunnel will be equipped with proper devices. The same persons will carry out trainings for tunnel operators.

Budget of the safety measures and equipment, as well as training and monitoring costs are accounted for in the overall cost estimate.

Potential Impacts of Tunnel Rehabilitation Works

No potential negative social impacts are anticipated during the course of the works in the project. Since the nearest village in the eastern direction from the tunnel is situated about 2,5 km away from the structure, and the village of Khevi is situated about 5, 0 km from the western tunnel face, the impact of the construction works is minimal.

Impacts that shall possibly occur against different natural receptors are given below:

- Within the course of the rehabilitation works part of the reinforced concrete shall be removed from the tunnel. The construction debris, except asbestos, shall be taken out of the tunnel and temporarily stored at the designated areas and promptly taken to disposal

site to avoid large accumulation of concrete waste. Some limited land is available for stockpiling inert waste near the eastern and western portals of the tunnel;

- During the rehabilitation works the asbestos cement pipes connecting with the central 500-mm intercepting sewer shall be removed from the water receiving channels along the tunnel sides. The total length of the pipes is about 680 m. The asbestos waste shall be disposed of by the Contractor in accordance with the specific conditions set by the Ministry of Environment Protection and Natural Resources and in the presence of their representatives. Pipes of the type partially deteriorate and if exposed to the sunlight and it is quite possible for the air to be polluted with asbestos dust. The asbestos pipes will be disposed of as described under 8.8.1.
- In the course of the rehabilitation works carried out along the tunnel, it is possible that reinforced concrete will have to be removed from the damaged walls of the tunnel and substantial amount of groundwater likely to be generated during these works can become polluted by oil hydrocarbons, and also by the suspended particulate matter. The mountain waters collected by the 500-mm intercepting sewer shall be let into the River Suramula and also into the River Rikotula. To avoid discharge of contaminated groundwater to the nearby rivers it is foreseen to install an oil-water separator for polluted wastewaters. Even if the water quality varies within the limits of its norm, it is necessary to treat discharge.
- It is anticipated that some impacts will be caused by the construction camp. Besides organizing rest-places for the personnel, it is necessary to arrange fuel reservoirs for the machinery working in the tunnel. It is also necessary to stockpile various building materials (e.g., cement, iron, etc.).
- Safety conditions for personnel also need to be managed (hygiene and sanitation, removal of domestic waste, supply of drinking water, facilities for storing materials, etc).

7.1.2 Potential Impacts during Construction Phase of By-pass Road

One of the proposed sources for aggregate and asphalt, Gzamsheni-5 Ltd site, claims to hold Environmental Permit for this site with aggregates crushing/sorting and asphalt plants. Environmental Permits normally include certain requirements related to environmental issues e.g. ambient air, noise and surface/ground waters. The RD and successful Contactor should check the availability and compliance with the conditions of Environmental Permit and general good practice prior to selection of particular aggregate and asphalt sources. It is therefore expected that the project will not deal with the environmental impacts at borrow and asphalt source areas, unless gross violations of environmental rules and requirements are detected during the project implementation. Other potential impacts at the bypass road include:

- In the course of the rehabilitation it is expected for impacts against the local fauna to occur during the works planned to widen the sharp (dangerous) curves of the bypass road. According to the preliminary assessments, about 40 trees shall be cut;
- At the stage of widening the above-mentioned curves, surplus soil (construction waste) shall be produced;
- Impacts caused by dangerous geological processes that can be produced due to the erosion that follows widening the curves. Stone falls can also cause obstructions or emergencies along the road;
- Slope erosion due to widening of curves and cutting of rock and soil without adequate erosion temporary and permanent erosion and sediment control measures;
- Inadequate and insufficient drainage to divert surface waters from the road and ditches;

- Impacts from the operation of the mobile asphalt plant if contractor options to such solution instead of using prescribed source.

7.2 Potential Impacts During Operational Phase

7.2.1 Impacts Connected with Tunnel Operational Stage

Main impacts characteristic of the operational period are: noise, ambient air and storm sewage. The first two ones have special importance for the settled areas, but settled areas are located far enough from the tunnel. As for the environmental impacts after the rehabilitation works and at the exploitation stage, there are no significant changes expected in this respect. The sewage collecting system has nothing in common with the situation outside the tunnel. Only serious concern is related with the safety and emergency response in case of accidents or fire and respective measures are envisaged for RD to take care of in its operations.

7.2.2 Impacts Connected with the By-pass Road Operational Phase.

As the bypass road is already existing and will have limited use after construction of tunnel rehabilitation works the operational phase impacts resulting from the bypass road are only minor and can be neglected, provided rock fall, erosion, landslide and other hazard risks are not instigated during construction and that adequate site stabilization is achieved. Other mostly negligible operational impacts include:

- Intermittent traffic noise impact on fauna;
- Risk of collision with wildlife and domestic animals;
- Negligible air pollution;
- Erosion, slides, slumps and other geohazards if road not maintained properly.

7.3 Project Positive Impacts

Implementation of tunnel rehabilitation measures will enhance traffic safety. The important elements for improvement of traffic safety are the following:

- improvement of lightening system of the tunnel;
- installation of modern ventilation system, which lower pollution levels in the tunnel;
- waterproofing of the tunnel will lead to dry tunnel and discharge of uncontaminated groundwater in the nearby streams;
- better tunnel monitoring will lead to quicker response time in case of accidents or mishaps;
- widening of curves on the bypass road will ensure safe movement of any kind of transport
- reducing of travel time due to improved tunnel condition.

8. ENVIRONMENTAL MANAGEMENT PLAN

8.1 Basic Approach

The environmental management plan basically consists of two components:

The first component was worked out within the scope of the project and implies a combination of site-specific and generic impact reducing measures and related environmental monitoring plan (represented both in the plain text format as well as in the form of a table in the next chapter).

The second component is composed of requirements towards the Contractor's environmental management plans directed towards the management of various environmental themes like reinstatement, waste & pollution control, cultural heritage, traffic management, emergency response.

> ***RD capability development:*** *One of the institutional measures proposed in the document is to advise the development of general environmental management plans for RD projects and operations applicable to waste management, pollution prevention and control, reinstatement, environmental emergency response, community liaison, cultural heritage, resettlement, etc., which could also be used to define standards following internationally accepted practices for the road infrastructure construction and maintenance (standards could include parameters for surface water, groundwater, sanitary sewage, noise, air quality, soil contamination).*

Before choosing the Contractor it is impossible to carry out detailed handling of the plans for the potential of different contractors may vary, they may use different safety and environmental protection procedures and have different plans for separate sections of the highway. That is why it is advisable for the winner to cooperate with the Road Department of the Ministry of Regional Development and Infrastructure of Georgia during the mobilization stage. The close cooperation shall aim at adjusting general environmental management plans to make them site-specific for the tunnel rehabilitation and bypass construction. The environmental management plans shall be based upon:

- Site-specific and general impact reducing measures contained in this EIA Report;
- General environmental management plans. Goals and objectives of the plans are given in the present EIA Report (see "Contractor's Environmental Management Plans");
- Contractor's own working plans and methods for the tunnel rehabilitation works;
- Framework Requirements of the World Bank and the Roads Department as well as Contractor's own procedures for the health, safety and environmental protection.

Monitoring reports (daily, weekly monthly, mid-term, and final) for the period of the rehabilitation works shall be attached to the scheme. The reports shall demonstrate the effectiveness of the carried out impact reducing measures. The reports shall be worked out by the supervisory and monitoring groups of the Roads Department. The format of the reports to be submitted to Contract managers and regulatory bodies shall coincide with a preliminarily plans.

8.2 Institutional Framework for EMP Implementation

With the view of successful fulfillment of the environmental requirements determined in the Environmental Impact Assessment and the management plans it is necessary for the future

contractor and the Roads Department personnel (or an environmental supervisory consultant officially acting in the name of the RD) to have appropriate institutional potential that shall ensure correspondence of the construction works with the environmental requirements.

The competence of the prospective Constructor shall be established during the pre-selection and bidding procedure on the basis of the assessment of capabilities in carrying out environmental management and self-control as well as the requirements towards track record.

The requirements are: submission of a corporate structure for health, safety and environmental management, submission of environmental management plan samples for specific areas that are worked out/approved for similar projects, description of the internal environmental supervision control structure/self-control plan. In some cases the subject of the project/Client (the Roads Department) has to take additional measures, e.g., supervising and training of the Contractor to ascertain the right degree of understanding of environmental requirements.

In some cases, Client of the project (Roads Department of the Ministry of Regional Development and Infrastructure of Georgia) has to take certain additional measures, for instance: training the Contractor in how to ensure execution of environmental protection with high quality. For instance: training of contractor in environmental protection; helping for preparing plans of management of specific issues; helping in pre-construction analysis and planning, etc.

Competency of Roads Department can be enhanced by engagement of external environmental supervisory consultant, as well as by development of environmental management systems in order to increase own potential (for instance: by establishing the environmental supervision unit at the Roads Department). In both cases monitoring during the building process should be assured by specific plan, worked out by the supervision management. Such a mechanism would ensure effective supervision over the Contractor's work by the Roads Department.

With both options for supervision management arrangements (engagement of external specialist team or setting up the internal unit) within the course of the construction works fulfillment of the environmental requirements as well as the fulfillment of the environmental management plan shall be implemented by means of an appropriate environmental monitoring plan. These arrangements would provide effective supervision on the behalf of the Roads Department of the activities and fulfillment of the monitoring plan requirements by the Contractor(s).

The environmental supervision management plan shall fully correspond with the entire project supervision management plan that shall be worked out by the Roads Department. The detail plans for environmental management constitute one of the most significant elements of the project quality control and is required to satisfy the World Bank’s safeguard policies.

Similarly, comprehensive arrangements would be required for Health and Safety (HS) supervision: **Safety First!**

RD capability development – safe operation of Rikoti Tunnel:
Collision and Fire Accident Emergency Response Plan should be developed for the operation of the tunnel by the RD, equipment and training provided, including budgeting for safety equipment, training and monitoring. These costs could be leveraged through donor funds.

8.3. Roads Department Responsibilities and Capacity Analysis

The Roads Department of the Ministry of Regional and Development and Infrastructure of Georgia (RD) is responsible for the elaboration of policy and strategic plan related to developing motor roads, management of road and traffic related issues and construction, rehabilitation, reconstruction and maintenance of the roads of public use utilizing funds from the state budget, loans, grants and other financial sources. The RD is carrying functions of state procurement entity in relation with the aforementioned services and activities (in accordance with the law of Georgia on State Procurements and is responsible for preparing tender documentation and organization of tenders.

Thus, the RD is responsible for the procurement of the design and EIA studies, as well as works on construction and rehabilitation of roads and is responsible for ensuring compliance with the Georgian legislation and environmental and social requirements of relevant donor organizations.

The RD should have adequate capacity to ensure due to the consideration of environmental and social concerns at the stage of strategic planning, project development, design and environmental studies and construction or reconstruction activities.

Within the RD there is a special unit dealing with the environmental issues of RD managed projects. The unit is supposed to review EIAs and EMPs related to RD projects and perform monitoring of compliance of the contractor's performance with the approved EMPs and EIAs, environmental standards and other environmental commitments of RD and Contractor. At the same time, the amount of rehabilitation projects and construction projects is increasing, therefore we consider that further strengthening of capacities to handle the environmental, social and HS management is most appropriate for RD.

To cope with its general tasks, the RD needs support including but not limited to the employment of an Environmental Supervision specialist(s), who would be in charge of monitoring of this rehabilitation project on a day-to-day basis.

8.4 Monitoring of EMP Implementation

The Environmental Unit of the Roads Department shall use the following approaches within the course of the environmental and social supervision. The objective of the supervision is to ensure the maximum fulfillment of the measures reducing environmental impacts. The measures are determined in the policies of the World Bank as well as environmental management plans.

Daily supervision of the works shall be carried out by the environmental team assembled by the Roads Department and lead by the qualified selected Environmental Supervisor. Team members shall be in immediate contact with all the management levels of the Contractor working at any part of the working space. The Roads Department shall assign personnel for inspecting the rehabilitation works along the tunnel. Considering that the rehabilitation works will be carried out simultaneous on both tunnel ends, a minimum of two environmental inspectors/officers could be required in the team, reporting to Environmental Supervisor. The inspectors together with the Contractor shall ensure taking impact reducing measures at any place. Inspectors representing the Roads Department shall be at the rehabilitation area during the whole working day. The organization structure proposed for the construction project is shown in the figure below.

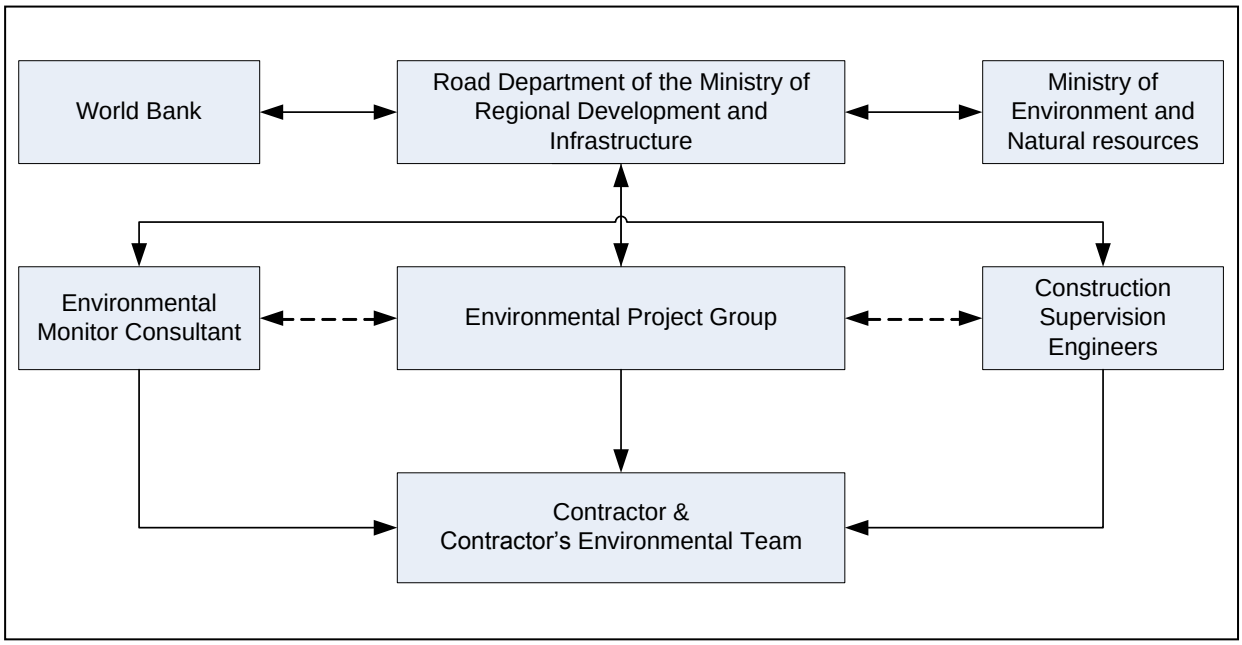


Figure 8-1 Typical EMP organization chart for construction phase.

As a minimum at least one lead Environmental Supervisor and one lead HS Supervisor should be constantly present on site on behalf of the RD (as described either RD own staff, or hired on the outsourcing basis), supported by two field inspectors. Funding for the environmental and HS teams should come either from RD budget or from the overall IBRD financed project as the consultancy and this should be negotiated during project appraisal and included in the project scope if such funds are not available to RD.

Environmental and HS Supervisors should be empowered to issue on-site instructions (through their field inspectors/officers present at the site) as well as the Corrective and/or Preventive Action Requests upon concurrence of the RD Project Manager, if serious and repeated violations are detected against EIA and EMP and other contractual requirements. They should act under Terms of Reference reviewed and approved by the RD and project financiers.

Supervisors and their inspectors should be well equipped and provided with required equipment (GPS, camera, basic measurement devices such as hand-held gas meters, etc.) with safe vehicles with maintenance and sufficient fuel for unrestricted mobility.

Similarly, contractor should have Environmental Manager and HS Manager with allocated officers, crews and helpers to manage environmental and HS processes and should have access to similar tools and amenities.

8.5 Reporting on EMP Implementation

Contractor, through the environmental specialist on the team, shall prepare monthly status reports on the EMP implementation. Such reports must carry information on the main types of activities carried out within the reporting period, status of any clearances/permits/licenses which are required for carrying out such activities, mitigation measures applied, and any environmental

issues emerged in relations with suppliers, local authorities, affected communities, etc. Contractor's monthly status reports shall be submitted to the technical supervisor and RD.

Construction supervisor prepares monthly reports on the status of EMP implementation and environmental performance of the contractor. These reports shall be based on the contractor's reports and carry analysis of their contents. The construction supervisor shall assess how accurate is the factual information provided in the contractor's reports, fill any gaps identified in them, and evaluate adequacy of mitigation measures applied by contractor. Construction supervisor should highlight any cases of incompliance with EMPs, inform on any acute issues brought up by contractor or revealed by supervisor himself, and propose corrective actions.

RD must ensure that monthly reports from the contractor and from the construction supervisor are made available for the environmental specialists of the Department promptly upon their arrival in RD administration. The Road Department, through its environmental specialists, shall report each semester to the World Bank on the status of environmental compliance of construction works. Such reporting shall contain information on all violations identified and the actions taken for fixing of such cases. RD shall inform the World Bank on any major environmental issues at any time, independently from the schedule of regular reporting.

8.6 Remedies for EMP Violation

The Road Department, as a client of construction works, will be responsible for enforcing compliance of contractor with the terms of the contract, including adherence to the EMP. For minor infringements, an incident which causes temporary but reversible damage, the contractor will be given 48 hours to remedy the problem and to restore the environment. If restoration is done satisfactorily during this period, no further actions will be taken. If it is not done during this period, RD will arrange for another contractor to do the restoration, and deduct the cost from the offending contractor's next payment. For major infringements, causing a long-term or irreversible damage, there will be a financial penalty up to 1% of the contract value in addition to the cost for restoration activities.

8.7 Environmental Management and Monitoring Approaches

The next chapters describe various mitigation and monitoring measures that shall be fulfilled during the whole period of the Rikoti Tunnel rehabilitation and by-pass construction works. Mitigation and monitoring is a significant part of the environmental management system that furthers the implementation of the worked out and agreed measures and making information about their effectiveness accessible. In cases when the measures reducing negative impacts seem to be less effective, they shall be possibly revised and replaced by alternative measures.

The next section 8.6 provides site-specific the environmental mitigation measures foreseen for the impacts characteristic for these specific rehabilitation works.

The site-specific and general environmental mitigation measures as well as the monitoring plan in the form of the tables are presented in the subsequent section 8.7.

It is important to note the following:

1. Sites-Specific and General EMPs form part of the construction contract with priority treatment as Contract Specifications.
2. Significant cost items are estimated and works descriptions are separately provided for inclusion into the tender/contract Bill of Quantities (Chapter 8.8, Table 8-3).
3. Costs for above-mentioned and all other mitigation measures are deemed to be included in the overall Contact Price and should be implemented by the Contractor acting on behalf f the Roads Department, including liability for Contract requirements and for compliance with the Government's permit issued for the implementation of the provisions of EIA and EMP and any conditions of the State Ecological Expertise.)

8.8 Environmental Mitigation Measures

The following site-specific impact reducing measures are suggested to avoid or reduce the impacts determined in this EIA.

8.8.1 Mitigating Measures Connected with Bypass Road Improvement

Mitigation Measure No 1.1

Before launching the reconstruction works along the by pass road of the tunnel the Contractor (in charge of carrying out the works) together with an invited specialist (botanist, intimately involving forestry authorities as well) the Contractor shall carry out additional quantitative and qualitative inventory of the trees within each curve of the road to be widened. The Contractor shall decide and agree with the RD its plan related to preserving the plants to the extent possible. In case of cutting the trees, new trees shall be planted to compensate for loss. The ratio of the cut and planted trees shall be 1:1.5 (15 new trees instead of 10 old ones). Threes planted for the purpose of compensation shall be the species dominating in the local growth. Before launching the works to widen the dangerous turns an inventory preceding the clearance works shall be carried out. Exact number of trees shall be determined with tree inventory at pre-construction survey. The purpose of the inventory is to identify the species and exact number of the trees to be cut. Inventory shall also determine locations for planting new species. The ratio of 1:1.5 applies then to this compensation measure.

Mitigation Measure No 1.2

Before launching the reconstruction works along the by-pass road of the tunnel the Contractor shall preliminarily prepare the land where the soil cut at the by pass road shall be placed. The works shall be approved by the local administration and cleared with the RD. The land shall be arranged so as not to disturb the traffic and prevent the material from being washed towards the road. Erosion control and stockpile retainment measures shall be defined and implemented.

Mitigation Measure No 1.3

Before launching the reconstruction works along the by pass road of the tunnel the Contractor shall work out anti-erosion and anti-rock fall measures necessary for the stability of the steep part of the widened road.

Mitigation Measure No. 1.4

As mentioned in section 4.5, according to latest estimates of engineers excavated material from the bypass road is within the order of 5,800 m^3. Portion of this material (1,600 m^3) will be reused on-site as base fill, thus reducing the amount of material for final disposal to approximately 4,200 m^3. Disposal plan for the surplus 4,200 m^3 of excavated material resulting from reconstruction of the bypass road as described in chapter 4.5 is as follows:

It is proposed that bypass spoil be deposited in the area at Village of Osiauri, Khashuri District, near Gzamsheni-5 Ltd site (see Map 8-1, Figure 8-1). The proposed disposalo site is located 18 km apart from Rikoti Tunnel, at the left side of the existing E-60 Highway. The land plot is owned by alocal resident. It has been used as a borrow area in the past and served as a depository of the solid waste later on. Filled part of the borrow pit is properly reinstated. The remaining depression can accommodate some 4,600 m^3. The land owner is willing to receive the waste material. No transaction of the title to the land is considered. The waste managment plan to be developed by the construction contractor must carry attached written agreement of the land owner as well as a written permission from the government authorities for the disposal of waste material at this site. No disposal may take place withouth RDMRDI's approval of the waste management plan.

The mitigation measure is proposed to be included as a separate line item in the bidding document and contactor contract and should include both hauling to 18 km distance, disposal, covering with topsoil and reinstatement and revegetation to a condition for agricultural use.

Mitigation Measure No. 1.5

Pre-construction survey will identify locations and special mitigation measures for the slope stabilization and drainage along the bypass section and these mitigation measures shall be included in the Reinstatement Plan provided by the contractor for approval by RD prior to initiation of works on by-pass site.

Mitigation Measure No. 1.6

Mitigation measures for the asphalt plant would include:

- Secure official approval for installation and operation of asphalt plants from the Ministry of Environment Protection and Natural Resources (MoE).
- Provide spill and fire protection equipment and submit an emergency response plan (in case of spills, accidents, fires and the like) to the authority in responsibility prior to operation of the plant;
- Asphalt plants shall be 500 m downwind from any settlements to mitigate for the odor emission and safety risks;
- Bitumen will not be allowed to enter either running or dry streambeds nor shall it be disposed of in ditches or small waste disposal sites prepared by the contractor to account for water pollution due to spilled bitumen;
- Bitumen storage and mixing areas must be protected against spills and all contaminated soil must be properly handled according to legal environmental requirements. Such storage areas must be contained so that any spills can be immediately contained and cleaned up.
- Complete and comprehensive site clean-up after the demobilization.

Mitigation Measure No. 1.7

The borrow areas suggested for use should have license to operate and environmental permits, which would include certain requirements related to environmental issues e.g. ambient air, noise and surface/ground waters. It is therefore expected that the project will not lead to additional impacts from borrow sites and no mitigation measures are envisaged, unless gross violations of environmental rules and requirements are detected during the project implementation.

8.8.2 Mitigation Measures Connected with Tunnel Rehabilitation Works

Mitigation Measure No 2.1

Due to selected alternative and the rehabilitation works to be carried out along the tunnel, the Contractor will have to dispose reinforced concrete remains removed from the damaged walls and pavement of the tunnel, latest engineering estimate of which is approximately 20,000 cubic meters (alternative D+ optional). The limited temporary storage areas available, or alternatives identified and suggested by the contractor, shall be agreed with RD and the local authorities. The issue is especially important in relation to the areas in the vicinity of the western tunnel portal for the areas adjacent to the operating roads. During the rehabilitation works, without allowing for **significant accumulation of stockpiles of concrete wastes**, these shall be **continuously hauled** to the area near Village of Osiauri, Khashuri District, to the site owned and operated by Gzamsheni-5 Ltd. This site is located 18 km apart from Rikoti Tunnel, at the left side of the Tbilisi-Senaki E-60 Highway. The owner holds an Environmental Permit for this site with aggregates crushing/sorting and asphalt plants. Environmental Permit includes certain requirements related to environmental issues e.g. ambient air, noise and surface/ground waters.

Demolished concrete wastes removed from the tunnel should be loaded on the dump trucks for transporting to the Gzamsheni-5 base for recycling.

Concrete wastes taken out of the tunnel can be reused as granular base material for future road construction.

For the temporary storage of limited amounts of concrete waste areas in the vicinity of the western and eastern tunnel portals are proposed. In particular, at the eastern portal of the tunnel there are available free lands (each 3,000 m^2). At the western tunnel face there are three areas of the following dimensions:

- 100 x 15 = 1 500 m^2 900 m from the tunnel face;
- 80 x15 = 1200 m^2 700 m from the tunnel face;
- 170 x 15 = 2 550 m^2 300 m from the tunnel face.

Mitigation Measure No 2.2

Within the tunnel rehabilitation project it is very important to safely dispose of the asbestos cement pipes (total estimated length of these asbestos pipes is 680 m, diameter 146 mm) connected with the central 500-mm intercepting steel sewer. The asbestos pipes of the type can partially deteriorate if they are exposed to the sunlight and it is quite possible for the air to be polluted with asbestos dust. The Contractor's final disposing arrangements for the asbestos pipes will have to be cleared / confirmed with the Ministry of Environment Protection and Natural Resources before actual removal and disposal.

Upon face-to-face consultations the MoE Department of Wastes Management communicated requirements on disposal of asbestos pipes. According to consultations with MoE, and taking into account that asbestos does not dissolve in the water that precludes contamination of the soil and ground water, this material may be disposed (buried) in the ground under at least 2 m high soil cover. In addition, disposal sites have to be visibly and durably marked and the information board shall be installed with asbestos burial warning and prohibition of any excavation works.

Upon these consultations with MoE it is proposed in the EMP to dispose the pipes in the same area as identified for the disposal of excess soil – a privately owned land plot near the Gzamsheni-5 Ltd enterprise. This site is located 18 km apart from Rikoti Tunnel, at the left side of the existing Tbilisi-Senaki Highway. The waste management plan to be developed by the contractor must carry written consent of the land owner as well as writeen permission/instructions from the Ministry of Environment on the disposal of asbeston-containing waste. The plan must be approved by RDMRDI before the removal of the asbestos containing pipes begin.

Actual disposal area for asbestos pipes is located in 150 m east of Gzamsheni-5 (crushing/sorting and asphalt plants) site. Dirt road leads to disposal (burial) area from Gzamsheni-5 facility.

Bill of quantities for the tunnel contract should include line item for safe and well organized dismantling of the 680 m total length 146 mm dia. asbestos pipes from the Tunnel, collection of all asbestos waste without demolishing as far as practicable and immediate loading and shipment of hazardous waste to the disposal location at Gzamsheni-5 base. Burial of the asbestos waste should be no less than below 2m depth. Strict control should be exercised to prevent escape of asbestos dust either during dismantling or transportation and burial. Provision for safety PPE and equipment for all exposed workers (including relevant dust masks). Signage installation at the disposal site is part of the works. Clearance with the Client and obtaining authorization from MoE for all actions is required. Dust control measurements should be conducted in the tunnel to detect the presence of the asbestos dust. Disposal should be comprehensively documented and conducted in the presence of the supervision project manager of RD, environmental supervisor, authorized representative of the MoE, authorized representative of the site owner and other authorities. No temporary storage of asbestos waste allowed on-site or any other place.

Annex D contains World Bank's guidelines with additional information regarding the treatment of asbestos in Bank financed projects. The Contractor shall be guided by the spirit of this publication while planning for and implementing asbestos dismantling and disposal operations.

The Contractor should demonstrate availability of the personnel trained and experienced in the management of asbestos and its disposal treatment in a safe manner.

Mitigation Measure No 2.3

Reducing impacts occurring in the process of arranging the construction camp.

In the period of gathering the background data within the scope of the section under construction an alternative area for construction camps was selected at the eastern tunnel portal. There is a non-functional two-storey building in the fenced plot. Total area of the land is 2,000 m^2. Areas around the building are not used.

The constructor is also authorized to find more acceptable areas other than the one mentioned above provided that while arranging the construction camp the constructor shall take into consideration all the environmental requirements.

As it is shown in the enclosed photos, there is no verdure (trees, shrubs) within the area. In case of deciding upon a different plot, the constructor shall assess the possibility of preserving the local verdure untouched.

If the Constructor uses the land given on the picture, soil layer shall be removed from the places determined for arranging fuel reservoirs or temporary limited volume storage of construction waste materials such as concrete. The soil shall be placed at the point preliminarily selected for the purpose. Conditions for storing the soil shall meet the requirements of the approved reinstatement plan. In particular, the dimension of the stored soil layer shall not exceed 2m. The place of storage shall select so that to avoid wash out the materials or erosion. Along the whole perimeter ditch drains shall be arranged around the stored soil stockpiles.

No soil shall be let to escape out of the designated site due to potential lead pollution. The potential contaminated areas proposed for used as temporary construction camp sites are shown in the figure below.

Figure 8-1, Designated potential contaminated area at east and west tunnel portal

The household waters of the construction site (shower, kitchen, toilet, etc.) shall be collected in the drained into the sanitary pit within the area of the building. The wastewaters shall be periodically collected and discharged into the collector system of Khashuri, when the sanitary pit fills up.

For the storage of fuels and lubricants at the temporary construction base it is important to carry out impact reducing measures to meet all environmental requirements. The measures include:

- A waterproof holding bund/barrier shall be arranged around the reservoir for mineral oils;
- The area inside the bund/barrier shall be leveled;
- Land used for receiving and delivery of fuel with special fuel trucks shall be prepared so as to comply with the leak-control measures.

The construction camp and other temporary storage areas shall be cleaned-up regularly and completely reinstated upon completion of the construction works.

In addition, by the end of the construction works as the final site clean-up activities all defaced structures and debris should be removed from the site around and adjacent to both eastern and western portals!

Mitigation Measure No 2.4

The concrete needed for tunnel rehabilitation works will be prepared at the batch plant installed on c. 5,000 m^2 area near the east portal at the right side of the road. The major components of this plant will be cement silo, concrete mixer, process water tank and belt conveyor. Cement will be imported to site by special cement trucks. The sand and gravel will be transported to site from Gzamsheni-5 Ltd base located near Village of Osiauri, Khashuri District, 18 km apart from the tunnel. Such supply will be provided based on preliminary agreement with Gzamsheni-5, which also includes recycling of concrete removed from the tunnel lining. Extraction of the process water is envisaged from Suramula River flowing near the tunnel. Prior installation of the concrete batch plant, the topsoil will be stripped and stockpiled on the c. 3,000 m^2 area at the right side of the tunnel in accordance with environmental requirements. Assuming the average topsoil layer thickness of 0.15 m, the estimated topsoil quantity will be 2,250 m^3.

After completion of rehabilitation works, the batch plant will be fully uninstalled and removed from site. The stripped topsoil will be returned to the site with further reinstatement.

Noise and dust compose the major envisaged environmental impacts expected due to operation of the batch plant. Assuming that the nearest settlement, which is Village of Chumateleti, is located approximately 2 km apart from the site, no impacts on population should occur. The process water needed for concrete preparation will be stored in the intake tank, from which it will be delivered to concrete mixer in predetermined doses. Therefore, no significant water spills are expected, though, despite this, construction of drainage system is considered for treatment of the accumulated precipitation (storm water). The treated water will be disposed to the nearby dry ravine. Based on above, the need for borrow area for extraction of the sand and gravel is not considered. Here it also should be noted that the aggregates required for concrete may be extracted only from Mtkvari riverbed borrow area that is currently carried out by Gzamsheni-5.

Mitigation Measure No 2.5

Before mobilization the Contractor should develop two Site-Specific Health and Safety Plans (bypass, tunnel) and clear with the RD & financiers.

Mitigation Measure No 2.6

Measures to recover the areas used during the construction works to their initial state.

As soon as the rehabilitation works are over it is necessary to recover the territories used by the temporary construction camps and temporary tips of the building refuse. The recovery works imply:

- Loosening the impacted ground and covering it with the soil layer removed earlier;
- The Constructor is responsible for the fulfillment of the recovery works.

Mitigation Measure No 2.7

The volume of domestic waste depends upon the number of those employed at the construction works. According to the project, the works shall take 16 months. The schedule is a single-shift (8 hr) one. On the average the number of those who work at the construction camp is 25. The majority of the workers represent the local countryside. After completing the works they shall

immediately return home. The maximum waste of the refuse produced can be 0.7 kilos per person, and 17.5 kilos for the whole staff. Correspondingly, approximately 8.4 tons of waste is produced during the construction period. In connection with the disposal of the building debris the management shall look for an agreement with the utility of Khashuri. Before its final disposal the refuse shall be temporarily collected and stored on the site, in special hermetic containers so there shall be no access for rodents, insects and animals.

In order to reduce the possible negative impacts caused by the domestic waste, it is necessary to agree the places (tips) with the local and regional authorities. Agreement on the disposal of the waste shall be drawn with a subcontractor. Before being disposed the domestic waste shall be temporarily stored in special arranged waste areas.

The Constructor and its waste collection subcontractors are responsible for the safe disposal of the refuse of any type. The Contractor shall obtain any information dealing with the disposal from the local authorities.

The selected contractor will be obliged to submit and clear waste management plan both with RD and the Ministry of Environment Protection and Natural Resources of Georgia.

Mitigation Measure No 2.8

Treatment of contaminated groundwater generated during tunnel works.

Groundwater generated during tunnel rehabilitation works can become polluted by oil hydrocarbons, and also by particulate particles. To avoid discharge of contaminated collected groundwater to the nearby rivers Suramula and Rikotula it is foreseen to install an oil-water separator for polluted wastewaters. Detailed information regarding the water treatment separator is given in Annex A.

Such treatment facility is small-sized and easy to install. Its condition should be checked maximum once in a month by sampling and testing of outflow water.

Ground water quantities are very difficult to estimate in advance due to existence of so called geological fault crossing the soil above tunnel and several ravines cut into the terrain above the tunnel. Therefore the size of the treatment facility based on an preliminary assessment and might needs to be adjusted during construction.

It might be advisable to leave the water treatment separator during tunnel operation, because due to traffic in the tunnel may happen leakage of oil hydrocarbons and despite small quantities of water is possible to avoid their discharge in above-mentioned rivers. Operational supervision could be performed by regular operational personnel of the tunnel.

Mitigation Measure No 2.9

Ventilation is one of the most important safety measures in road tunnels. The objective of the ventilation system is to dilute or remove harmful substances contained in exhaust gas from vehicles, in order to prevent the harmful substances from injuring the health of tunnel users and maintenance personnel and to maintain good visibility in tunnels. Due to the length of the tunnel

and considering that the tunnel will be for indefinitely time used as bi-directional tube, semi-transverse ventilation systems are required in accordance to European safety standards to cope with the fire safety and smoke evacuation requirements.

The semi transverse system comprises of a supply duct, whilst the whole traffic space acts as the exhaust duct, discharging to the tunnel portals. In the event of fire smoke will be discharged into the smoke exhaust air duct. The ventilation system will be used for lowering turbidity and pollutant (CO).

The control of the ventilation fans take place by an adequate amount of Anemometer, inside the tunnel, to measure the air speed and the air direction. With a sufficient quantity of Obscuration-Analyzers, distributed along the tunnel, the ventilation control system will be assisted. In case of traffic jams or stopped traffic the ventilation capacity will automatically adjusted.

In case of a power interruption of the main power supply line from Khashuri, an emergency generator will take on the power supply of the ventilation system.

8.9 Environmental Management and Monitoring Plan

Above-described and some other site-specific mitigation measures are considered in the Table 8-1 below in a concise format.

More generic mitigation measures are considered in Table 8-2. This is followed by the list of method statements & plans that has to be prepared and submitted prior to initiation of any construction works by the Contractor for approval by RD and its Construction Supervisor.

Environmental monitoring plan is contained in the Table 8-3.

8.7 Environmental Management Plan

Table 8-1. Site-Specific Environmental Management and Monitoring Plan.

Type of works	Building site	Expected Impact	Site-Specific Mitigation Measure	Monitoring Measure	Responsibility		
					Responsible Agency	Kind and periodicity of monitoring	Agency carrying out monitoring
1	2	3	4	5	6	7	8
Works necessary to widen the dangerous curves of the tunnel bypass road.	Three dangerous curves at the tunnel bypass road.	At the road widening stage it is foreseen to cut the soil in the upper part of the mountainous side. Several trees shall be cut there.	Before launching the works to widen the dangerous turns a inventory preceding the clearance works shall be carried out. The purpose of the inventory is to identify the species and exact number of the trees to be cut. The ratio of the cut and planted trees shall be 1:1,5 (15 new trees instead of 10 old ones). Species planted for the purpose of compensation shall be species dominating in the local forest.	Inventory of trees approved. Carrying out inspections in the course of works aiming at widening the dangerous turns of the bypass road.	Contractor	Permanent monitoring before the works carried out to widen the dangerous curves.	Roads Department of the Ministry for Regional Development and Infrastructure of Georgia
Temporary construction camp.	Temporary construction camp at the eastern tunnel portal.	Impact on vegetation and soils. Inadequate use of land resources	As soon as the rehabilitation works are completed it is necessary to recover to their initial condition the areas used by the temporary construction camps and temporary tips of the building refuse according to the reinstatement plan.	Inspection at the stage of fulfillment of the rehabilitation works.	Contractor	Monitoring prior to construction works. Afterwards periodically once a week. Full-fledged monitoring after completion of works. Inspection of the land realized in accordance with the land reinstatement plan	Roads Department of the Ministry for Regional Development and Infrastructure of Georgia, Local controlling authorities

Type of works	Building site	Expected Impact	Site-Specific Mitigation Measure	Monitoring Measure	Responsibility		
					Responsible Agency	Kind and periodicity of monitoring	Agency carrying out monitoring
1	2	3	4	5	6	7	8
Management of water resources on construction camps and the objects used for infrastructure purposes	Construction camps and all the objects used for infrastructure	Pollution of water resources and ground, uncontrolled discharge of sewage and oil containing waters	Discharge of sewage water from temporary construction objects (temporary construction camps, construction materials storage places) should not have any influence on surface water objects. Accumulation of polluted water should take place in septic tanks and special sewage water collection pits. In case of filling there should take place their carrying over and discharge into the operating sewerage network (e.g. in Khashuri). With the purpose of storage of combustible and lubrication materials at the areas of temporary construction camps installation of fuel and lubricant tanks and reservoirs should take place in compliance with environmental protection requirements. In particular, the reservoirs should be bunds against spill and leakage (impermeable layers like clay or other equivalent measures). Fuelling of construction facilities and vehicles should take place at the area specially arranged for that in accordance with requirements of the approved Pollution Prevention and Control Plan	Inspection during the whole phase of construction process. Monitoring of compliance with the requirements of the approved Pollution Prevention and Control Plan	Contractor	Permanent monitoring carried out during the whole course of the rehabilitation works.	Roads Department of the Ministry for Regional Development and Infrastructure of Georgia

Type of works	Building site	Expected Impact	Site-Specific Mitigation Measure	Monitoring Measure	Responsibility		
					Responsible Agency	Kind and periodicity of monitoring	Agency carrying out monitoring
1	2	3	4	5	6	7	8
Protection of the upper humus layer of soil, avoidance of soil erosion and deterioration of soil physical structure	Part of the temporary construction camp where the fuel reservoirs and temporary stores for building materials shall be arranged.	Degradation of soil quality, deterioration of its structure and decrease of productivity .	Bringing the areas used during the construction works (temporary construction camp, temporary storage of the construction waste prior to disposal) back to their initial state in accordance with the requirements of the approved reinstatement plan. In consideration of the local soil conditions and topography, maintaining the humus topsoil in a stable state in accordance with the requirements of the reinstatement plan.	Monitoring in the course of the works. Periodical checking of the stored soil layer.	Contractor	Monitoring once a week; Full-fledged monitoring after completion of works.	Roads Department of the Ministry for Regional Development and Infrastructure of Georgia
Safety of the labor, vehicles, operators of building equipment and drivers.	At the whole area of the workflow including construction camps	Safety of the labor, machinists, drivers and special personnel.	Provision of the employed personnel with detail information on the activity specified by the project. HSE Tool box talks. Carrying out of trainings relating to safety actions according to specialties. Equipment of the working personnel with personal protection gear (PPE). Checking the knowledge of technical personnel (operators, drivers and others) in respect of safety measures.	Periodical inspection and preliminary discussion of special trainings Tracking exposure of workers to high concentration of CO during works in tunnel	Contractor Technical supervisor	Weekly monitoring. Monitoring of trainings held.	Roads Department of the Ministry for Regional Development and Infrastructure of Georgia

Type of works	Building site	Expected Impact	Site-Specific Mitigation Measure	Monitoring Measure	Responsibility		
					Responsible Agency	Kind and periodicity of monitoring	Agency carrying out monitoring
1	2	3	4	5	6	7	8
Ambient air, noise, vibration	All areas connected with construction activities including temporary bypass road.	Deterioration of the ambient air quality by the exhausts of the machinery working in the tunnel. The changes shall have negative impacts upon the personnel working in the tunnel.	All cars and construction machines must be checked regularly in order to prevent air pollution. Regular maintenance programs must be carried out for all mobile or other equipments.	Controlling machinery working in the tunnel.	Contractor	Permanent monitoring of the machinery working in the tunnel.	Roads Department of the Ministry for Regional Development and Infrastructure of Georgia
Protection of soil, ground, surface and ground water from pollution by remains.	On the area envisaged for carrying out of works	Negative impact of remains that are left without control.	Controlling the waste in accordance with the waste control plan given in the present document.	Permanent control on creation and storage of new remains in order to avoid their non controlled storage.	Contractor	Permanent monitoring during all stages of construction works..	Roads Department of the Ministry for Regional Development and Infrastructure of Georgia

Type of works	Building site	Expected Impact	Site-Specific Mitigation Measure	Monitoring Measure	Responsibility		
					Responsible Agency	Kind and periodicity of monitoring	Agency carrying out monitoring
1	2	3	4	5	6	7	8
Installation of wastewater treatment facility to avoid discharge of polluted water into the rivers Suramula and Rikotula	Adjacent lands to the rivers	Impact on the quality of the rivers without treatment of wastewaters	Installation of wastewater treatment facility for polluted wastewaters at the adjacent lands to the rivers Rikotula and Suramula as described in Annex A, which is possible to use during rehabilitation works and also during the tunnel operation phase.	Permanent control of the oil separator, which needs periodically cleaning	Contractor on rehabilitation stage; Relevant Company of Roads Department during tunnel operation phase	Once a week, during construction works and , also during the tunnel operation phase	Roads Department

Table 8-2: General Environmental Management and Monitoring Plan.

GENERAL MITIGATION MEASURES DURING CONSTRUCTION AND OPERATION				
Activity	**Potential Impact**	**Mitigation measures**	**Institutional Responsibility**	
			Implement	Monitor
CONSTRUCTION PHASE				
Top soil preservation	Loss of top soil.	Removing of any available top soil occurring within clearing corridor. Topsoil shall be removed and stored for reuse. Long-term stockpiles of topsoil will immediately be protected to prevent erosion or loss of fertility.	Contractor	RD construction supervisor
Bottom of embankment of designed road lying very close to trees rows	Potential damaging of trees during construction activities	To avoid any damage to the existing trees during construction activities a temporary vegetation protection fence shall be established during construction activities.	Contractor	RD construction supervisor
Operation of borrow areas and quarries	Potential disfigurement of landscape, vegetation losses and damage to access roads Increased dust emission Siltation and obstruction of surface waters	All proposed borrow areas are already in operation. Thus environmental impacts concerning potential disfigurement of landscape, vegetation losses and damage to access roads are kept to a minimum. Wet aggregates and/or provide cover on haul trucks to minimize dust emission and material spillage. Locate stockpiles away from surface waters. Prior to operation of borrow area, the contractor shall submit a plan through the Construction Supervisor to the MoE indicating the location of the proposed extraction site as well as rehabilitation measures and implementation schedule for the borrow areas and access roads. Rehabilitation measures may not be necessary for borrow areas still in operation after road works have finished.	Contractor	RD construction supervisor
Operation of asphalt plant	Odor emission and safety risks	Asphalt plants shall be 500 m downwind from settlements. Provide spill and fire protection equipment and submit an emergency response plan (in case of spills, accidents, fires and the like) to the authority in responsibility prior to operation of the plant. Secure official approval for installation and operation of asphalt plants from the Ministry of Environment Protection and Natural Resources (MoE).	Contractor	RD construction supervisor, MoE
	Water pollution due to spilled bitumen	Bitumen will not be allowed to enter either running or dry streambeds nor shall it be disposed of in ditches or small waste disposal sites prepared by the contractor. Bitumen storage and mixing areas must be protected against spills and all contaminated soil must be properly handled according to legal environmental requirements. Such storage areas must be contained so that any spills can be immediately contained and cleaned up.	Contractor	RD construction supervisor, MoE

GENERAL MITIGATION MEASURES DURING CONSTRUCTION AND OPERATION				
Activity	**Potential Impact**	**Mitigation measures**	**Institutional Responsibility**	
			Implement	Monitor
Site selection, site preparation and operation of contractor's yard	Potential soil and water pollution	The contractor shall submit documents for approval (short statement and site plan in appropriate scale) which indicate: • Site location, surface area required and layout of the work camp. The layout plan shall also contain details of the proposed measures to address adverse environmental impacts resulting from its installation. • Sewage management plan for provision of sanitary latrines and proper sewage collection and disposal system to prevent pollution of watercourses; • Waste management plan covering provision of garbage tons, regular collection and disposal in a hygienic manner, as well as proposed disposal sites for various types of wastes (e.g., domestic waste, used tires, etc.) consistent with appropriate regulations; • Description and layout of equipment maintenance areas and lubricant and fuel storage facilities including distance from water sources and irrigation facilities. Storage facilities for fuels and chemicals will be located away from watercourses. Such facilities will be bounded and provided with impermeable lining to contain spillage and prevent soil and water contamination • Prior to the commencement of works the site installations shall be inspected for approval	Contractor	RD construction supervisor, MoE
	Competition for water resources	Prior to establishment of the work camps, conduct consultations with local authorities to identify sources of water that will not compete with the local population.	Contractor	RD construction supervisor
	Health and safety risks to workers and adjacent communities	For health and safety protection of workers and adjacent communities the following shall be provided: • adequate health care facilities (including first aid facilities) within construction sites; • training of all construction workers in basic sanitation and health care issues, general health and safety matters, and on the specific hazards of their work; • personal protection equipment for workers, such as safety boots, helmets, gloves, protective clothing, goggles, and ear protection in accordance with legal legislation; • clean drinking water to all workers; • adequate protection to the general public, including safety barriers and marking of hazardous areas; • safe access across the construction site to people whose settlements and access are temporarily severed by road construction; • adequate drainage throughout the camps so that stagnant water bodies and puddles do not form; • sanitary latrines and garbage bins in construction site, which will be periodically cleared by the contractors to prevent outbreak of diseases. Where feasible the contractor will arrange the temporary integration of waste collection from work sites into existing waste collection systems and disposal facilities of nearby communities.	Contractor	RD construction supervisor, MoE

GENERAL MITIGATION MEASURES DURING CONSTRUCTION AND OPERATION				
Activity	**Potential Impact**	**Mitigation measures**	**Institutional Responsibility**	
			Implement	Monitor
Work site operation / Operation of equipment maintenance and fuel storage areas	Worker's health and soil / water pollution	Prior to the commencement of works, the work site personnel shall be instructed about safety rules for the handling and storage of hazardous substances (fuel, oil, lubricants, bitumen, paint etc.) and also the cleaning of the equipment. In preparation of this the contractor shall establish a short list of materials to be used (by quality and quantity) and provide a rough concept explaining the training / briefing that shall be provided for the construction personnel. Locate storage facilities for fuels and chemicals away from watercourses. Such facilities will be bounded and provided with impermeable lining to contain spillage and prevent soil and water contamination. Store and dispose waste/used oil consistent with environmental legal requirements. Work site restoration: After completion of construction works the contractor shall execute all works necessary to restore the sites to their original state (removal and proper disposal of all materials, wastes, installations, surface modeling if necessary, spreading and leveling of stored top soil).	Contractor	RD construction supervisor, MoE
Operation of construction camp	Road construction projects bear a high potential risk to affect local communities and the health and well-being of those that live in or near to the temporary work camps by supporting the spread of STD and HIV/AIDS. In addition, the transport sector itself actually helps the epidemic, as infrastructure and associated transport services give people and infections mobility.	Providing information to workers, encouraging changes in individual's personal behavior and encouraging the use of preventive measures. The goal of the information is to reduce the risk of HIV / STD transmission among the beneficiaries (construction workers and camp support staff)	Contractor	RD construction supervisor, MoE
Earth works and various construction activities	Loss of topsoil	Topsoil shall be stripped and reused to cover areas where excess materials will be dumped and on road embankments. In addition a soil management plan shall be provided detailing measures to be undertaken to minimize effects of wind and water erosion on stockpiles, measures to minimize loss of fertility of top soil, timeframes, haul routes and disposal sites.	Contractor	RD construction supervisor
Earth works and various construction activities (continuation)	Siltation of surface waters and/or impact on soils due to improper disposal of excess materials	Mostly all extraction material will be reused. In addition the reclaimed asphalt pavement will be recycled. It will be used as sub base material. Asphalt will be milled and cement added for stabilization, thus reducing the volume of material to be disposed. Thus potential impacts due to the need for disposal of excess material will be kept to a minimum.	Contractor	RD construction supervisor

GENERAL MITIGATION MEASURES DURING CONSTRUCTION AND OPERATION				
Activity	**Potential Impact**	**Mitigation measures**	**Institutional Responsibility**	
			Implement	Monitor
	Competition for water resources	Conduct consultation with local authorities to identify sources of water (for spraying and other construction requirements) that will not compete with the local population.	Contractor	RD construction supervisor
	Air pollution due to exhaust emission from the operation of construction machinery	Maintain construction equipment to good standard and avoidance, as much as possible, idling of engines. Banning of the use of machinery or equipment that cause excessive pollution (e.g., visible smoke).	Contractor	RD construction supervisor
	Disturbance of adjacent settlements due to elevated noise levels	Restrict work between 0600 to 2100 hours within 500m of the settlements. In addition, a limit of 70 dBA will be set in the vicinity of the construction site and strictly followed.	Contractor	RD construction supervisor
	Soil compaction due to operation of heavy equipment	Confine operation of heavy equipment within the corridor that is absolutely necessary for the road construction to avoid soil compaction and damage to land.	Contractor	RD construction supervisor
	Traffic impairment	Submit a traffic management plan to local traffic authorities prior to mobilization. Provide information to the public about the scope and schedule of construction activities and expected disruptions and access restrictions Allow for adequate traffic flow around construction areas. Provide adequate signalization, appropriate lighting, well-designed traffic safety signs, barriers and flag persons for traffic control.	Contractor	RD construction supervisor
Works near watercourses	Impairment of water quality, potential erosion of river embankment	Submit a method statement or plan for the execution of works near watercourses including measures that will be undertaken to address adverse environmental impacts such as erosion of river embankment and siltation of watercourses that may result from such activities. Avoid "dropping structures" into rivers/streams. This will be done by "sawing" appropriate sections of the structure and using cranes to lift these sections or alternatively construct a platform onto which the structure could be dropped. Discharge of sediment-laden construction water (e.g., from areas containing dredged spoil) directly into surface watercourses will be forbidden. Sediment laden construction water will be discharged into settling lagoons or tanks prior to final discharge.	Contractor	RD construction supervisor

GENERAL MITIGATION MEASURES DURING CONSTRUCTION AND OPERATION				
Activity	**Potential Impact**	**Mitigation measures**	**Institutional Responsibility**	
			Implement	Monitor
OPERATION PHASE				
Increased traffic flow	Elevated levels of gaseous and noise emissions due to increased traffic. In addition increased pedestrian vs. vehicle accidents due to traffic volume and higher speed as a result of improved road design.	Integrate in the engineering design safety features such as speed control signs, proper road markings, streetlights, pedestrian crossing, livestock crossing and other visual means.	Design Consultants	RD construction supervisor
Increased traffic volumes and higher vehicle speeds	Increased risk of accidents with possible spills of harmful substances.	Spill-contingency plan A contingency plan or emergency response plan is a set of procedures to be followed to minimize the effects of an abnormal event on the Project roads, such as a spill of oil, fuel or other substances that may harm drinking water resources or have adverse effects on the natural balance of sensitive areas.	RD	RD
Damaged drainage or uncontrolled erosion.	Harmful environmental impacts resulting from damaged drainage or uncontrolled erosion.	Routine monitoring of drainage system and erosion control at least twice a year.	RD	RD

Prior to construction works, the following method statements/plans shall be submitted by the Contractor for approval by Construction Supervision:

- Detailed Method Statement for Asbestos Dismantling and Disposal shall be provided for Client's approval before commencement of any works which would expose asbestos hazard
- Before mobilization the Contractor should develop two Site-Specific Health and Safety Plans (bypass, tunnel) and clear with the RD & financiers.
- Prior to initiation of works on by-pass site pre-construction survey should be conducted and Reinstatement Plan provided by the contractor for approval by RD to account for locations and mitigation measures for the slope stabilization and drainage along the entire bypass section
- A plan indicating the location of the proposed extraction site as well as rehabilitation measures to be implemented for the borrow areas and access roads upon project completion. Rehabilitation measures may not be necessary for borrow areas still in operation after road works have finished
- Dust management plan which shall include schedule for spraying on access roads and details of the equipment to be used
- Layout of the work camp and details of the proposed measures to address adverse environmental impacts resulting from its installation
- Sewage management plan for provision of sanitary latrines and proper sewage collection and disposal system to prevent pollution of watercourses
- Waste management plan covering provision of garbage bins, regular collection and disposal in a hygienic manner, as well as proposed disposal sites for various types of wastes (e.g., domestic waste, used tires, etc.) consistent with appropriate regulations. The selected contractor will be obliged to submit and clear waste management plan with both RD and the Ministry of Environment Protection and Natural Resources of Georgia.
- Description and layout of equipment maintenance areas and lubricant and fuel storage facilities including distance from water sources and irrigation facilities. Storage facilities for fuels and chemicals will be located away from watercourses. Such facilities will be bounded and provided with impermeable lining to contain spillage and prevent soil and water contamination
- Soil Management Plan detailing measures to be undertaken to minimize effects of wind and water erosion on stockpiles of topsoil and excess materials, measures to minimize loss of fertility of top soil, timeframes, haul routes and disposal sites for excess materials.
- Emergency response plan (in case of spills, accidents, fires and the like) prior to operation of the asphalt plant
- If Applicable: Method statement or plan for the execution of works near or in the watercourses including measures that will be undertaken to address adverse environmental impacts such as erosion of river embankment and siltation of watercourses that may result from such activities

Table 8-3. General Environmental Monitoring Plan.

Issue	What parameter is to be monitored?	Where is the parameter to be monitored	How Is the parameter to be monitored?	When is the parameter to be monitored? Frequency	Institutional responsibility
Top soil preservation	Stockpiling and means of protection	Job site	Inspections; observation	Upon preparation of the construction site, after stockpiling and after completion of works on shoulders	RD Construction Supervision
Equipment servicing and fuelling	Prevention of spilling of oil and fuel	Contractor's yard	Inspections; observations	Unannounced inspections during construction	RD Construction Supervision
Worker's safety and health	Official approval for worker's camp; Availability of appropriate personal protective equipment; Organization of traffic on the construction site	Job site and worker's camp	Inspection; interviews; comparisons with the Contractor's method statement	Unannounced inspections during construction and upon complaint	RD Construction Supervision
Worker's education on AIDS and STD	Has relevant education been provided?	To be determined by assigned RD Construction Supervision	To be determined by assigned RD Construction Supervision	After beginning of works and at appropriate intervals throughout construction	RD Construction Supervision
Material supply Asphalt plant	Possession of official approval or valid operation license	Asphalt plant	Inspection	Before work begins	RD Construction Supervision
Borrow areas	Possession of official approval or valid operation license	Sand and gravel borrow pit	Inspection	Before work begins	RD Construction Supervision
Material transport Asphalt	Are the truck loads covered or wetted?; Compliance with the Contractor's method statement (restricted working hours; haul routes) dust suppression methods where required	Job site / haul routes	Supervision	Unannounced inspections during work	RD Construction Supervision
Stone		Job site / haul routes	Supervision spot checks	Unannounced inspections during work	RD Construction Supervision
Sand and gravel		Job site / haul routes	Supervision	Unannounced inspections during work	RD Construction Supervision
Surface water protection	Contractor's compliance with his approved method statement	Works near watercourses	Inspection	Unannounced inspections during works near watercourses	RD Construction Supervision
Tree protection	If applicable, i.e. trees close to construction site installation of tree protection fence.	At sites where trees and forests are located along the construction site.	Supervision	After begin of construction works at the respective site	RD Construction Supervision
Air pollution from improper maintenance of equipment Asphalt plant and Machinery	Exhaust fumes, dust	At site	Visual inspection	Unannounced inspections during construction works	RD Construction Supervision, MoE

Issue	What parameter is to be monitored?	Where is the parameter to be monitored	How Is the parameter to be monitored?	When is the parameter to be monitored? Frequency	Institutional responsibility
Increased road kills of animals due to higher traffic loads and vehicle speeds	Road kills of animals	Along the new road	Keep records of accidents. In the case that accident hot spots with large mammals are identified, appropriate protective measures shall be elaborated (e.g. reflectors / local fencing, warning signs, speed reductions etc.)	Throughout the Year	RD
Increased traffic volumes may increase possible spills of harmful substances	Accidents that cause spills of harmful substances	Along the new road	Counting of accidents	Throughout the Year	RD
Damaged drainage or uncontrolled erosion	Leakages in drainage system and damages due to erosion	Culverts and drainage facilities	Documentation	Throughout the Year	RD

Map 8-1. Non-hazardous bypass spoil, tunnel concrete, hazardous tunnel asbestos waste sources and disposal sites.

(Map inset shows two soil sampling points near Eastern Tunnel Portal indicated with pink symbols as well as an area for batch plant and workers camp where soil disturbance should be minimized. No spoil should leave these sites to avoid cross-contamination. No other areas should be disturbed.)

Figure 8-1. Bypass spoil disposal site near Gzamsheni-5 office.

Figure 8-2. Eastern tunnel portal: potential worker's camp and space for concrete batch and/or asphalt mobile plant location.

8.10 Cost Estimate of Environmental Mitigation Measures

The estimated costs for implementing the mitigation measures and monitoring plan are provided in the following table. Costs during construction shall be in the Contractor's civil work's package while costs for assisting the Roads Department of the Ministry of Regional Development in the implementation of the EMP and carrying out relevant environmental training shall be included in the RD Construction Supervision costs.

Table 8-3: Expenditures of reducing environmental impacts and monitoring

#	Item	Unit	Quantity	Unit Cost in USD	Total in USD
Impact reducing measures described in the document [2]					
#1	Planting trees to compensate the cut ones (*)	tree seedling	80	5	400
#2	Measures protecting from landslides and erosion (*)	lump sum	1	100,000	100,000
#3	Selecting construction sites and arranging temporary construction camps in accordance with the environmental principles. (*)	Minimal, included in the cost estimates of the technical design			
	Removal of humus soil layer, storage and using it again	m^3	2660	7	18.620
#4	Technical safety measures for the construction sites (*)	lump sum	1	21,000	21,000
#5	Training labor and personnel in the safety and health issues	lump sum	1	5,000	5,000
#6	Occasional archaeological discoveries, training the labor in the issues connected with the corresponding activities. (*)	lump sum	1	2,000	2,000
#7	Recovering the territories affected by the impacts, loosening the damaged soils & covering them with a layer of soil preliminarily cut.	lump sum	1	36,000	36,000
#8	Identification of places for disposal of the waste. Implementation of procedures for treating the waste (*)	lump sum	1	12,000	12,000
#9	Wastewater treatment facility(*)	Lump sum	1	20,000	20,000
#10	Anti-vermin and pesticide control measures(*)	Minimal			
#11	Delivery of 4,200 m^3 by-pass spoil material with dump trucks to 18 km distance for disposal at damaged private plot, covering with borrow topsoil, reinstatement and replanting of the site to condition for agricultural use by the owner of the plot. Reclamation of any temporary storage of spoil waste on by-pass or other place. (*)	m^3	4,200	4.50	16,800
#12	Delivery of 20,000 m^3 tunnel concrete waste with dump trucks to 18 km distance for disposal at Gzamsheni-5 Ltd owned aggregates crushing/sorting, for concrete recycling and reuse. Reclamation of any temporary storage of concrete waste near tunnel or other place. (*)	m^3	20,000	7	140,000
#13	Safe and well organized dismantling of the 680 m total length 146 mm dia. asbestos pipes in the Tunnel, collection of all asbestos waste without demolishing as practicable and immediate loading and shipment of hazardous waste to the disposal location at Gzamsheni-5 base. Burial of the asbestos waste below 2m depth. Strict control to prevent escape of asbestos dust either during dismantling or transportation and burial. Provision of safety PPE and equipment for all exposed workers. Signage installation at the disposal site. (*)	m^3	40	15	600
#14	Subcontract for all the waste collection (with the exception of asbestos, spoil and concrete waste) generated during construction of tunnel (*)	lump sum	1	5,000	5,000
#15	Subcontract for all the waste collection (with the exception of asbestos, spoil and concrete waste) generated during construction of bypass (*)	lump sum	1	5,000	5,000
#16	Complete site cleanup (all temporary camps and storage areas) for tunnel (*)	lump sum	1	5,000	5,000
#17	Complete site cleanup (all temporary camps and storage areas) for bypass (*)	lump sum	1	5,000	5,000

[2] Presumable expenditure of the construction period (2 years)

#	Item	Unit	Quantity	Unit Cost in USD	Total in USD
Monitoring described in the environmental monitoring plan					
#18	Monitoring of the site-clearance works (*)	month	24	500	12,000
#19	Regular recovery of the environmentally sensitive areas used for the construction works (*)	Minimal			
#20	Monitoring of the water resources management at the construction camps (*)	month	24	500	12,000
#21	Monitoring of the humus soil layer's storage (*)	month	24	500	12,000
#22	Protection of the safety and health of the labor / periodical checking of the training	hours	100	100	10,000
#23	Monitoring of the surface water protection measure in the course of the construction works (*)	month	24	250	6,000
#24	Monitoring of the ground water protection measure in the course of the construction works (*)	month	24	250	6,000
#25	Ambient water and noise, regular checking of the vehicles and building machinery (*)	month	24	500	12,000
Emergency Response Training and Engagement of Environmental Supervision Consultant					
#26	Training of tunnel operators in emergency response (*)	lump sum	1	15,000	15,000
#27	Environmental Supervision Consultant and 2 Environmental Officers	month	24	5,000	120,000
				TOTAL	597,420

Note (*): Measures are included in the technical design / supervision activities

8.11 Proposed Provisions for the Bidding Document and Construction Contract

Following provisions are proposed for incorporation in the bidding and contract documents for the tunnel rehabilitation works to ensure compliance with the provisions set out in the EMP:

1. RD, as a client of construction works, will be responsible for enforcing compliance of contractor with the terms of the contract, including adherence to the EMP. For minor infringements, an incident which causes temporary but reversible damage, the contractor will be given 48 hours to remedy the problem and to restore the environment. If restoration is done satisfactorily during this period, no further actions will be taken. If it is not done during this period, RD will arrange for another contractor to do the restoration, and deduct the cost from the offending contractor's next payment.
   To that end, the Bidding Document should provide that for major infringements, causing a long-term or irreversible damage, there will be a financial penalty up to 1% of the contract value in addition to the cost for restoration activities.

2. Bidding document should include above listed major items for environmental management in the Bill of Quantities (BoQ) as a potential deterrent to Contractor if it fails to implement these costed mitigation measures. Estimated costs provided in this Table 8-3 should be used for evaluation whether bidder/contractor under-costs these items in their proposal and in case of significant deviation the bid should be declared non-responsive.

3. Bidding document should also provide for additional measures envisage as well to enhance contractor compliance with the minor items from EMP mitigation measures which can not be included as a separate items but which may have strong environmental consequences. The mechanism proposed is to withhold 5% payment from monthly payments against invoiced amount of works in case Corrective or Preventive Action Requests opened for rectification of environmental or HS violations were not implemented id due by the time of this particular invoice. Payments can be affected once actions are fully implemented by the Contractor.

4. Bidding document should also require subcontracting for all the waste collection (with the exception of asbestos, spoil and concrete waste treated separately) generated during construction separately for both sites – tunnel and bypass. In its bid contractor should name the subcontractor and provide unit rates for hazardous and non-hazardous waste disposal in clearance with regulations and prevailing practice.

5. Bidding documents should provide provisions for Environmental Manager and HS Manager as required Key Personnel together with Project Manager and other key construction personnel, including requirement requesting their CVs as part of the bid. In addition, during negotiations bidding documents should provide that Environmental Manager and HS Manager be interviewed by the Clint representatives and change of personnel requested if capabilities of nominated persons are found inadequate.

6. Additional bidding and contract requirement should be to inspect quality of contractors equipment on compliance with environmental and HS requirements (aiming that leaking or unsafe and poorly maintained equipment should not be allowed on the site).

8.12 Contractor's Environmental and Social Management Plans

The effective implementation of the environmental management system is based on the development and implementation of environmental and social management plans by the Contractor.

A summary of the environmental and social management plans to be made available by the Contractor is presented in the table below. The plans are described in terms of their purpose and objectives, anticipated date for completion, and the responsible party (contractor) for development and implementation of the plan.

The Roads Department will review and approve these plans. The construction Contractor is then responsible for their implementation with the Roads Department maintaining a strong overview and monitoring role.

In view of the fact that the distance between the settled areas and the area necessary for the implementation of the tunnel rehabilitation works is quite large and there are no state or private lands included in it, the list of the environmental management procedures does not include social aspects.

Table 8-4: List of Contractor's environmental management plans

#	Plan	Purpose and objectives of the plan	Date of performance	Responsibility for working out and implementing the plan
1	Traffic management plan	Sets out specific actions for construction contractor to properly manage traffic and its potential impacts, including safety and accidents. .	Before commencement of the rehabilitation works, the Contractor shall work out and prove the final detailed version of the traffic safety plan.	The Constructor is responsible for the fulfillment of the requirements that shall be met according to the approved final detail plan for the rehabilitation works. The follow-up action shall be carried out by the Roads Department.
2	Reinstatement plan	The plan foresees measures that shall be implemented by the Contractor in order to recover the territories damaged during the tunnel rehabilitation stage.	Before commencement of the works, the Constructors shall work out and prove a final detailed plan for the recovery of territories.	According to the requirements of the plan approved before launching the construction works, the Constructor shall be responsible for the full recovery of the damaged territories. The follow-up action shall be carried out by the Roads Department.
3	Environmental pollution prevention and waste management plans	Elaboration of plans by Contractor and Department of Roads, to reduce or eliminate environmental pollution .	Contractor, together with sub contractors shall implement all requirements of environmental pollution prevention and debris management plans before commencing works. All construction aspects shall be envisaged during preparation of plans.	Contractor is responsible to solve all raised issues, according to environmental pollution prevention and debris management plans. The Roads Department shall periodically revise implementation of plans.

Outline of Traffic Management Plan

The traffic management plan is required in order minimize the possibility of damaging the natural environment to its minimum due to traffic diversions and closures during construction.

Objectives of the plan

With the view of promoting the traffic control, the Contractor shall work out requirements dealing with the special issue. The requirements are the reduction of negative environmental impacts by means of special exhaust control, high quality servicing for vehicles, standards compliance.

In order to achieve the objectives during the tunnel rehabilitation the plan will address the following:

- Dimension of vehicles and the traffic schedule;
- Local traffic procedures;
- Description of the types and number of vehicles connected with the transportation of heavy loads;
- Restrictions set for passing through territories other than the working ones determined in the project;

- Strict observance of the speed limits determined in the project, applied particularly strictly when passing Chumateleti (10 km/h speed limit along this settlement);
- Short-term training on environmental protection and safety issues to be held for drivers;
- Modalities of announcements in media to inform public on increased traffic occurrences;
- Travel management planning.

Responsibility
Prior to commencing the works, the Contractor shall develop a traffic management plan for the project. The Contractor shall be supervised and controlled by the Roads Department.

Monitoring and review
The Constructor shall prepare weekly reports presenting the monitoring of compliance with the traffic management plan. A manager of the Roads Department shall periodically check Contractor's activities connected with the fulfillment of the traffic management plans.

Outline of Reinstatement Plan

The plan for recovering the territories affected by the impacts foresees the principles and goals that are necessary for the rehabilitation of the lands where the ecological conditions were damaged due to the works. It is difficult to make full-scale qualitative and quantitative assessments of all the territories within the active impact zone unless the rehabilitation works are over.

In consideration of what was underlined above, the Constructor shall work out special methodology and procedures in the form of an action plan for carrying out recovery works within the impacted affected territories.

Objectives of the plan
The reinstatement plan shall determine the measures to be fulfilled as well as responsibilities to make it possible for the Contractor to make a schedule that is necessary for achieving the objectives of the plan. The measures to be scheduled are:

- Topsoil protection;
- Stabilization of the ground affected by the impacts;
- Removal or spreading of the surplus soil.

Responsibility
The Contractor shall develop a detailed reinstatement plan, including the following topics:

- Methodology together with the description of the rehabilitation works;
- Plan for inspecting the works carried out;

The plan shall be approved by an environmental manager of the Roads Department.

A representative of the Department shall periodically check the quality and compliance of the works carried out by the Contractor with the reinstatement plan.

Monitoring and review
Prior construction works, the Contractor shall prepare a descriptive report upon the background data characteristic of the land determined for the activities. The report shall be agreed with a representative of the Environmental Department under the Roads Department. The report shall

document the necessity of recovering every single area. After finishing the works, the Contractor shall make a report upon the rehabilitation works. Compliance of the reinstatement works shall be determined by an authorized person representing the Roads Department.

Outline of Pollution Prevention and Waste Management Plan

The pollution prevention and waste management plan shall be developed at the tunnel rehabilitation stage. The construction contractor will be required to develop a construction specific waste management plan prior to the start of the construction work with consideration of requirements specified in this chapter. The Roads Department may use the agreement on waste disposal signed by the construction contractor with the third party

Objectives of the plan

The objectives of the pollution prevention and waste control management plan are:

- To identify potential pollutants
- To provide procedures for transporting, handling, storing, using and disposing of pollutants
- To describe the proposed measures to prevent spillages and pollution to land and water
- To protect water resources
- To harmonize the issues governing the generation, handling, treatment and disposal of wastes generated during the construction phase as well as for the moment of completion and putting into operation of the motor road with the various regulations and rules currently active in Georgia;
- To make the aspects connected with the transportation, processing and removal of the waste produced during the design works, after launching the works and at the stage of putting the tunnel into operation, to correspond with different instructions and rules operating in the country;
- To identify any third party agreements for waste transfer or handling;
- To obtain and use different methods to reduce the volume of the waste to its minimum;
- To enforce strict duty of care on the project managers and the contractors;
- To establish temporary secure storage of waste generated during construction phase in defined areas away from watercourses, drains and aquifers;
- To provide monitoring and auditing procedures over implementation of waster management requirements.

Responsibility

The Contractor together with the partner Subcontractors are mainly responsible for the procedures connected with the disposal of the waste.

With this regard, the Contractor shall:

- Waste disposal contractors use facilities for treatment and disposal of waste that meet acceptable standards
- Specialists involved in waste management have adequate training and follow stipulated waste management procedures for minimizing, handling and storing waste
- Audits are carried out to ensure these are achieved

Monitoring and review

Monitoring of the waste plan shall be carried out before launching he construction works, after their fulfillment and periodically. The plan shall be implemented by the Roads Department.

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Annex A. Wastewater Treatment Unit

The function of the distilling aggregate is to clean the contaminated precipitation and industrial wastewaters contaminated with mineral oils. The aggregate was worked out by Moscow research Institute. Its capacity makes 6 m^3/hr The aggregate is recommended for wide application.

It is a single metal block of triple-change arresters and filters. The dimensions of the aggregate are: 2500x1000x1500 mm, weight – within 2200 kg.

Taking into consideration the capacity, dimensions and engineering data of the aggregate it can be used to distil flowing waters and wastewaters.

The special scheme for operating the aggregate is given on the drawing.

The wastewater is supplied to the first level (4) of the arrester through a water pipe (2) and distributing chute (3). The main mass of floatable substances and mineral oils shall be caught by means of the arrester (5) and collecting chutes (7). The mineral oils flow into the collecting tank (14) by gravity. The floating gauge (15) shows if the reservoir is filled. After filling the reservoir the mineral oils shall be moved out of the territory for secondary use or/and processing.

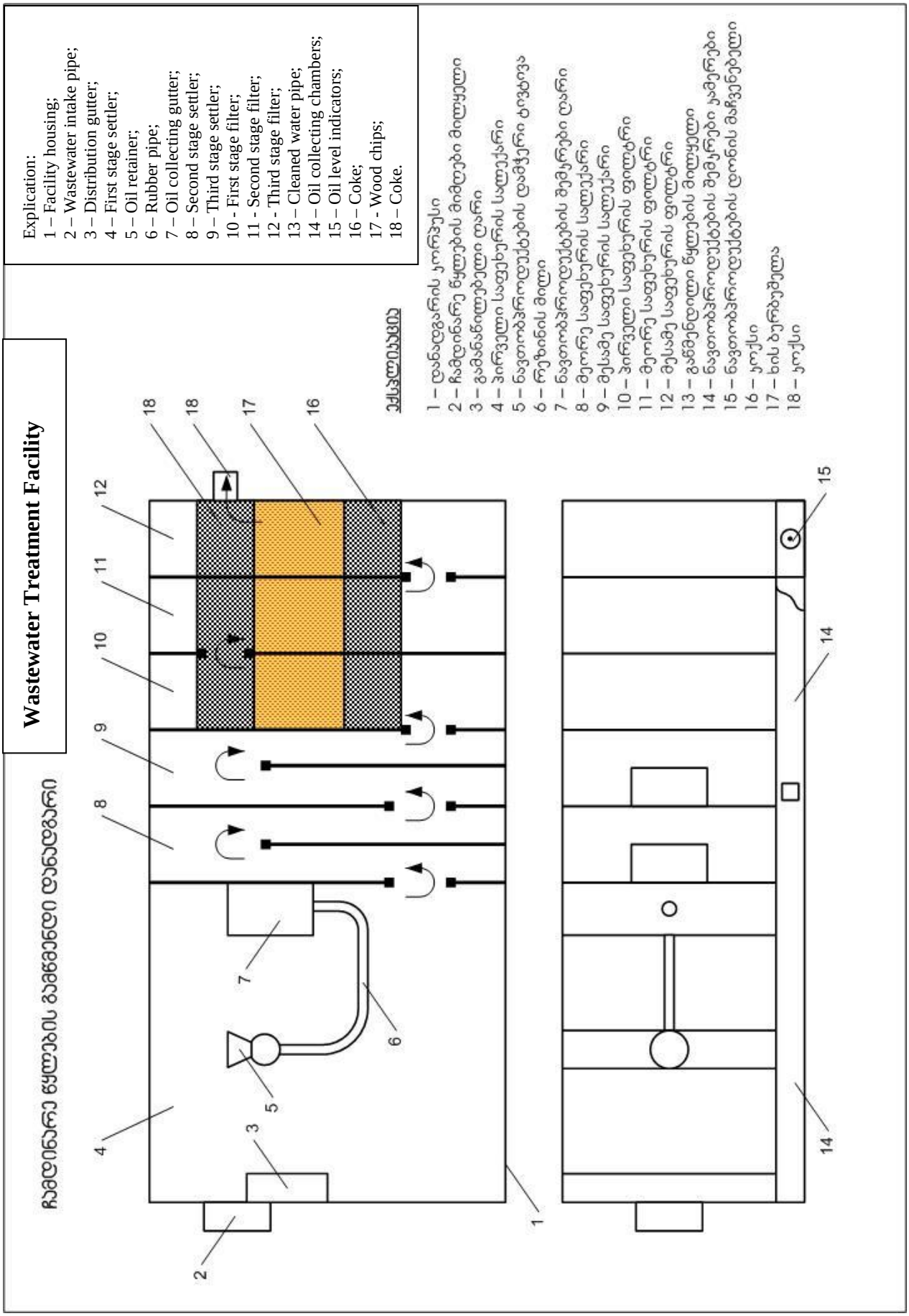
After the first level (4) the wastewater shall pass the second (8) and the third (9) levels flowing from the bottom to the top. The rest floatable substances shall be partially settled there. The arresters shall be cleaned by hand. The frequency of cleanings depends upon the volume of the collected mass.

After passing through the arresters the water flows up to the three-stage filters (10, 11, 12) where the wastewater shall be fully cleaned and it shall be possible to drop the water into the flowing water drainage system through the stack (13). The draining conditions shall be agreed with the leadership of "Tbiltskhalkanali" Ltd.

The engineering calculations of the aggregates are made in accordance with the requirements of the SNIP11-93-74, "Motor-car Maintenance Services", paragraph 6, table 9. According to the very requirements and the preliminary data given in the above-mentioned table the following substances are to be filtered:

- 700 mg/Ltr. floatable substances;
- 75 mg/ Ltr. mineral oils.

As it was said above the basic mass floatable substances and mineral oils are arrester by means of a three-stage arresting aggregate. The calculations are made on the basis of the SNIP 02.04.07-85 according to the requirements of which 0, 3-mm diameter particles shall be arrested. (particles with the size of 6 m.mic. and more are meant).


Explication:
1 – Facility housing;
2 – Wastewater intake pipe;
3 – Distribution gutter;
4 – First stage settler;
5 – Oil retainer;
6 – Rubber pipe;
7 – Oil collecting gutter;
8 – Second stage settler;
9 – Third stage settler;
10 - First stage filter;
11 - Second stage filter;
12 - Third stage filter;
13 – Cleaned water pipe;
14 – Oil collecting chambers;
15 – Oil level indicators;
16 – Coke;
17 - Wood chips;
18 – Coke.
Wastewater Treatment Facility

According to the results of the research undertaken at the scientific-research institute (ВНИИ "ВОДГЕО") the treatment efficiency of the proposed three-stage settler is 97%. Therefore the remaining quantity of suspended materials after treatment of the wastewater in the settler will be 700 X 0.03 = 21 mg/l. The quantity of sludge in an hour will be:
$P = (C_1-C_2)Q /1,000 = (700-21) X 6 / 1,000 = 4$ kg.

The volume:
$W_{sm} = P_{sm} X 100 / (100 - P) X \gamma = 0.004 X 100 / (100-70) X 1.5 = 0.009 m^3/h$,

where P – is a humidity of newly settled materials $t/m^3 = 70$
γ – is a volume weight of newly settled materials $t/m^3 = 1.5$

The calculation of the cleaning efficiency of the settler for oil products has been made for the emergence rate of particles 100 m.mic. and more in diameter which is 0.07 cm/sec. Since the time of holding of water in the settler is more than the emergence rate the efficiency of retaining oil products in wastewater is considered to be 95%, i.e. 75 X 0.05 = 3.75 mg/l.

The quantity of oil products emerged in hour is:
$P_{op} = Q X (C_1-C_2) / 1000 = 6 X (75-3.75) /1,000 = 0.4$ kg/h.

The volume will be
$W_{op} = P_{op.} / \gamma = 0.0004 / 0.95 = 0.004 m^3/h$

The filters installed in the facility are design to retain remaining fine dispersive particles of suspended materials and oil products in the water coming from the settler. The characteristics of water entering the filters are as follows:

- suspended materials – 21 mg/l;
- oil products – 3.75 mg/l.

According to the results of the research the rate of the filter (considering the filter materials) is assumed to be 6 m/h.

The filter shall be arranged as follows:
1. The lower layer of the filter (1/4 of its total height) will be filled by coke (16). Coke may be substituted by loose haydite, silica sand, anthracite, etc.;
2. The mid layer of the filter (2/4 of its total height) may be filled by wood chips (17), which can be substituted by glass fiber and/or kapron waste;
3. The upper layer of the filter (1/4 of its total height) will be filled by coke (18).

On the basis of the test results and operational data of similar filters their cleaning efficiency for suspended substances is assumed to be 55%, and 70% for oil products. Therefore the concentrations of suspended particles and oil products after each stage will be:

at the first stage: suspended particles - 21 X 0.45 = 9.45 mg/l
oil products – 3.75 X 0.3 = 1.12 mg/l

at the second stage: suspended particles – 9.45 X 0.45 = 4.3 mg/l
oil products – 1.12 X 0.3 = 0.336 mg/l

at the third stage: suspended particles – 4.3 X 0.45 = 1.9 mg/l
oil products – 0.336 X 0.3 = 0.1 mg/l

The fouling factor of the filters is determined on the basis of periodical surface checks and the analysis of distilled water. In case of need filter materials shall be replaced by new ones.

The main function of the aggregate is to distil the wastewater. The function is directly related to the protection of the reservoirs and soils from pollution.

Taking into consideration that the an aggregate of the type ensures the above-mentioned level of distilling it shall be expected that the standards currently in force in the country shall not be violated after letting the distilled water into reservoirs/ collecting system and diluting it.

Annex B. Climate and Metrology

Initial Conditions for Atmosphere Pollution Report

(Meteo-characteristics)

average annual temperature of atmospheric air as per month

№	Name	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
1	Rikoti Range	-2.4	-2.0	1.8	6.5	11.7	15.3	18.3	18.3	14.7	9.7	3.9	-0.2	8

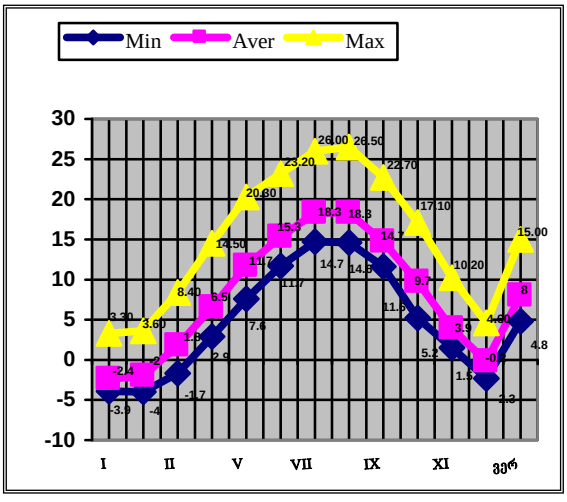
average minimum annual temperature of atmospheric air as per month

№	Name	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
1	Rikoti Range	-3.9	-4.0	-1.7	2.9	7.6	11.7	14.7	14.6	11.6	5.2	1.5	-2.3	4.8

average maximum annual temperature of atmospheric air as per month

№	Name	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
1	Surami	3.3	3.6	8.4	14.5	20.3	23.2	26.0	26.5	22.7	17.1	10.2	4.6	15.0

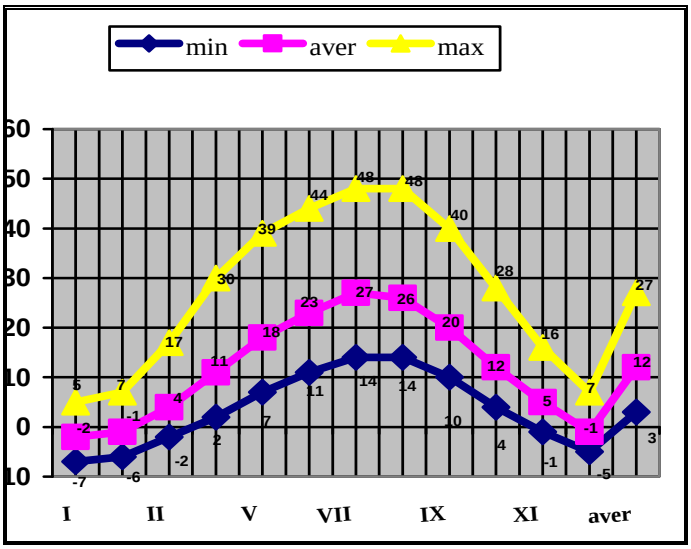
Minimum, average and maximum annual temperature
according to the long term observations upon the atmospheric air



Annual average Soil temperature (^{0}C) as per month

№	Name	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Aver.
Khashuri	Average	-2	-1	4	11	18	23	27	26	20	12	5	-1	12
	Average maximum	5	7	17	30	39	44	48	48	40	28	16	7	27
	average minimum	-7	-6	-2	2	7	11	14	14	10	4	-1	-5	3

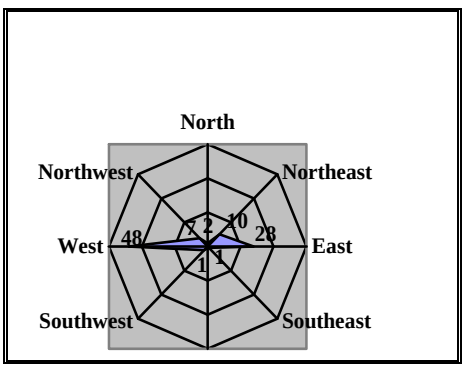
Minimum, average and maximum annual temperature
according to the long term observations upon the Soil



Frequency of average annual wind direction (%)

Name	North.	Northeast	East.	Southeast	South.	Southwest	West.	Northwest	Still
Khashuri	2	10	28	1	1	3	48	7	46

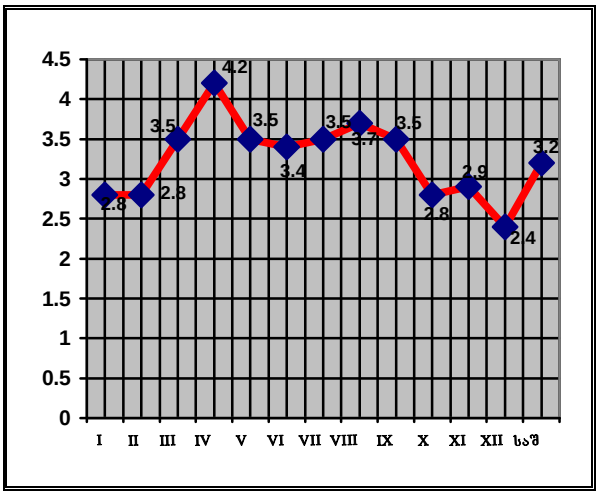
Frequency of average annual wind direction (%)



Average annual and monthly wind speed (m/sec)

Name	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	aver
Khashuri	2.8	2.8	3.5	4.2	3.5	3.4	3.5	3.7	3.5	2.8	2.9	2.4	3.2

Average annual wind speed (m/sec)



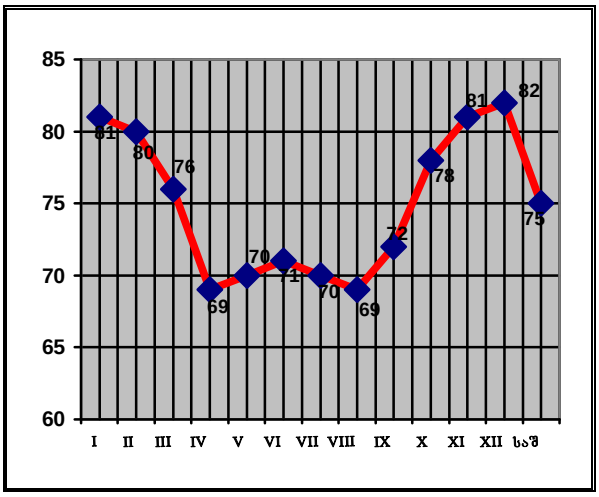
Wind speed gradation probability (%)

Name	0-1	2-3	4-5	6–7	8–9	10-11	12-13	14-15	16-17	18-20
Khashuri	51.4	14.3	14.5	8.5	4.0	1.0	0.6	0.6	1.2	3.8

U* =15.7 m/sec

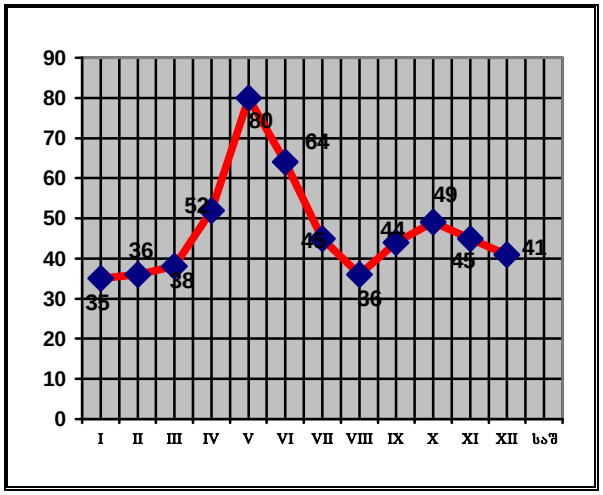
Relative humidity (%)

Name	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	aver.
Khashuri	81	80	76	69	70	71	70	69	72	78	81	82	75



Precipitation (mm)

Name	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	annual
Khashuri	35	36	38	52	80	64	45	36	44	49	45	41	565



Snow cover according to the decades (Surami meteo-station)

Month	XII	I			II			III		
decade	3	1	2	3	1	2	3	1	2	3
number of days	6	6	6	7	8	7	6	6	4	2

Annex C. Modeling Air Emissions

Calculations and Graphical Modelling of Air Emissions for the Rikoti Tunnel

Air pollution Overview

Aiming prevention of accumulation of exhausted gas, the tunnel construction allows exploitation of ventilation system inside the tunnel that is split into two parts (for left and right portals). According to the passport data each portal is served by exhausting system with the capacity of 40.0 thousand m^3/hr. Taking in consideration intensity of general traffic and separate groups (current and perspective – as per year) and using the special software we have calculated maximum output of emission by seconds. The results are shown below. (Maximum hourly intensity is taken as an initial datum for calculation).

2009 (Left-hand direction)

Transport emission gr/km	Group No.	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	Ir	5	1,3	1,1	0,03	0,03	0,005	0,0000004
Automobile - Foreign	Iforeign	2	0,7	0,4	0,02	0,03	0,002	0,0000002
Miniibus	II	12	2	2,5	0,08	0,06	0,011	0,0000008
Bus on petrol	III	35	5,2	8,5	0	0,04	0,04	0,0000012
Bus on diesel	IV	7	6	5	0,3	0,07	0,025	0,000002
Truck on petrol > 3,5 t	V	60	5,2	10	0	0,05	0,05	0,000004
Truck on diesel < 12 t	VI	9	7	5,5	0,4	0,1	0,025	0,000002
truck on diesel > 12 t	VII	12	8	6,5	0,5	0,12	0,03	0,0000024
Automobile – Russian – emission	**I r**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Automobile – foreign - emission	**I foreign**	**0,037422**	**0,043659**	**0,0074844**	**0,00037422**	**0,00056133**	**0,000037422**	**3,7422E-09**
Minibus emission	**II**	**0,13365**	**0,07425**	**0,02784375**	**0,000891**	**0,00066825**	**0,000122513**	**8,91E-09**
Bus on petrol emission	**III**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Bus on diesel emission	**IV**	**0,0051975**	**0,01485**	**0,0037125**	**0,00022275**	**0,000051975**	**1,85625E-05**	**1,485E-09**
Truck on petrol > 3,5 t emission	**V**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Truck on diesel < 12 t emission	**VI**	**0,02673**	**0,0693**	**0,016335**	**0,001188**	**0,000297**	**0,00007425**	**5,94E-09**
truck on diesel > 12 t emission	**VII**	**0,0891**	**0,198**	**0,0482625**	**0,0037125**	**0,000891**	**0,00022275**	**1,782E-08**
Total	**I+VII**	**0,2920995**	**0,400059**	**0,10363815**	**0,00638847**	**0,002469555**	**0,000475497**	**3,78972E-08**

"ML=((L-L0)/3600)*Mk*Gk*Rv

Data for Right-hand direction	**I r**	**I foreign**	**II**	**III**	**IV**	**V**	**VI**	**VII**
L km	1,782							
L0 km								
vehicle/hr	0	126	75	0	5	0	20	50
selected speed ratio	0,3							
Select suitable speed ratio (km/hr) .								
10 (km/hr)	1,35			0,02784375				
15 (km/hr)	1,28							
20 (km/hr)	1,2							

25 (km/hr)	1,1
30 (km/hr)	1
35 (km/hr)	0,88
40 (km/hr)	0,75
45 (km/hr)	0,63
50 (km/hr)	0,5
60 (km/hr)	0,3
75 (km/hr)	0,45
80 (km/hr)	0,5
100 (km/hr)	0,65

Data on right-hand cross junction

Transport emission on neutral run gr/min	Group No.	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	Ir	0,8	0,02	0,12	0,02	0,006	0,0005	0,0000004
Automobile - Foreign	Iforeign	0,3	0,01	0,05	0,01	0,006	0,0003	0,0000002
Miniibus	II	2	0,04	0,25	0,04	0,012	0,0011	0,0000008
Bus on petrol	III	4	0,08	0,9	0	0,009	0,4	0,0000012
Bus on diesel	IV	1,1	0,11	0,6	0,2	0,015	0,0025	0,0000016
Truck on petrol > 3,5 t	V	10	0,12	1,2	0	0,009	0,005	0,000004
Truck on diesel < 12 t	VI	1,5	0,12	0,6	0,23	0,02	0,0025	0,000002
truck on diesel > 12 t	VII	12	8	6,5	0,5	0,12	0,03	0,0000025

Mjvri=T*P/40*jami(M/60*Gk)

Transport with neutral run at right-hand cross junction	Type	**Gk 20min.**
Automobile - Russian	Ir	**0**
Automobile - Foreign	Iforeign	**0**
Miniibus	II	**0**
Bus on petrol	III	**0**
Bus on diesel	IV	**0**
Truck on petrol > 3,5 t	V	**0**
Truck on diesel < 12 t	VI	**0**
truck on diesel > 12 t	VII	**0**

Traffic light cycle in 20 minutes (T)	**40**
prohibiting traffic light duration (P) min.	**0,5**
Traffic length up to the traffic light (km)	**0**

	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	0	0	0	0	0	0	0
Automobile - Foreign	0	0	0	0	0	0	0
Miniibus	0	0	0	0	0	0	0
Bus on petrol	0	0	0	0	0	0	0
Bus on diesel	0	0	0	0	0	0	0
Truck on petrol > 3,5 t	0	0	0	0	0	0	0
Truck on diesel < 12 t	0	0	0	0	0	0	0
Truck on diesel > 12 t	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Total for the cross gr/sec	
Carbonic Acid	**0,2920995**
Nitric oxides, among them:	**0,400059**
Nitric dioxide	**0,3200472**
Nitric oxide	**0,05200767**
Hydrocarbon (2704)	**0,0074844**
Hydrocarbon (2732)	**0,09615375**
Soot	**0,00638847**
Sulphuric dioxide	**0,002469555**
Formaldehyde	**0,000475497**
Benzapilene	**3,78972E-08**

2009 (Left-hand direction)

Transport emission gr/km	Group No.	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	Ir	5	1,3	1,1	0,03	0,03	0,005	0,0000004
Automobile - Foreign	Iforeign	2	0,7	0,4	0,02	0,03	0,002	0,0000002
Miniibus	II	12	2	2,5	0,08	0,06	0,011	0,0000008
Bus on petrol	III	35	5,2	8,5	0	0,04	0,04	0,0000012
Bus on diesel	IV	7	6	5	0,3	0,07	0,025	0,000002
Truck on petrol > 3,5 t	V	60	5,2	10	0	0,05	0,05	0,000004
Truck on diesel < 12 t	VI	9	7	5,5	0,4	0,1	0,025	0,000002
truck on diesel > 12 t	VII	12	8	6,5	0,5	0,12	0,03	0,0000024
Automobile - Russian	Ir	0	0	0	0	0	0	0
Automobile - Foreign	Iforeign	0,037422	0,043659	0,0074844	0,0003742	0,00056133	0,000037422	3,7422E-09
Miniibus	II	0,135432	0,07524	0,028215	0,0009029	0,00067716	0,000124146	9,0288E-09
Bus on petrol	III	0	0	0	0	0	0	0
Bus on diesel	IV	0,004158	0,01188	0,00297	0,0001782	0,00004158	0,00001485	1,188E-09
Truck on petrol > 3,5 t	V	0	0	0	0	0	0	0
Truck on diesel < 12 t	VI	0,02673	0,0693	0,016335	0,001188	0,000297	0,00007425	5,94E-09
truck on diesel > 12 t	VII	0,0891	0,198	0,0482625	0,0037125	0,000891	0,00022275	1,782E-08
Total	**I+VII**	**0,292842**	**0,398079**	**0,1032669**	**0,0063558**	**0,00246807**	**0,000473418**	**3,7719E-08**

"ML=((L-L0)/3600)*Mk*Gk*Rv

Data for the left-hand direction	Ir	Iforeign	II	III	IV	V	VI	VII
L km	1,782							
L0 km	0							
automobile/hr	0	126	76	0	4	0	20	50
speed ratio	0,3							

speed km/hr	10	1,35
	15	1,28

20	1,2
25	1,1
30	1
35	0,88
40	0,75
45	0,63
50	0,5
60	0,3
75	0,45
80	0,5
100	0,65

Data on the left cross junction

Transport emission on neutral run gr/min	Group No.	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	Ir	0,8	0,02	0,12	0,02	0,006	0,0005	0,0000004
Automobile - Foreign	Iforeign	0,3	0,01	0,05	0,01	0,006	0,0003	0,0000002
Minibus	II	2	0,04	0,25	0,04	0,012	0,0011	0,0000008
Bus on petrol	III	4	0,08	0,9	0	0,009	0,4	0,0000012
Bus on diesel	IV	1,1	0,11	0,6	0,2	0,015	0,0025	0,0000016
Truck on petrol > 3,5 t	V	10	0,12	1,2	0	0,009	0,005	0,000004
Truck on diesel < 12 t	VI	1,5	0,12	0,6	0,23	0,02	0,0025	0,000002
truck on diesel > 12 t	VII	12	8	6,5	0,5	0,12	0,03	0,0000025

Mjvri=T*P/40*jami(M/60*Gk)

Transport with neutral run at left-hand cross junction	type	Gk 20minutes
Automobile - Russian	Ir	**0**
Automobile - Foreign	Iforeign	**0**
Miniibus	II	**0**
Bus on petrol	III	**0**
Bus on diesel	IV	**0**
Truck on petrol > 3,5 t	V	**0**
Truck on diesel < 12 t	VI	**0**

truck on diesel > 12 t	VII	0
Traffic light cycle in 20 minutes (T)		40
prohibiting traffic light duration (P) min.		0,5
Traffic length up to the traffic light (km)		0

		Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Total								
	Automobile - Russian	0	0	0	0	0	0	0
	Automobile - Foreign	0	0	0	0	0	0	0
	Miniibus	0	0	0	0	0	0	0
	Bus on petrol	0	0	0	0	0	0	0
	Bus on diesel	0	0	0	0	0	0	0
	Truck on petrol > 3,5 t	0	0	0	0	0	0	0
	Truck on diesel < 12 t	0	0	0	0	0	0	0
	truck on diesel > 12 t	0	0	0	0	0	0	0
Total		**0**	**0**	**0**	**0**	**0**	**0**	**0**

Total for the cross gr/sec	
Carbonic Acid	**0,292842**
Nitric oxides, among them:	**0,398079**
Nitric dioxide	**0,3184632**
Nitric oxide	**0,05175027**
Hydrocarbon (2704)	**0,0074844**
Hydrocarbon (2732)	**0,0957825**
Soot	**0,0063558**
Sulphuric dioxide	**0,00246807**
Formaldehyde	**0,000473418**
Benzapilene	**3,7719E-08**

Total 2009

Calculation of autotransport emission

City				
Highway				
Section	Rikoti Tunnel			
Data about the Section				
Coordinates	X (m)	Y(m)	Z (width)	
start	0	0		10
end	1782	0		
length of the section	1782			

Data on traffic flow

automobile type, unit/hr (Gk)	Right-hand Direction	Left-hand Direction	km/hr	ratio
Automobile - Russian	0	0	60	0,3
Automobile - Foreign	126	126		
Miniibus	75	76		
Bus on petrol	0	0		
Bus on diesel	5	4		
Truck on petrol > 3,5 t	0	0		
Truck on diesel < 12 t	20	20		
Truck on diesel > 12 t	50	50		

Data on emission at the section

Substance	Code	emission power (g/sec)
Carbonic Acid (CO)	337	0,5849415
Nitric oxides (NOx)	3000	0,798138
Nitric dioxide (NO2)	301	0,6385104
Nitric oxide (NO)	304	0,10375794
Hydrocarbon (petrol fraction)	2704	0,0149688
Hydrocarbon (diesel fraction)	2732	0,19193625
Soot	328	0,01274427
Sulphuric dioxide	330	0,004937625
Formaldehyde	1325	0,000948915
Benzapilene	703	7,56162E-08

Data on the right-hand cross junction

Traffic light cycle in 20 minutes (T)	40
prohibiting traffic light duration (P) min.	0,5
Traffic length up to the traffic light (LO)	0

Data on traffic flow on the right-hand cross junction

vehicle type, number of units during 20 minutes (Gk)	
Automobile - Russian	0
Automobile - Foreign	0
Miniibus	0
Bus on petrol	0
Bus on diesel	0
Truck on petrol > 3,5 t	0
Truck on diesel < 12 t	0
truck on diesel > 12 t	0

Emission data on the right-hand cross junction

Substance	Code	emission power (g/sec)
Carbonic Acid (CO)	337	0
Nitric oxides (NOx)	3000	0
Nitric dioxide (NO2)	301	0
Nitric oxide (NO)	304	0
Hydrocarbon (petrol fraction)	2704	0
Hydrocarbon (diesel fraction)	2732	0
Soot	328	0
Sulphuric dioxide	330	0
Formaldehyde	1325	0
Benzapilene	703	0

Data on the left-hand cross junction

Traffic light cycle in 20 minutes (T)	40
prohibiting traffic light duration (P) min.	0,5
Traffic length up to the traffic light (LO)	0

Data on traffic flow on the left-hand cross junction

vehicle type, number of units during 20 minutes (Gk)	(Gk)
Automobile - Russian	0
Automobile - Foreign	0
Miniibus	0
Bus on petrol	0
Bus on diesel	0
Truck on petrol > 3,5 t	0
Truck on diesel < 12 t	0
truck on diesel > 12 t	0

Emission data on the left-hand cross junction

Substance	Code	emission power (g/sec)
Carbonic Acid (CO)	337	0
Nitric oxides (NOx)	3000	0
Nitric dioxide (NO2)	301	0
Nitric oxide (NO)	304	0
Hydrocarbon (petrol fraction)	2704	0
Hydrocarbon (diesel fraction)	2732	0
Soot	328	0
Sulphuric dioxide	330	0
Formaldehyde	1325	0
Benzapilene	703	0

Total emission

Carbonic Acid (CO)	**337**	**0,5849415**
Nitric oxides (NOx)	**3000**	**0,798138**
Nitric dioxide (NO2)	**301**	**0,6385104**
Nitric oxide (NO)	**304**	**0,10375794**
Hydrocarbon (petrol fraction)	**2704**	**0,0149688**
Hydrocarbon (diesel fraction)	**2732**	**0,19193625**
Soot	**328**	**0,01274427**
Sulphuric dioxide	**330**	**0,004937625**
Formaldehyde	**1325**	**0,000948915**
Benzapilene	**703**	**7,56162E-08**

2020 (Left-hand Direction)

Vehicle emission g/km	Group No.	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	Ir	5	1,3	1,1	0,03	0,03	0,005	0,0000004
Automobile - Foreign	Iforeign	2	0,7	0,4	0,02	0,03	0,002	0,0000002
Miniibus	II	12	2	2,5	0,08	0,06	0,011	0,0000008
Bus on petrol	III	35	5,2	8,5	0	0,04	0,04	0,0000012
Bus on diesel	IV	7	6	5	0,3	0,07	0,025	0,000002
Truck on petrol > 3,5 t	V	60	5,2	10	0	0,05	0,05	0,000004
Truck on diesel < 12 t	VI	9	7	5,5	0,4	0,1	0,025	0,000002
truck on diesel > 12 t	VII	12	8	6,5	0,5	0,12	0,03	0,0000024
Automobile – Russian – emission	**I r**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Automobile – foreign - emission	**I foreign**	**0,063261**	**0,0738045**	**0,0126522**	**0,00063261**	**0,000948915**	**0,000063261**	**6,3261E-09**
Minibus emission	**II**	**0,228096**	**0,12672**	**0,04752**	**0,00152064**	**0,00114048**	**0,000209088**	**1,52064E-08**
Bus on petrol emission	**III**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Bus on diesel emission	**IV**	**0,008316**	**0,02376**	**0,00594**	**0,0003564**	**0,00008316**	**0,0000297**	**2,376E-09**
Truck on petrol > 3,5 t emission	**V**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Truck on diesel < 12 t emission	**VI**	**0,042768**	**0,11088**	**0,026136**	**0,0019008**	**0,0004752**	**0,0001188**	**9,504E-09**
truck on diesel > 12 t emission	**VII**	**0,147906**	**0,32868**	**0,08011575**	**0,00616275**	**0,00147906**	**0,000369765**	**2,95812E-08**
Total	**I+VII**	**0,490347**	**0,6638445**	**0,17236395**	**0,0105732**	**0,004126815**	**0,000790614**	**6,29937E-08**

"ML=((L-L0)/3600)*Mk*Gk*Rv

Data for the right-hand direction	**I r**	**I foreign**	**II**	**III**	**IV**	**V**	**VI**	**VII**
L km	1,782							
L0 km								
vehicle/hr	0	213	128	0	8	0	32	83
selected speed ratio	0,3							
Select suitable speed ratio (km/hr)								
10 (km/hr)	1,35			0,04752				
15 (km/hr)	1,28							
20 (km/hr)	1,2							

25 (km/hr)	1,1
30 (km/hr)	1
35 (km/hr)	0,88
40 (km/hr)	0,75
45 (km/hr)	0,63
50 (km/hr)	0,5
60 (km/hr)	0,3
75 (km/hr)	0,45
80 (km/hr)	0,5
100 (km/hr)	0,65

Data on the right-hand cross junction

Transport emission gr/km	Group No.	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	Ir	0,8	0,02	0,12	0,02	0,006	0,0005	0,0000004
Automobile - Foreign	Iforeign	0,3	0,01	0,05	0,01	0,006	0,0003	0,0000002
Miniibus	II	2	0,04	0,25	0,04	0,012	0,0011	0,0000008
Bus on petrol	III	4	0,08	0,9	0	0,009	0,4	0,0000012
Bus on diesel	IV	1,1	0,11	0,6	0,2	0,015	0,0025	0,0000016
Truck on petrol > 3,5 t	V	10	0,12	1,2	0	0,009	0,005	0,000004
Truck on diesel < 12 t	VI	1,5	0,12	0,6	0,23	0,02	0,0025	0,000002
truck on diesel > 12 t	VII	12	8	6,5	0,5	0,12	0,03	0,0000025

Mjvri=T*P/40*jami(M/60*Gk)

Transport with neutral run at right-hand cross junction	type	**Gk minutes**	**20**
Automobile - Russian	Ir		**0**
Automobile - Foreign	Iforeign		**0**
Miniibus	II		**0**
Bus on petrol	III		**0**
Bus on diesel	IV		**0**
Truck on petrol > 3,5 t	V		**0**
Truck on diesel < 12 t	VI		**0**
truck on diesel > 12 t	VII		**0**

Traffic light cycle in 20 minutes (T)	**40**
prohibiting traffic light duration (P) min.	**0,5**
Traffic length up to the traffic light (km)	**0**

	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	0	0	0	0	0	0	0
Automobile - Foreign	0	0	0	0	0	0	0
Miniibus	0	0	0	0	0	0	0
Bus on petrol	0	0	0	0	0	0	0
Bus on diesel	0	0	0	0	0	0	0
Truck on petrol > 3,5 t	0	0	0	0	0	0	0
Truck on diesel < 12 t	0	0	0	0	0	0	0
truck on diesel > 12 t	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Total for the cross gr/sec	
Carbonic Acid	**0,490347**
Nitric oxides, among them:	**0,6638445**
Nitric dioxide	**0,5310756**
Nitric oxide	**0,086299785**
Hydrocarbon (2704)	**0,0126522**
Hydrocarbon (2732)	**0,15971175**
Soot	**0,0105732**
Sulphuric dioxide	**0,004126815**
Formaldehyde	**0,000790614**
Benzapilene	**6,29937E-08**

2020 (Right-hand Direction)

Transport emission gr/km	Group No.	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	Ir	5	1,3	1,1	0,03	0,03	0,005	0,0000004
Automobile - Foreign	Iforeign	2	0,7	0,4	0,02	0,03	0,002	0,0000002
Miniibus	II	12	2	2,5	0,08	0,06	0,011	0,0000008
Bus on petrol	III	35	5,2	8,5	0	0,04	0,04	0,0000012
Bus on diesel	IV	7	6	5	0,3	0,07	0,025	0,000002
Truck on petrol > 3,5 t	V	60	5,2	10	0	0,05	0,05	0,000004
Truck on diesel < 12 t	VI	9	7	5,5	0,4	0,1	0,025	0,000002
truck on diesel > 12 t	VII	12	8	6,5	0,5	0,12	0,03	0,0000024
Automobile - Russian	Ir	0	0	0	0	0	0	0
Automobile - Foreign	Iforeign	0,063261	0,0738045	0,0126522	0,0006326	0,000948915	0,000063261	6,3261E-09
Miniibus	II	0,228096	0,12672	0,04752	0,0015206	0,00114048	0,000209088	1,52064E-08
Bus on petrol	III	0	0	0	0	0	0	0
Bus on diesel	IV	0,008316	0,02376	0,00594	0,0003564	0,00008316	0,0000297	2,376E-09
Truck on petrol > 3,5 t	V	0	0	0	0	0	0	0
Truck on diesel < 12 t	VI	0,044105	0,114345	0,02695275	0,0019602	0,00049005	0,000122513	9,801E-09
truck on diesel > 12 t	VII	0,147906	0,32868	0,08011575	0,0061628	0,00147906	0,000369765	2,95812E-08
Total	**I+VII**	**0,491684**	**0,6673095**	**0,1731807**	**0,0106326**	**0,004141665**	**0,000794327**	**6,32907E-08**

"ML=((L-L0)/3600)*Mk*Gk*Rv

Data for the left-hand direction	Ir	Iforeign	II	III	IV	V	VI	VII
L km	1,782							
L0 km	0							
vehicle/hr	0	213	128	0	8	0	33	83
speed ratio	0,3							

movement	sped	km/hr	
10			1,35
		15	1,28
		20	1,2

25	1,1
30	1
35	0,88
40	0,75
45	0,63
50	0,5
60	0,3
75	0,45
80	0,5
100	0,65

Data on the left-hand cross junction

Transport emission on neutral run gr/min	Group No.	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	Ir	0,8	0,02	0,12	0,02	0,006	0,0005	0,0000004
Automobile - Foreign	Iforeign	0,3	0,01	0,05	0,01	0,006	0,0003	0,0000002
Miniibus	II	2	0,04	0,25	0,04	0,012	0,0011	0,0000008
Bus on petrol	III	4	0,08	0,9	0	0,009	0,4	0,0000012
Bus on diesel	IV	1,1	0,11	0,6	0,2	0,015	0,0025	0,0000016
Truck on petrol > 3,5 t	V	10	0,12	1,2	0	0,009	0,005	0,000004
Truck on diesel < 12 t	VI	1,5	0,12	0,6	0,23	0,02	0,0025	0,000002
truck on diesel > 12 t	VII	12	8	6,5	0,5	0,12	0,03	0,0000025

Mjvri=T*P/40*jami(M/60*Gk)

Transport with neutral run at left-hand cross junction	Type	Gk 20minutes
Automobile - Russian	Ir	0
Automobile - Foreign	Iforeign	0
Miniibus	II	0
Bus on petrol	III	0
Bus on diesel	IV	0
Truck on petrol > 3,5 t	V	0
Truck on diesel < 12 t	VI	0
truck on diesel > 12 t	VII	0

Traffic light cycle in 20 minutes (T)	**40**
prohibiting traffic light duration (P) min.	**0,5**
Traffic length up to the traffic light (km)	**0**

		Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Total								
	Automobile - Russian	0	0	0	0	0	0	0
	Automobile - Foreign	0	0	0	0	0	0	0
	Miniibus	0	0	0	0	0	0	0
	Bus on petrol	0	0	0	0	0	0	0
	Bus on diesel	0	0	0	0	0	0	0
	Truck on petrol > 3,5 t	0	0	0	0	0	0	0
	Truck on diesel < 12 t	0	0	0	0	0	0	0
	truck on diesel > 12 t	0	0	0	0	0	0	0
Total		**0**	**0**	**0**	**0**	**0**	**0**	**0**

Total for the cross gr/sec	
Carbonic Acid	**0,4916835**
Nitric oxides, among them:	**0,6673095**
Nitric dioxide	**0,5338476**
Nitric oxide	**0,086750235**
Hydrocarbon (2704)	**0,0126522**
Hydrocarbon (2732)	**0,1605285**
Soot	**0,0106326**
Sulphuric dioxide	**0,004141665**
Formaldehyde	**0,000794327**
Benzapilene	**6,32907E-08**

Total for 2020

Calculation of vehicle emission

City				
Highway				
Section	Rikoti Tunnel			
Data on the section				
Coordinates	X (m)	Y(m)	Z (width)	
start	0	0		10
end	1782	0		
section length	1782			

data on traffic flow

vehicle type, number of units during 20 minutes (Gk)	right-hand direction	left-hand direction	km/hr	ratio
Automobile - Russian	0	0	60	0,3
Automobile - Foreign	213	213		
Miniibus	128	128		
Bus on petrol	0	0		
Bus on diesel	8	8		
Truck on petrol > 3,5 t	0	0		
Truck on diesel < 12 t	32	33		
truck on diesel > 12 t	83	83		

Emission data on the section

Substance	code	emission power (gr/sec)
Carbonic Acid (CO)	337	0,9820305
Nitric oxides (NOx)	3000	1,331154
Nitric dioxide (NO2)	301	1,0649232
Nitric oxide (NO)	304	0,17305002
Hydrocarbon (petrol fraction)	2704	0,0253044
Hydrocarbon (diesel fraction)	2732	0,32024025
Soot	328	0,0212058
Sulphuric dioxide	330	0,00826848
Formaldehyde	1325	0,001584941
Benzapilene	703	1,26284E-07

Data for the right-hand cross junction

Traffic light cycle in 20 minutes (T)	40
prohibiting traffic light duration (P) min.	0,5
Traffic length up to the traffic light (LO)	0

Data on the traffic flow on the right-hand cross junction

vehicle type, number of units during 20 minutes (Gk)	
Automobile - Russian	0
Automobile - Foreign	0
Miniibus	0
Bus on petrol	0
Bus on diesel	0
Truck on petrol > 3,5 t	0
Truck on diesel < 12 t	0
truck on diesel > 12 t	0

Emission data on the right-hand cross junction

Substance	Code	emission power (g/sec)
Carbonic Acid (CO)	337	0
Nitric oxides (NOx)	3000	0
Nitric dioxide (NO2)	301	0
Nitric oxide (NO)	304	0
Hydrocarbon (petrol fraction)	2704	0
Hydrocarbon (diesel fraction)	2732	0
Soot	328	0
Sulphuric dioxide	330	0
Formaldehyde	1325	0
Benzapilene	703	0

Data on the left-hand cross junction

Traffic light cycle in 20 minutes (T)	40
prohibiting traffic light duration (P) min.	0,5
Traffic length up to the traffic light (LO)	0

Data on the traffic flow on the right-hand cross junction

vehicle type, number of units during 20 minutes (Gk)	(Gk)
Automobile - Russian	0
Automobile - Foreign	0
Miniibus	0
Bus on petrol	0
Bus on diesel	0
Truck on petrol > 3,5 t	0
Truck on diesel < 12 t	0
truck on diesel > 12 t	0

Emission data on the left-hand cross junction

Substance	Code	emission power (g/sec)
Carbonic Acid (CO)	337	0
Nitric oxides (NOx)	3000	0
Nitric dioxide (NO2)	301	0
Nitric oxide (NO)	304	0
Hydrocarbon (petrol fraction)	2704	0
Hydrocarbon (diesel fraction)	2732	0
Soot	328	0
Sulphuric dioxide	330	0
Formaldehyde	1325	0
Benzapilene	703	0

Total emission		(g/sec)
Carbonic Acid (CO)	**337**	**0,9820305**
Nitric oxides (NOx)	**3000**	**1,331154**
Nitric dioxide (NO2)	**301**	**1,0649232**
Nitric oxide (NO)	**304**	**0,17305002**
Hydrocarbon (petrol fraction)	**2704**	**0,0253044**
Hydrocarbon (diesel fraction)	**2732**	**0,32024025**
Soot	**328**	**0,0212058**
Sulphuric dioxide	**330**	**0,00826848**
Formaldehyde	**1325**	**0,001584941**
Benzapilene	**703**	**1,26284E-07**

2040 (left-hand direction)

Transport emission gr/km	Group No.	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	Ir	5	1,3	1,1	0,03	0,03	0,005	0,0000004
Automobile - Foreign	Iforeign	2	0,7	0,4	0,02	0,03	0,002	0,0000002
Miniibus	II	12	2	2,5	0,08	0,06	0,011	0,0000008
Bus on petrol	III	35	5,2	8,5	0	0,04	0,04	0,0000012
Bus on diesel	IV	7	6	5	0,3	0,07	0,025	0,000002
Truck on petrol > 3,5 t	V	60	5,2	10	0	0,05	0,05	0,000004
Truck on diesel < 12 t	VI	9	7	5,5	0,4	0,1	0,025	0,000002
truck on diesel > 12 t	VII	12	8	6,5	0,5	0,12	0,03	0,0000024
Automobile – Russian – emission	**I r**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Automobile – foreign - emission	**I foreign**	**0,109593**	**0,1278585**	**0,0219186**	**0,00109593**	**0,001643895**	**0,000109593**	**1,09593E-08**
Minibus emission	**II**	**0,393822**	**0,21879**	**0,08204625**	**0,00262548**	**0,00196911**	**0,000361004**	**2,62548E-08**
Bus on petrol emission	**III**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Bus on diesel emission	**IV**	**0,0135135**	**0,03861**	**0,0096525**	**0,00057915**	**0,000135135**	**4,82625E-05**	**3,861E-09**
Truck on petrol > 3,5 t emission	**V**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Truck on diesel < 12 t emission	**VI**	**0,077517**	**0,20097**	**0,0473715**	**0,0034452**	**0,0008613**	**0,000215325**	**1,7226E-08**
truck on diesel > 12 t emission	**VII**	**0,253044**	**0,56232**	**0,1370655**	**0,0105435**	**0,00253044**	**0,00063261**	**5,06088E-08**
Total	**I+VII**	**0,8474895**	**1,1485485**	**0,29805435**	**0,01828926**	**0,00713988**	**0,001366794**	**1,0891E-07**

"ML=((L-L0)/3600)*Mk*Gk*Rv

Data for the right hand direction	**I r**	**I foreign**	**II**	**III**	**IV**	**V**	**VI**	**VII**
L km	1,782							
L0 km								
vehicle/hr	0	369	221	0	13	0	58	142
selected speed ratio	0,3							
Select suitable speed ratio (km/hr)								
10 (km/hr)	1,35			0,08204625				
15 (km/hr)	1,28							
20 (km/hr)	1,2							

25 (km/hr)	1,1
30 (km/hr)	1
35 (km/hr)	0,88
40 (km/hr)	0,75
45 (km/hr)	0,63
50 (km/hr)	0,5
60 (km/hr	0,3
75 (km/hr)	0,45
80 (km/hr)	0,5
100 (km/hr)	0,65

Data on right-hand cross junction

Transport emission on neutral run gr/min	Group No.	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	Ir	0,8	0,02	0,12	0,02	0,006	0,0005	0,0000004
Automobile - Foreign	Iforeign	0,3	0,01	0,05	0,01	0,006	0,0003	0,0000002
Miniibus	II	2	0,04	0,25	0,04	0,012	0,0011	0,0000008
Bus on petrol	III	4	0,08	0,9	0	0,009	0,4	0,0000012
Bus on diesel	IV	1,1	0,11	0,6	0,2	0,015	0,0025	0,0000016
Truck on petrol > 3,5 t	V	10	0,12	1,2	0	0,009	0,005	0,000004
Truck on diesel < 12 t	VI	1,5	0,12	0,6	0,23	0,02	0,0025	0,000002
truck on diesel > 12 t	VII	12	8	6,5	0,5	0,12	0,03	0,0000025

Mjvri=T*P/40*jami(M/60*Gk)

Transport with neutral run at right-hand cross junction	Type	**Gk 20minutes**
Automobile - Russian	Ir	**0**
Automobile - Foreign	Iforeign	**0**
Miniibus	II	**0**
Bus on petrol	III	**0**
Bus on diesel	IV	**0**
Truck on petrol > 3,5 t	V	**0**
Truck on diesel < 12 t	VI	**0**
truck on diesel > 12 t	VII	**0**

Traffic light cycle in 20 minutes (T)	**40**
prohibiting traffic light duration (P) min.	**0,5**
Traffic length up to the traffic light (km)	**0**

	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	0	0	0	0	0	0	0
Automobile - Foreign	0	0	0	0	0	0	0
Miniibus	0	0	0	0	0	0	0
Bus on petrol	0	0	0	0	0	0	0
Bus on diesel	0	0	0	0	0	0	0
Truck on petrol > 3,5 t	0	0	0	0	0	0	0
Truck on diesel < 12 t	0	0	0	0	0	0	0
truck on diesel > 12 t	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Total for the cross-run gr/sec	
Carbonic Acid	**0,8474895**
Nitric oxides, among them:	**1,1485485**
Nitric dioxide	**0,9188388**
Nitric oxide	**0,149311305**
Hydrocarbon (2704)	**0,0219186**
Hydrocarbon (2732)	**0,27613575**
Soot	**0,01828926**
Sulphuric dioxide	**0,00713988**
Formaldehyde	**0,001366794**
Benzapilene	**1,0891E-07**

2040 (Right-hand Direction)

Transport emission gr/km	Group No.	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	Ir	5	1,3	1,1	0,03	0,03	0,005	0,0000004
Automobile - Foreign	Iforeign	2	0,7	0,4	0,02	0,03	0,002	0,0000002
Miniibus	II	12	2	2,5	0,08	0,06	0,011	0,0000008
Bus on petrol	III	35	5,2	8,5	0	0,04	0,04	0,0000012
Bus on diesel	IV	7	6	5	0,3	0,07	0,025	0,000002
Truck on petrol > 3,5 t	V	60	5,2	10	0	0,05	0,05	0,000004
Truck on diesel < 12 t	VI	9	7	5,5	0,4	0,1	0,025	0,000002
truck on diesel > 12 t	VII	12	8	6,5	0,5	0,12	0,03	0,0000024
Automobile - Russian	Ir	0	0	0	0	0	0	0
Automobile - Foreign	Iforeign	0,109593	0,1278585	0,0219186	0,0010959	0,001643895	0,000109593	1,09593E-08
Miniibus	II	0,393822	0,21879	0,08204625	0,0026255	0,00196911	0,000361004	2,62548E-08
Bus on petrol	III	0	0	0	0	0	0	0
Bus on diesel	IV	0,014553	0,04158	0,010395	0,0006237	0,00014553	0,000051975	4,158E-09
Truck on petrol > 3,5 t	V	0	0	0	0	0	0	0
Truck on diesel < 12 t	VI	0,077517	0,20097	0,0473715	0,0034452	0,0008613	0,000215325	1,7226E-08
truck on diesel > 12 t	VII	0,256608	0,57024	0,138996	0,010692	0,00256608	0,00064152	5,13216E-08
Total	**I+VII**	**0,852093**	**1,1594385**	**0,30072735**	**0,0184823**	**0,007185915**	**0,001379417**	**1,0992E-07**

"ML=((L-L0)/3600)*Mk*Gk*Rv

Data for the left-hand direction	I r	I foreign	II	III	IV	V	VI	VII
L km	1,782							
L0 km	0							
vehicle/hr	0	369	221	0	14	0	58	144
speed ratio	0,3							

movement	speed	km/hr	
10			1,35
		15	1,28
		20	1,2

25	1,1
30	1
35	0,88
40	0,75
45	0,63
50	0,5
60	0,3
75	0,45
80	0,5
100	0,65

Data on the left-hand cross junction

Transport emission on neutral run gr/min	Group No.	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	Iრ	0,8	0,02	0,12	0,02	0,006	0,0005	0,0000004
Automobile - Foreign	Iუ(ჱხო	0,3	0,01	0,05	0,01	0,006	0,0003	0,0000002
Miniibus	II	2	0,04	0,25	0,04	0,012	0,0011	0,0000008
Bus on petrol	III	4	0,08	0,9	0	0,009	0,4	0,0000012
Bus on diesel	IV	1,1	0,11	0,6	0,2	0,015	0,0025	0,0000016
Truck on petrol > 3,5 t	V	10	0,12	1,2	0	0,009	0,005	0,000004
Truck on diesel < 12 t	VI	1,5	0,12	0,6	0,23	0,02	0,0025	0,000002
truck on diesel > 12 t	VII	12	8	6,5	0,5	0,12	0,03	0,0000025

Mjvri=T*P/40*jami(M/60*Gk)

Transport with neutral run atleft-hand cross junction	Type	Gk 20minutes
Automobile - Russian	I r	0
Automobile - Foreign	I foreign	0
Miniibus	II	0
Bus on petrol	III	0
Bus on diesel	IV	0
Truck on petrol > 3,5 t	V	0
Truck on diesel < 12 t	VI	0
truck on diesel > 12 t	VII	0

Traffic light cycle in 20 minutes (T)	**40**
prohibiting traffic light duration (P) min.	**0,5**
Traffic length up to the traffic light (km)	**0**

Total	Carbonic Acid	Nitric oxides	Hydrocarbon	Soot	Sulphuric dioxide	Formaldehyde	Benzapilene
Automobile - Russian	0	0	0	0	0	0	0
Automobile - Foreign	0	0	0	0	0	0	0
Miniibus	0	0	0	0	0	0	0
Bus on petrol	0	0	0	0	0	0	0
Bus on diesel	0	0	0	0	0	0	0
Truck on petrol > 3,5 t	0	0	0	0	0	0	0
Truck on diesel < 12 t	0	0	0	0	0	0	0
truck on diesel > 12 t	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Total for the cross-run gr/sec	
Carbonic Acid	**0,852093**
Nitric oxides, among them:	**1,1594385**
Nitric dioxide	**0,9275508**
Nitric oxide	**0,150727005**
Hydrocarbon (2704)	**0,0219186**
Hydrocarbon (2732)	**0,27880875**
Soot	**0,01848231**
Sulphuric dioxide	**0,007185915**
Formaldehyde	**0,001379417**
Benzapilene	**1,0992E-07**

Total 2040

Vehicle emission calculation

City

Highway

Section — Rikoti Tunnel

Data on the section

Coordinates	X (m)	Y(m)	Coordinates
start	0	0	
end	1782	0	
section length	1782		

Data on the traffic flow

vehicle type, number of units during 20 minutes (Gk)	right-hand direction	left-hand direction	km/hr	ratio
Automobile - Russian	0	0	60	0,3
Automobile - Foreign	369	369		
Miniibus	221	221		
Bus on petrol	0	0		
Bus on diesel	13	14		
Truck on petrol > 3,5 t	0	0		
Truck on diesel < 12 t	58	58		
truck on diesel > 12 t	142	144		

Emission data on the Section

Substance	Code	emission power (g/sec)
Carbonic Acid (CO)	337	1,6995825
Nitric oxides (NOx)	3000	2,307987
Nitric dioxide (NO2)	301	1,8463896
Nitric oxide (NO)	304	0,30003831
Hydrocarbon (petrol fraction)	2704	0,0438372
Hydrocarbon (diesel fraction)	2732	0,5549445
Soot	328	0,03677157
Sulphuric dioxide	330	0,014325795
Formaldehyde	1325	0,002746211
Benzapilene	703	2,1883E-07

Data on the right-hand cross junction

Traffic light cycle in 20 minutes (T)	40
prohibiting traffic light duration (P) min.	0,5
Traffic length up to the traffic light (LO)	0

Traffic flow data on the right-hand cross junction

vehicle type, number of units during 20 minutes (Gk)	
Automobile - Russian	0
Automobile - Foreign	0
Miniibus	0
Bus on petrol	0
Bus on diesel	0
Truck on petrol > 3,5 t	0
Truck on diesel < 12 t	0
truck on diesel > 12 t	0

Emission data on the right-hand cross junction

Substance	Code	emission power (g/sec)

Carbonic Acid (CO)	337	0
Nitric oxides (NOx)	3000	0
Nitric dioxide (NO2)	301	0
Nitric oxide (NO)	304	0
Hydrocarbon (petrol fraction)	2704	0
Hydrocarbon (diesel fraction)	2732	0
Soot	328	0
Sulphuric dioxide	330	0
Formaldehyde	1325	0
Benzapilene	703	0

Data on the left-hand cross junction

Traffic light cycle in 20 minutes (T)	40
prohibiting traffic light duration (P) min.	0,5
Traffic length up to the traffic light (LO)	0

Traffic flow data on the left-hand cross junction

vehicle type, number of units during 20 minutes (Gk)	(Gk)
Automobile - Russian	0
Automobile - Foreign	0
Miniibus	0
Bus on petrol	0
Bus on diesel	0
Truck on petrol > 3,5 t	0
Truck on diesel < 12 t	0
truck on diesel > 12 t	0

Emission data on the left-hand cross junction

Substance	Code	emission power (g/sec)
Carbonic Acid (CO)	337	0
Nitric oxides (NOx)	3000	0
Nitric dioxide (NO2)	301	0
Nitric oxide (NO)	304	0
Hydrocarbon (petrol fraction)	2704	0
Hydrocarbon (diesel fraction)	2732	0
Soot	328	0
Sulphuric dioxide	330	0
Formaldehyde	1325	0
Benzapilene	703	0

Total Emission

		(g/sec)
Carbonic Acid (CO)	**337**	**1,6995825**
Nitric oxides (NOx)	**3000**	**2,307987**
Nitric dioxide (NO2)	**301**	**1,8463896**
Nitric oxide (NO)	**304**	**0,30003831**
Hydrocarbon (petrol fraction)	**2704**	**0,0438372**
Hydrocarbon (diesel fraction)	**2732**	**0,5549445**
Soot	**328**	**0,03677157**
Sulphuric dioxide	**330**	**0,014325795**
Formaldehyde	**1325**	**0,002746211**
Benzapilene	**703**	**2,1883E-07**

The dissemination ratio of polluting substances in the atmospheric air is calculated by means of the software "Ecolog-3". Considering the current conditions and the perspectives the initial datum is taken as to be the quantitative characters and the parameters of their emission, as shown above.

Meteorological characteristics and ratio, that determine the conditions of emission of polluting substances into the atmospheric air, are described in the table below.

Meteorological characteristics and ratio, determining the conditions of emission of polluting substances into the atmospheric air

#	**Name of the meteorological character and ratio**	**Meaning**
I	II	III
1.	Atmospheric temperature stratification ratio	200
2.	Site relief influential ratio	1
3.	Air average maximum temperature during the hottest month of the year ^{o}C	26.4
4.	Air average maximum temperature during the coldest month of the year ^{o}C	-2.4
5.	average annual set of winds,	%
	_ North	2
	_ North-East	10
	_ East	28
	_ South-East	1
	_ South	1
	_ South-West	3
	_ West	48
	_ North-West	7
6.	Wind Speed (according to the several-year data). Frequency of exaggeration equals 5% .	15,7

Background conditions of atmospheric air quality

There is no atmospheric air quality observation point at the considered site. Consequently, it is impossible to obtain the exact data on concentration of pollutants and hazards.

In order to conduct the atmospheric air pollution assessment of the considered area, one shell use the methodology guidelines, according to the number of population. Possible concentrations of pollutants are shown in the table below.

Number of population (thousand people)	Meaning of Background concentration, mg/m^3			
	Nitric dioxide	Sulphuric dioxide	Hydrocarbon	Dust
250-125	0,03	0,05	1,5	0,2
125-50	0,015	0,05	0,8	0,15
50-10	0,008	0,02	0,4	0,1
<10	0	0	0	0

There is no population settlement neither on East nor on the West sides of the portal around the tunnel site. Therefore, we can consider background data to equal zero.

The estimations are made in three versions (for the year 2009, and forecasts for 2020 and 2040 years), The 500 meter radius section is taken as a control point in accordance with the MPL norms and consequent graphical illustration is shown below.

Graphical Illustration of Estimations, 2009

Year 2009

Maximum concentrations formed by Nitric dioxide (Code -301)

Maximum concentrations formed by Nitric oxide (Code -304)

Maximum concentrations formed by Saturated hydrocarbon (kerosene fraction) formed concentrates (Code-2732)

Maximum concentrations formed by total influence 6009 group (codes 301+330)

Graphical illustration of estimations, year 2020

Maximum concentrations formed by Nitric Dioxide (code-301)

Maximum concentrations formed by Nitric oxide (Code -304)

Maximum concentrations formed by Saturated hydrocarbon (kerosene fraction) formed concentrates (Code-2732)

Maximum concentrations formed by Carbon oxide (Code-337)

Maximum concentrations formed by total influence 6009 group (codes 301+330)

Graphical illustration of estimations, year 2040

Maximum concentrations formed by Nitric Dioxide (code-301)

Maximum concentrations formed by Nitric oxide (Code -304)

Maximum concentrations formed by Soot (Code-328)

Maximum concentrations formed by Carbon oxide (Code-337)

Maximum concentrations formed by Saturated hydrocarbon (kerosene fraction) formed concentrates (Code-2732)

Maximum concentrations formed by total influence 6009 group (codes 301+330)

Estimation analysis at the edge of 500 meter zone

Name of the Substance	Substance Code	2009	2020	2040
Nitric (IV) oxide (Nitric dioxide)	0301	0,32	0,54	0,93
Nitric (II) oxide (Nitric oxide)	0304	0,01	0,02	0,03
Black Carbon (Soot)	0328	0	0	0,01
Sulphuric dioxide	0330	0	0	0
Carbon oxide	0337	0	0,0084	0,01
Benzapilene (3,4- Benzapilene)	0703	0	0	0
Formaldehyde	1325	0	0	0
Petrol fraction	2704	0	0	0
kerosene fraction	2732	0,0069	0,01	0,02
Total influence group # 6009	301+330	0,32	0,54	0,93

As the estimates show the concentrations formed by pollutants at the legal limited distance (500 meter area) will not exceed permissible norms, therefore the emission of pollutants exhausted from the tunnel could be considered permissible.

Annex D. Good Practice Note: Asbestos

Text of the Good Practice Note publication attached:

"Good Practice Note: Asbestos: Occupational and Community Health Issues", World Bank Group, May, 2009.

http://siteresources.worldbank.org/EXTPOPS/Resources/AsbestosGuidanceNoteFinal.pdf

Good Practice Note: Asbestos: Occupational and Community Health Issues

SUMMARY
The purpose of this Good Practice Note is to increase the awareness of the health risks related to occupational asbestos exposure, provide a list of resources on international good practices available to minimize these risks, and present an overview of some of the available product alternatives on the market. The need to address asbestos-containing materials (ACM) as a hazard is no longer under debate but a widely accepted fact.

Practices regarding asbestos that are normally considered acceptable by the World Bank Group (WBG) in projects supported through its lending or other instruments are addressed in the WBG's General Environmental, Health and Safety (EHS) Guidelines.[1] This Good Practice Note provide background and context for the guidance in the WBG EHS Guidelines.

Good practice is to minimize the health risks associated with ACM by avoiding their use in new construction and renovation, and, if installed asbestos-containing materials are encountered, by using internationally recognized standards and best practices (such as those presented in Appendix 3) to mitigate their impact. In all cases, the Bank expects borrowers and other clients of World Bank funding to use alternative materials wherever feasible.

ACM should be avoided in new construction, including construction for disaster relief. In reconstruction, demolition, and removal of damaged infrastructure, asbestos hazards should be identified and a risk management plan adopted that includes disposal techniques and end-of-life sites.

2. ASBESTOS AND HEALTH RISKS

2.1. What is Asbestos, and Why are We Concerned with its Use?

Asbestos is a group of naturally occurring fibrous silicate minerals. It was once used widely in the production of many industrial and household products because of its useful properties, including fire retardation, electrical and thermal insulation, chemical and thermal stability, and high tensile strength. Today, however, asbestos is recognized as a cause of various diseases and cancers and is considered a health hazard if inhaled.[2] The ILO estimates that over the last several decades 100,000 deaths globally have been due to asbestos exposure,[3] and the WHO states that 90,000 people die a year globally because of occupational asbestos exposure.[4]

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[1] 1 http://www.ifc.org/ifcext/enviro.nsf/AttachmentsByTitle/gui_EHSGuidelines2007_GeneralEHS/$FILE/Final+- +General+EHS+Guidelines.pdf (pp. 71, 91, 94) .

[2] http://www.who.int/occupational_health/publications/draft.WHO.policy.paper.on.asbestos.related.diseases.pdf. See also Stayner L, et al., "Exposure-Response Analysis of Risk of Respiratory Disease Associated with Occupational Exposure to Chrysotile Asbestos." *Occupational Environmental Medicine.* 54: 646-652 (1997).

[3] http://www.ilo.org/wow/Articles/lang--en/WCMS_081341

[4] http://www.who.int/occupational_health/publications/asbestosrelateddiseases.pdf

Over 90% of asbestos[5] fiber produced today is chrysotile, which is used in asbestos-cement (A-C) construction materials: A-C flat and corrugated sheet, A-C pipe, and A-C water storage tanks. Other products still being manufactured with asbestos content include vehicle brake and clutch pads, roofing, and gaskets. Though today asbestos is hardly used in construction materials other than asbestos-cement products, it is still found in older buildings in the form of friable surfacing materials, thermal system insulation, non-friable flooring materials, and other applications. The maintenance and removal of these materials warrant special attention.

Because the health risks associated with exposure to asbestos area now widely recognized, global health and worker organizations, research institutes, and some governments have enacted bans on the commercial use of asbestos (see Box 1), and they urge the enforcement of national standards to protect the health of workers, their families, and communities exposed to asbestos through an International Convention.[6]

BOX 1. BANS ON THE USE OF ASBESTOS AND ASBESTOS PRODUCTS

A global ban on commercial use of asbestos has been urged by the Building and Wood Workers Federation (IFBWW), the International Metalworker's Federation, the International Trade Union Confederation, the government of France, and the distinguished scientific group Collegium Ramazzini. All member states of the European Union and over 40 countries worldwide (see Appendix 1) have banned all forms of asbestos, including chrysotile.[7] In June 2006, the General Conference of the ILO adopted a resolution to "promote the elimination of all forms of asbestos and asbestos-containing materials."

- Landrigan PJ, Soffritti M. "Collegium Ramazzini Call for an International Ban on Asbestos." *Am. J. Ind. Med.* 47: 471-474 (2005).
- The International Ban Asbestos Secretariat keeps track of national asbestos bans. http:// ibassecretariat.org./lka_alpha_asb_ban_280704.php
- General Conference of the International Labor Organization, "Resolution Concerning Asbestos," *Provisional Record*, International Labor Conference, Ninety-fifth Session, Geneva, 2006, Item 299, pp. 20/47-48.
- World Health Organization: http://www.who.int/occupational_health/publications/asbestosrelateddiseases.pdf

2.2. Health Concerns Linked to Asbestos-Containing Products

Health hazards from breathing asbestos dust include asbestosis, a lung scarring disease, and various forms of cancer (including lung cancer and mesothelioma of the pleura and peritoneum).[8] These diseases usually arise decades after the onset of asbestos exposure. Mesothelioma, a signal tumor for asbestos exposure, occurs among workers' family members

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[5] Asbestos defined in Castleman, B. *Asbestos: Medical and Legal Aspects* 5th Ed. New York: Aspen, 2005, 894 pp.

[6] ILO Asbestos Convention No. 162, (see http:www.ilo.org/ilolex or http://www.itcilo.it/actrav/osh_es/m%F3dulos/legis/c162.htm)

[7] http://www.who.int/occupational_health/publications/asbestosrelateddiseases.pdf. Directive 2003/18/EC of the European Council and Parliament amending Council Directive 83/477/EEC, and Directive 99/77/EEC

[8] http://www.euro.who.int/document/aiq/6_2_asbestos.pdf

from dust on the workers' clothes and among neighbors of asbestos air pollution point sources.[9] Some experimental animal studies show that high inhalation exposures to all forms of asbestos for only hours can cause cancer.10 Very high levels of airborne asbestos have been recorded where power tools are used to cut A-C products and grind brake shoes. For chrysotile asbestos, the most common variety, there is no threshold (non-zero) of exposure that has been shown to be free from carcinogenic risks. Construction materials are of particular concern, because of the large number of workers in construction trades, the difficulty of instituting control measures, and the continuing threat posed by in-place materials that eventually require alterations, repair, and disposal.[11] Renovations and repairs in buildings containing A-C materials can also endanger building occupants. In addition to the problems from products made with commercial asbestos, asbestos also occurs as a contaminant in some deposits of stone, talc, vermiculite, iron ore, and other minerals. This can create health hazards for workers and residents at the site of excavation and in some cases in the manufacture and use of consumer products the materials are used to make. While asbestos is a known carcinogen when inhaled, it is not known to be carcinogenic when ingested, as through drinking water,[12] although pipe standards have been issued for asbestos-cement pipes conducting "aggressive" water.[13]

From the industrial hygiene viewpoint, asbestos creates a chain of exposure from the time it is mined until it returns to the earth at landfill or unauthorized disposal site. At each link in the chain, occupational and community exposures coexist. Workers in the mines are exposed to the fibers while extracting the ore; their families breathe fibers brought home on work clothes; workers in the mills and factories process the fiber and manufacture products with it; and their families are also secondarily exposed. Communities around the mines, mills, and factories are contaminated with their wastes; children play on tailings piles and in contaminated schoolyards; transportation of fiber and products contaminates roads and rights-of-way.[14] Tradesmen who install, repair and remove ACM are exposed in the course of their work, as are bystanders in the absence of proper controls. Disposal of asbestos wastes from any step in this sequence not only exposes the workers handling the wastes but also local residents when fibers become airborne because of insufficient covering and erosion control. Finally, in the absence of measures to remove ACM from the waste stream and dispose of them properly, the cycle is often repeated when discarded material is scavenged and reused.[15]

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[9] "Asbestos." World Health Organization IARC Monographs on the Evaluation of Carcinogenic Risks to Humans/ Overall Evaluations of Carcinogenicity: An Updating of IARC Monographs 1 to 42, Suppl. 7. Lyon: International Agency for Research on Cancer, 1987, pp. 106-116.

[10] Wagner JC, Berry G, Skidmore JW, Timbrell V. "The Effects of the Inhalation of Asbestos in Rats." *Br. J. Cancer* 29: 252-269 (1974).

[11] International Program on Chemical Safety, "Conclusions and Recommendations for Protection of Human Health," *Chrysotile Asbestos*, Environmental Health Criteria 203. Geneva: World Health Organization, 1998, p. 144.

[12] http://whqlibdoc.who.int/hq/2000/a68673_guidelines_3.pdf

[13] http://whqlibdoc.who.int/hq/2000/a68673_tech_aspects_4.pdf

[14] Jones, Robert "Living in the Shadow of the Asbestos Hills (The Need for Risk Based Cleanup Strategies for Environmental Asbestos Contamination in South Africa)." Environmental Exposure, Crisis Preparedness and Risk Communication, Global Asbestos Congress, Tokyo, Japan, November 19 - 21, 2004. http://park3.wakwak.com/~gac2004/en/index_abstract_e.html. See also Oberta, AF "Case Study: An Asbestos Cement Plant in Israel -- Contamination, Clean-up and Dismantling." Hellenic Asbestos Conference, Athens, Greece, October 29 - 31, 2002. http://www.ibas.btinternet.co.uk/Frames/f_lka_hellen_asb_conf_rep.htm

[15] Boer, A.M., L.A. Daal, J.L.A. de Groot, J.G. Cuperus "The Combination of the Mechanical Separator and the Extraction Cleaner Can Process the Complete Asbestos-containing Waste-stream and Make it Suitable for Reuse."

2.3. Increasing Use of Asbestos Fiber

There is evidence that, after a decline in the 1990s, the use of asbestos fiber is increasing globally. A recent study[16] shows that a 59% increase in metric tons was consumed in 12 countries from 2000 to 2004.

3. International Convention and Standards for Working with Asbestos

3.1. International Convention

The International Labor Organization (ILO) established an Asbestos Convention (C162) in 1986 to promote national laws and regulations for the "prevention and control of, and protection of workers against, health hazards due to occupational exposure to asbestos."[17] The convention outlines aspects of best practice: Scope and Definitions, General Principles, Protective and Preventive Measures, Surveillance of the Working Environment, and Workers' Health. As of March 4, 2008, 31 countries had ratified the Convention;[18] 17 of them have banned asbestos.

Some of the ILO asbestos convention requirements:

- work clothing to be provided by employers;
- double changing rooms and wash facilities to prevent dust from going home on street clothes
- training of workers about the health hazards to themselves and their families;
- periodic medical examinations of workers,
- periodic air monitoring of the work environment, with records retained for 30 years;
- development of a work plan prior to demolition work, to protect workers and provide for proper waste disposal; and
- protection from "retaliatory and disciplinary measures" of workers who remove themselves from work that they are justified in believing presents a serious danger to health

Standard considerations for working with and procuring ACM are common to most projects. An overview of some basic ones is provided in Appendix 5

3.2. International Standards and National Regulations

Standards and regulations for work involving ACM have been published by nongovernmental organizations and government agencies. Appendix 3 provides a listing of some resources, including international organizations (e.g., WHO, ISO, ASTM) and national governments (e.g., UK, US, Canada, South Africa). The resources range from manuals to individual standards and cover a variety of work guidelines, including surveys, identification, inspection, maintenance, renovation, repair, removal, and disposal. Some of the key issues discussed in these standards and regulations are as follows:

European Conference on Asbestos Risks and Management, Rome, Italy, December 4 -6, 2006. http://venus.unive.it/fall/menu/Boer.pdf

[16] R. Virta, US Geological Survey, 2007.

[17] www.ilo.org/ilolex

[18] http://www.ilo.org/ilolex/english/convdisp1.htm

- **The scale of occupational hazards.** The health risk is not simply a function of the properties of the ACM, but also reflects the type of work being done and the controls used. Although A-C products, for example, may seem to intrinsically present less of a risk than fire-proofing, air monitoring has shown that cutting dry A-C sheet with a power saw can release far greater amounts of airborne fibers than scraping wet, saturated fireproofing off a beam. The relationship between the nature of A-C products, the work being done and the controls used to control the release of fibers and debris is important (as discussed in ASTM E2394 and HSG189/2[19]).

- **Controlling exposure to airborne fibers.** Because asbestos fibers are primarily an inhalation hazard, the basic purpose of the regulations and standards is to control the concentration of asbestos fibers in the air inhaled by workers or others. Concentration limits have been set by regulations in numerous countries for workers whose duties involve contact with ACM; however, they do not purport to totally eliminate the risk of asbestos disease, but only to reduce it. Exposure limits for individuals other than workers, including occupants of buildings and facilities and the community, are lower than those for workers in deference to the very young and old as well as the physically compromised

- **Measuring exposure to airborne fibers.** Compliance with exposure limits is demonstrated by air sampling in workers' breathing zone or in the space occupied by the affected individuals, with analysis of the sample by optical or electron microscopy, as explained in Appendix 3. Abatement protocols determine whether a building can be reoccupied after asbestos abatement.

- **Proper disposal.** Proper disposal of ACM is important not only to protect the community and environment but also to prevent scavenging and reuse of removed material. ACM should be transported in leak-tight containers to a secure landfill operated in a manner that precludes air and water contamination that could result from ruptured containers. Similar requirements apply to remediation of sites such as mines, mills, and factories where asbestos fiber was processed and products manufactured. (See EPA NESHAP regulations, Appendix 3.)

- **Transboundary movement of waste**. Waste asbestos (dust and fibers) is considered a hazardous waste under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. The Basel Convention imposes use of a prior informed consent procedure for movement of such wastes across international borders. Shipments made without consent are illegal. Parties have to ensure that hazardous waste is disposed of in an environmentally sound manner (ESM. Strong controls have to be applied from the moment of generation, to its storage, transport, treatment, reuse, recycling, recovery and final disposal[20]

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[19] See Appendix 3.

[20] See Basel Convention Secretariat http://www.basel.int/

- **Identifying asbestos products.** A-C products include flat panels, corrugated panels used for roofing, water storage tanks, and pressure, water, and sewer pipes. In some countries asbestos may still be used in making wallboard, heat-resistant gloves and clothes for industrial use, and brake and clutch friction elements and gaskets used in vehicles.[21] Thermal insulation containing asbestos and sprayed asbestos for insulation and acoustic damping were widely used through the 1970s and should be looked for in any project involving boilers and insulated pipes. Insulation dating from before 1980 should be presumed to contain asbestos unless analyzed and found not to. The microscopic methodology for analyzing bulk samples for the presence of asbestos is widely available in industrialized countries and is not expensive; it is less available in developing countries. In a developing country samples may have to be mailed out for testing; alternatively, training may be available for a laboratory in the country.

- **Training.** It is impossible to overemphasize the importance of training for working with ACM in any capacity—whether it involves inspections, maintenance, removal, or laboratory analysis. The duration of the training as well as the course content depends on the type of work the individual will be doing. Quality control and proficiency testing for laboratories and individual analysts are also important.

4. ALTERNATIVES TO ASBESTOS-CONTAINING MATERIALS

4.1. Growing Marketplace

Safer substitutes for asbestos products of all kinds are increasingly available (see Appendix 4). These include fiber-cement products using combinations of local vegetable fibers and synthetic fibers, as well as other products that serve the same purposes.[22] The WHO is actively involved in evaluating alternatives.[23]

4.2. Cost and Performance Issues

Fiber-cement roof panels using polyvinyl alcohol (PVA) or polypropylene combined with cellulose now cost 10-15% more to manufacture than A-C sheets. Polypropylene-cellulose-cement roofing, a new product, is made at a cost of about 12 percent more than A-C roofing and has superior impact resistance. The non-asbestos fiber-cement panels are lighter, less brittle, and have improved nailability over A-C. The increase in the overall cost of building construction that such products represent is to some degree offset by the obviation of special hygiene measures in installation/maintenance/renovation, the lack of a continuing hazard to building workers and occupants, and reduced costs of waste removal and disposal. Micro concrete tiles are cheaper than A-C to produce, and can be made in a basic workshop near the building site with locally available small contractors and materials, lowering transport costs. Compared with A-C pipes, iron pipes can be transported and installed with less difficulty and breakage, take greater compression loading and last longer.

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[21] In 2004, Russia, China, India, Kazakhstan, Thailand, and Ukraine together accounted for about three-quarters of world asbestos consumption. Other major consumers of asbestos are Iran, Brazil, Vietnam, and Indonesia.

[22] 7. The U.K. Health and Safety Executive commissioned a report that concluded that the main replacement fibrous materials for asbestos in fiber-cement products and brakes are less hazardous than chrysotile asbestos. See Harrison PTC, *et al.* "Comparative Hazards of Chrysotile Asbestos and Its Substitutes: A European Perspective." *Envir. Health Persp.* 107: 607-611 (1999). http://www.ehponline.org/members/1999/107p607-611harrison/harrison-full.html

[23] http://www.who.int/ipcs/assessment/asbestos/en/

5. World Bank Group Approach to Asbestos Health Risk

The WBG EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP).[24] When one or more members of the WBG are involved in a project, the EHS Guidelines are applied as required by their respective policies and standards.

The WBG's EHS Guidelines[25] specify that the use of ACM should be avoided in new buildings and construction or as a new material in remodeling or renovation activities. Existing facilities with ACM should develop an asbestos management plan that clearly identifies the locations where the ACM is present, its condition (e.g., whether it is in friable form or has the potential to release fibers), procedures for monitoring its condition, procedures to access the locations where ACM is present to avoid damage, and training of staff who can potentially come into contact with the material to avoid damage and prevent exposure. The plan should be made available to all persons involved in operations and maintenance activities. Repair or removal and disposal of existing ACM in buildings should be performed only by specially trained personnel[26] following host country requirements or, if the country does not have its own requirements, internationally recognized procedures.[27] Decommissioning sites may also pose a risk of exposure to asbestos that should be prevented by using specially trained personnel to identify and carefully remove asbestos insulation and structural building elements before dismantling or demolition.[28]

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[24] Defined as the exercise of professional skill, diligence, prudence, and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility

[25] http://www.ifc.org/ifcext/enviro.nsf/AttachmentsByTitle/gui_EHSGuidelines2007_GeneralEHS/$FILE/Final+-+General+EHS+Guidelines.pdf (pp. 71, 91, 94)

[26] Training of specialized personnel and the maintenance and removal methods applied should be equivalent to those required under applicable regulations in the United States and Europe (examples of North American training standards are available at: http://www.osha.gov/SLTC/asbestos/training.html)

[27] Examples include the ASTM International E1368 - Standard Practice for Visual Inspection of Asbestos Abatement Projects; E2356 - Standard Practice for Comprehensive Building Asbestos Surveys; and E2394 - Standard Practice for Maintenance, Renovation and Repair of Installed Asbestos Cement Products.

[28] http://www.ifc.org/ifcext/enviro.nsf/AttachmentsByTitle/gui_EHSGuidelines2007_GeneralEHS/$FILE/Final+-+General+EHS+Guidelines.pdf (pp. 71, 91, 94)

APPENDIX 1. COUNTRIES THAT HAVE BANNED THE USE OF ASBESTOS

1. Argentina
2. Australia
3. Austria
4. Belgium
5. Bulgaria
6. Chile
7. Cyprus
8. Czech Republic
9. Denmark
10. Egypt
11. Estonia
12. Finland
13. France
14. Gabon
15. Germany
16. Greece
17. Honduras
18. Hungary
19. Iceland
20. Ireland
21. Italy
22. Japan
23. Jordan
24. Kuwait
25. Latvia
26. Lithuania
27. Luxembourg
28. Malta
29. Netherlands
30. Norway
31. Poland
32. Portugal
33. Republic of Korea
34. Romania
35. Saudi Arabia
36. Seychelles
37. Slovakia
38. Slovenia
39. South Africa
40. Spain
41. Sweden
42. Switzerland
43. United Kingdom
44. Uruguay

APPENDIX 2. WORLD BANK GROUP ASBESTOS REFERENCES

Policy guidance	***References***
ACM should be avoided in new buildings or as new material in remodeling or renovation • Existing buildings: ACM Survey and management plan needed • Disposal of ACM shall be carried out by specially trained individuals only following host country requirements, or in their absence, internationally recognized procedures	*Guidance: General Environment Health and Safety Guidelines April 2007, p 34 and 71*.
Some examples of project requirements: • risk assessment to determine extent of problem; surveys to abate asbestos exposure; management plan; removal by trained personnel; prohibition of ACM; procedures for handling, removal, transport, and disposal of asbestos.	• Ukraine -Equal Access to Quality Education (Project ID PO77738) • KH- Health Sector Support (Project ID: P070542) • ID- Health Workforce and Services (Project. ID: P073772) • Changchun, China -TBK Shili Auto Parts Co., (IFC, 2005)

APPENDIX 3. LIST OF RESOURCES FOR ASBESTOS STANDARDS AND REGULATIONS

NOTE: this listing is not meant to be all-inclusive, but is a sample of available information

INTERNATIONAL STANDARDS

WHO Policy and Guidelines (www.who.org)

- www.searo.who.int/LinkFiles/Publications_and_Documents_prevention_guidelines.pdf(p. 70)
- www.searo.who.int/en/Section23/Section1108/Section1835/Section1864_8658.htm

International Organization for Standardization (ISO) (www.iso.org)

- ISO 10312 (1995): Ambient air -- Determination of asbestos fibres -- Direct transfer transmission electron microscopy method. [Method similar to ASTM D6281]
- ISO 13794 (1999): Ambient air – Determination of asbestos fibres – Indirect-transfer transmission electron microscopy method.
- ISO/FDIS 16000-7: Indoor air – Part 7: Sampling strategy for determination of airborne asbestos fibre concentrations.
- ISO 8672: Air quality -- Determination of the number concentration of airborne inorganic fibres by phase contrast optical microscopy -- Membrane filter method (1993) [Method similar to AIA RTM1]

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal

- Basel Convention Secretariat (www.basel.int)

International Labour Organization (www.ilo.org)

- Chemical Safety Card, ICSC 0014: www.ilo.org/public/english/protection/safework/cis/products/icsc/dtasht/_icsc00/icsc0014.htm

European Union
(europa.eu.int/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&lg=EN&numdoc=32003L0018&model=guichett)

- Directive 2003/18/EC amending Council Directive 83/477/EEC on the Protection of Workers from the Risks Related to Exposure to Asbestos at Work. (March 2003). Provides regulations including: worker protection, training and medical surveillance; inspections for asbestos-containing materials; notification of asbestos work; air sampling; exposure limits of 0,1 fibres per cm^3 (8-hr TWA) measured by Phase Contrast Microscopy.

NATIONAL STANDARDS

ASTM International (www.astm.org)

- Manual on Asbestos Control: Surveys, Removal and Management – Second Edition (March 2005). Author: Andrew F. Oberta, MPH, CIH. Discusses in detail how E2356, E2394 and E1368 are used to support an asbestos management program.
- E2356 Standard Practice for Comprehensive Building Asbestos Surveys. July, 2004. Covers baseline surveys for management of ACM and includes assessment protocols to make and prioritize removal vs. maintenance decisions. ASTM E2356

provides information for long-term management of ACM in a Baseline Survey and for preparation of the plans and specifications for a removal project. It contains detailed procedures and equipment (mostly ordinary hardware items) needed to take bulk samples of common types of suspect ACM. Once materials have been identified as asbestos-containing, an assessment is made as to which can be left in place. Quantitative assessment of the Current Condition and Potential for Disturbance of all friable and non-friable materials allows removal priorities to be tabulated and graphically displayed. Budgetary estimates for removal can be established on the basis of the quantitative assessments.

- E2394 Standard Practice for Maintenance, Renovation and Repair of Installed Asbestos Cement Products (October 2004). Describes materials, hazardous operations, necessary precautions and infrastructure requirements with detailed procedures in appendices. Not intended for installation of asbestos-cement products in new construction or renovation
- E1368 Standard Practice for Visual Inspection of Asbestos Abatement Projects (May 2005). Provides an approach to managing a removal project to enhance prospects of passing final inspections and clearance air sampling. Describes preparation, removal and inspection procedures and criteria.
- E2308 Standard Guide on Limited Asbestos Screens of Buildings (2005). Provides the minimum amount of information needed to facilitate a real estate transaction.
- D6281 Standard Test Method for Airborne Asbestos Concentration in Ambient and Indoor Atmospheres as Determined by Transmission Electron Microscopy Direct Transfer (TEM). A method for distinguishing asbestos from non-asbestos fibers on an air sample filter and identifying and quantifying smaller and thinner fibers than Phase Contrast Microscopy
- D7201: Practice for Sampling and Counting Airborne Fibers, Including Asbestos Fibers, in the Workplace, by Phase Contrast Microscopy (with an Option of Transmission Electron Microscopy)
- Combines methodology of NIOSH 7400 and 7402

Australia
(www.ascc.gov.au/ascc/AboutUs/Publications/NationalStandards/ListofNationalCodesofPractice.htm)

- Safe Removal of Asbestos 2nd edition [NOHSC: 2002 (2005)]
- Code of Practice for the Management and Control of Asbestos in the Workplace [NOHSC: 2018 (2005)]

U. K. Health and Safety Executive (http://www.hse.gov.uk/asbestos/index.htm)

- Asbestos Regulations (http://www.opsi.gov.uk/si/si2006/20062739.htm)
- Asbestos Essentials (http://www.hse.gov.uk/asbestos/essentials/index.htm). Includes sections on manager Tasks and methods and equipment.

Publications include:

- Working with Asbestos in Buildings INDG289 08/01 C600. An overview (16 pages) of asbestos hazards and precautions
- MDHS100 Surveying, sampling and assessment of asbestos containing materials (2001). Contains many illustrations and examples of asbestos-containing products as well as sampling and analytical methods. MDHS100 is comparable in thoroughness to ASTM in its discussion of bulk sampling techniques and equipment, organizing a survey and assessment of ACM using a numerical algorithm based on the product type, extent of damage, surface treatment and type of asbestos fiber. The document contains numerous photographs of typical ACM found in buildings.
- HSG189/2 Working with asbestos cement (1999). Describes asbestos-cement products and methods of repairing and removing them, including fiber

concentrations for controlled and uncontrolled operations.

- The Control of Asbestos at Work Regulations (2002). Requirements for the protection of people being exposed to asbestos, including the requirement for those with responsibility for the maintenance and/or repair of non-domestic premises, to identify and manage any risk from asbestos within their premises

National Institute of Building Sciences (http://www.nibs.org/pubsasb.html)

- Guidance Manual: Asbestos O&M Work Practices, Second Edition (1996). Contains procedures for small-scale work on friable and non-friable ACM including asbestos-cement products.
- Asbestos Abatement and Management in Buildings: Model Guide Specification. Third Edition (1996). Contains information on project design and surveillance as well as applicable US regulations, plus removal contractor requirements for abatement work in specification format.

Austrian Standards Institute (http://www.on-norm.at/index_e.html)
ONORM M 9406, Handling of products containing weakly bound asbestos, 01 08 2001. Contains a protocol and algorithm for assessing the condition and potential fiber release from friable asbestos-containing materials.

International Chrysotile Association (www.chrysotile.com). [*Please note this organization represents asbestos industries and businesses]*

- Recommended Technical Method No. 1 (RTM1), Reference Method for the determination of Airborne Asbestos Fibre Concentrations at workplaces by light microscopy (Membrane Filter Method). Method using Phase Contrast Microscopy for counting fibers on an air sampling filter that does not distinguish asbestos from other fibers
- Recommended Technical Method No. 2 (RTM2) Method for the determination of Airborne Asbestos Fibres and Other Inorganic Fibres by Scanning Electron Microscopy. Method that identifies smaller fibers than Phase Contrast Microscopy and can distinguish types of asbestos fibers.

U.S. National Institute for Occupational Safety and Health (www.cdc.gov/niosh/topics/asbestos)

- Occupational Safety and Health Guidelines for Asbestos (www.cdc.gov/niosh/pdfs/0041.pdf)
- Recommendations for Preventing Occupational Exposure (www.cdc.gov/niosh/topics/asbestos/#prevention)
- Method 7400, Asbestos and other fibers by PCM (1994).Phase Contrast Microscopy method similar to AIA RTM1 that counts all fibers greater than 5µm long with a 3:1 aspect ratio
- Method 7402 Asbestos by TEM (1994). Method using Transmission Electron Microscopy that identifies and counts asbestos fibers greater than 5µm long and greater than 0.25µm in diameter with a 3:1 aspect ratio

U.S. Environmental Protection Agency (www.epa.gov/asbestos)

- Resources include managing asbestos-containing materials in buildings, schools, and the automotive industry. Includes procedures for inspection, analysis of bulk samples, assessment of friable ACBM, response actions (removal, encapsulation, enclosure), Operations and Maintenance, and clearance air sampling.
- National Emission Standards for Hazardous Air Pollutants: Subpart M - Asbestos. 40 CFR Part 61. (1990). Regulations include: definitions of friable and non-friable asbestos-containing materials; notification requirements for renovation and demolition of buildings and facilities containing ACM; work practices to prevent visible emissions; disposal of ACM and waste material in approved landfills; and operation and closure of landfills.
- 20T-2003 Managing Asbestos in Place: A Building Owner's Guide to Operations

and Maintenance Programs for Asbestos-Containing Materials “Green book” (1990)

- Guidance document covering: organizing an Operations and Maintenance (O&M) program including training O&M workers; recognizing types of O&M; work practices and precautions for O&M work.
- EPA-600/R-93/116 Method for the Determination of Asbestos in Bulk Building Materials (1993) Polarized Light Microscopy, Gravimetry, X-ray diffraction and Transmission Electron Microscopy methods of identifying and quantifying asbestos fibers in bulk building materials. The identification of materials as containing asbestos is done by analysis of bulk samples, usually with Polarized Light Microscopy. The analytical procedures described and the equipment to perform the analyses is similar to that found in academic or commercial geology laboratories, but specialized training to identify and quantify asbestos fibers in bulk building materials is needed as well as quality control and proficiency testing programs.
- Polarized Light Microscopy, Gravimetry, X-ray diffraction and Transmission Electron Microscopy methods of identifying and quantifying asbestos fibers in bulk building materials

U. S. Occupational Safety and Health Administration (Department of Labor) (www.osha.gov/SLTC/asbestos) / (www.osha.gov/SLTC/asbestos/standards.html)

- Occupational Exposure to Asbestos (Construction Industry Standard) 29CFR1926.1101. (1994). Regulations for: Permissible Exposure Limits of 0.1 f/cc over a full shift (8 hr time-weighted average) and short-term exposure limit of 1.0 f/ml for 30 minutes; employee exposure monitoring for compliance with the PELs; work practices for friable and non-friable ACM; respiratory protection; worker decontamination and hygiene facilities; notification of employees and other employers of employees; medical surveillance; record-keeping and training.
- OSHA Method ID 160 Asbestos in Air (1994). Phase Contrast Microscopy method similar to NIOSH 7400

Ontario Ministry of Labour (Canada) (**www.e-laws.gov.on.ca/DBLaws/Source/Regs/English/2005/R05278_e.htm)**

- Ontario regulation 278/05 Designated Substance — asbestos on construction projects and in buildings and repair operations (2005). Regulations covering: respiratory protection and work procedures; inspections for asbestos; management of friable and non-friable asbestos; advance written notice; asbestos bulk sampling and analysis; glove bag requirements and procedures; negative air enclosures; and clearance air testing requirements (0.01 f/cc by Phase Contrast Microscopy).

WorkSafe British Columbia (Canada) (www2.worksafebc.com/publications/OHSRegulation/Part6.asp)

- Part 6 Substance Specific Requirements: Asbestos. Regulations covering: identification of asbestos-containing materials; substitution with non-asbestos materials; worker training; exposure monitoring; containment and ventilation of work areas; work practices; decontamination; respirators and protective clothing.

Republic of South Africa, Department of Labour (www.acts.co.za/ohs/index.htm - type ‘asbestos’ in search box)

- Occupational Health and Safety Act, 1993; Asbestos Regulations, 2001.Regulations covering: notification; assessment and control of exposure; Occupational Exposure Limit of 0.2 f/cc - 4 hr TWA measured by Phase Contrast Microscopy; training; air monitoring; medical surveillance; non-employee exposure; respirators, personal protective equipment and facilities; asbestos building materials including asbestos cement sheeting and related products; disposal.

APPENDIX 4. SOME ALTERNATIVES TO ASBESTOS-CONTAINING PRODUCTS

Asbestos product	***Substitute products***
Asbestos-cement corrugated roofing	Fiber-cement roofing using synthetic fibers (polyvinyl alcohol, polypropylene) and vegetable/cellulose fibers (softwood kraft pulp, bamboo, sisal, coir, rattan shavings and tobacco stalks, etc.); with optional silica fume, fly ash, or rice husk ash. Microconcrete (Parry) tiles; galvanized metal sheets; clay tiles; vegetable fibers in asphalt; slate; coated metal tiles (Harveytile); aluminum roof tiles (Dekra Tile); extruded uPVC roofing sheets; recycled polypropylene and high-density polyethylene and crushed stone (Worldroof); plastic coated aluminum; plastic coated galvanized steel.
Asbestos-cement flat sheet (ceilings, facades, partitions)	Fiber-cement using vegetable/cellulose fibers (see above), wastepaper, optionally synthetic fibers; gypsum ceiling boards (BHP Gypsum); polystyrene ceilings, cornices, and partitions; façade applications in polystyrene structural walls (coated with plaster); aluminum cladding (Alucabond); brick; galvanized frame with plaster-board or calcium silicate board facing; softwood frame with plasterboard or calcium silicate board facing.
Asbestos-cement pipe	*High pressure:* Cast iron and ductile iron pipe; high-density polyethylene pipe; polyvinyl chloride pipe; steel-reinforced concrete pipe (large sizes); glass-reinforced polyester pipe. *Low pressure:* Cellulose-cement pipe; cellulose/PVA fiber-cement pipe; clay pipe; glass-reinforced polyester pipe; steel-reinforced concrete pipe (large diameter drainage).
Asbestos-cement water storage tanks	Cellulose-cement; polyethylene; fiberglass; steel; galvanized iron; PVA-cellulose fiber-cement
Asbestos-cement rainwater gutters; open drains (mining industry)	Galvanized iron; aluminum; hand-molded cellulose-cement; PVC

APPENDIX 5. CONSIDERATIONS FOR WORKING WITH ASBESTOS MATERIALS IN EXISTING STRUCTURES

A. Evaluation of alternatives

1. Determine if the project could include the installation, replacement, maintenance or demolition of:

- Roofing, siding, ducts or wallboard
- Thermal insulation on pipes, boilers, and ducts
- Plaster or fireproofing
- Resilient flooring materials
- Other potentially asbestos-containing materials

2. If the use of asbestos-containing materials (ACM) has been anticipated for new construction or renovation, provide information about alternative non-asbestos materials and their availability. For new construction, determine the expected difference for the entire project—on initial and operating costs, employment, quality, expected service life, and other factors—using alternatives to ACM (including consideration of the need for imported raw materials).

3. In many cases, it can be presumed that ACM are part of the existing infrastructure that must be disturbed. If there is a need to analyze samples of existing material to see if it contains asbestos, provide information on how and where can that be arranged.

4. Once the presence of ACM in the existing infrastructure has been presumed or confirmed and their disturbance is shown to be unavoidable, incorporate the following requirements in tenders for construction work in compliance with applicable laws and regulations.

B. Understanding the regulatory framework

1. Review the host country laws and regulations and the international obligations it may have entered into (e.g., ILO, Basel conventions) for controlling worker and environmental exposure to asbestos in construction work and waste disposal where ACM are present. Determine how the qualifications of contractors and workers who maintain and remove ACM are established, measured, and enforced.

2. Determine whether licensing and permitting of the work by authorities is required.

3. Review how removed ACM are to be disposed of to minimize the potential for pollution, scavenging, and reuse.

4. Incorporate the following requirements in tenders involving removal, repair, and disposal of ACM.

C. Considerations and possible operational requirements related to works involving asbestos

1. **Contractor qualification**

- Require that contractors demonstrate having experience and capability to observe international good practice standards with asbestos, including training of workers and supervisors, possession of (or means of access to) adequate equipment and supplies for the scope of envisioned works, and a record of compliance with regulations on previous work.

2. **Related to the technical requirements for the works**

- Require that the removal, repair, and disposal of ACM shall be carried out in a way that minimizes worker and community asbestos exposure, and require the selected contractor to develop and submit a plan, subject to the engineer's acceptance, before doing so.
- Describe the work in detail in plans and specifications prepared for the specific site and project, including but not limited to the following:
  - Containment of interior areas where removal will occur in a negative pressure enclosure;
  - Protection of walls, floors, and other surfaces with plastic sheeting;
  - Construction of decontamination facilities for workers and equipment;
  - Removing the ACM using wet methods, and promptly placing the material in impermeable containers;
  - Final clean-up with special vacuums and dismantling of the enclosure and decontamination facilities;
  - Disposal of the removed ACM and contaminated materials in an approved landfill;[29]
  - Inspection and air monitoring as the work progresses, as well as final air sampling for clearance, by an entity independent of the contractor removing the ACM.
- Other requirements for specific types of ACM, configurations and characteristics of buildings or facilities, and other factors affecting the work shall be enumerated in the plans and specifications. Applicable regulations and consensus standards shall be specifically enumerated.

3. **Related to the contract clauses**[30]

- Require that the selected contractor provide adequate protection to its personnel handling asbestos, including respirators and disposable clothing.

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[29] Alternative guidance for circumstances where approved landfills are not available for disposal of hazardous substances, such as asbestos, guidance is provided in the EHS General Guideline, reference above as well as in the Guideline on Waste Management Facilities.
http://www.ifc.org/ifcext/sustainability.nsf/AttachmentsByTitle/gui_EHSGuidelines2007_WasteManagement/$FILE/Final+-+Waste+Management+Facilities.pdf

[30] Standard contract clauses for asbestos work exist but are too extensive for this short note. To view an example, the U.S. National Institute of Building Sciences "Asbestos Abatement and Management in Buildings: Model Guide Specification" has a complete set – in copyright form – and the clauses and instructions for using them fill a two-inch binder.

- Require that the selected contractor notifies the relevant authorities of the removal and disposal according to applicable regulations as indicated in the technical requirements and cooperates fully with representatives of the relevant agency during all inspections and inquiries.

4. **Related to training and capacity building**

- Determine whether specialist industrial hygiene expertise should be hired to assure that local contractors learn about and apply proper protective measures in work with ACM in existing structures.

Originator: World Bank, Operations Policy and Country Services.

საქართველოს რეგიონული განვითარებისა და ინფრასტრუქტურის სამინისტრო
საქართველოს საავტომობილო გზების დეპარტამენტი

E-60 ავტომაგისტრალზე რიკოთის გვირაბის სარეაბილიტაციო სამუშაოების გარემოზე ზემოქმედების შეფასების ანგარიშის და გარემოს მენეჯმენტის გეგმის საჯარო განხილვის

ო ქ მ ი

2009 წლის 28 სექტემბერს, 11.00 საათზე, დაბა ხურამის გამგეობის შენობაში, ჩატარდა E-60 ავტომაგისტრალზე რიკოთის გვირაბის სარეაბილიტაციო სამუშაოების, გარემოზე ზემოქმედების შეფასების ანგარიშისა და გარემოზე ზემოქმედების მენეჯმენტის გეგმის საჯარო განხილვა. საჯარო განხილვის მიზანი იყო დაგეგმილ სამუშაოთა უშუალო ზემოქმედების არეალში მოქცეული ადგილობრივი მოსახლეობის ინფორმირება ამ სამუშაოთა არის, ვადების, სამუშაოთა მიმდინარეობისაგან მოსახლეობისათვის დროებით უხერხულობის გაჩენის შესაძლებლობის და სამუშაოების მსვლელობასთან დაკავშირებული არასასურველი მოვლენების შესამცირებლად დაგეგმილი ღონისძიებების შესახებ. ზსდ-ების დოკუმენტების განხილვისას დამსწრე საზოგადოების შესაძლებლობა ჰქონდა დასმა კითხვები და გამოეთქვა მოსაზრებები გეგმების სამოლიო სახით ჩამოყალიბების შესახებ. მათი შემდგომი გათვალისწინების მიზნით.

საჯარო განხილვას უძღვებოდნენ საავტომობილო გზების დეპარტამენტის ტექნიკური პოლიტიკის სამმართველოს, გარემოს დაცვის განყოფილების უფროსი ბატონი ოთარ ბაბუაშვილი და დეპარტამენტის მიერ გარემოზე ზემოქმედების შეფასების დოკუმენტის მომზადებისათვის დაქირავებული საკონსულტაციო კომპანიის KOCKS Consult-ის წარმომადგენელი გარემოს დაცვის სპეციალისტი ბატონი **ოთარი თურმანიძე**

საჯარო განხილვას ესწრებოდნენ:

საქართველოს საავტომობილო გზების დეპარტამენტის თანამშრომლები: ტექნიკური პოლიტიკის /პროექტირება/ სამმართველოს გარემოს დაცვის განყოფილების უფროსი ოთარ ბაბუაშვილი და ტექნიკური პოლიტიკის /პროექტირება/ სამმართველოს გარემოს დაცვის განყოფილების უფროსი ლეონა ბუბაშვილი.

დაბა სურამის ადგილობრივი მოსახლეობა (დაახლოებით 25 ადამიანი)

შეხვედრა გახსნა და დამსწრეთ მოახსენა დაგეგმილ სარეაბილიტაციო სამუშაოების შესახებ ოთარ ხატაშვილმა. ან პროექტის ტექნიკურ და საინჟინრო მხარეზე იხაუბრა და მოსახლეობას მიაწოდა მათთვის საინტერესო დეტალური ინფორმაცია.

პროექტის გარემოზე ზემოქმედების შეფასება და მენეჯმენტის გეგმა დამსწრეებს გააცნო გარემოს დაცვის სპეციალისტმა ოთარ თურმანიძემ. განხილულ იქნა პროექტთან დაკავშირებული სამუშაოები, მათი შესაძლო ზემოქმედება გარემოზე და ადამიანების ჯანმრთელობაზე, ამ ზემოქმედების შემარბილებელი ღონისძიებები რომელიც საშუალებას იძლევა მისაღებ მინიმუმამდე იქნას დაყვანილი ყოველგვარი მავნე ზემოქმედება გვირაბის მშენებლობის და ექსპლუატაციის ფაზაში.

თავმჯდომარის მოადგილე

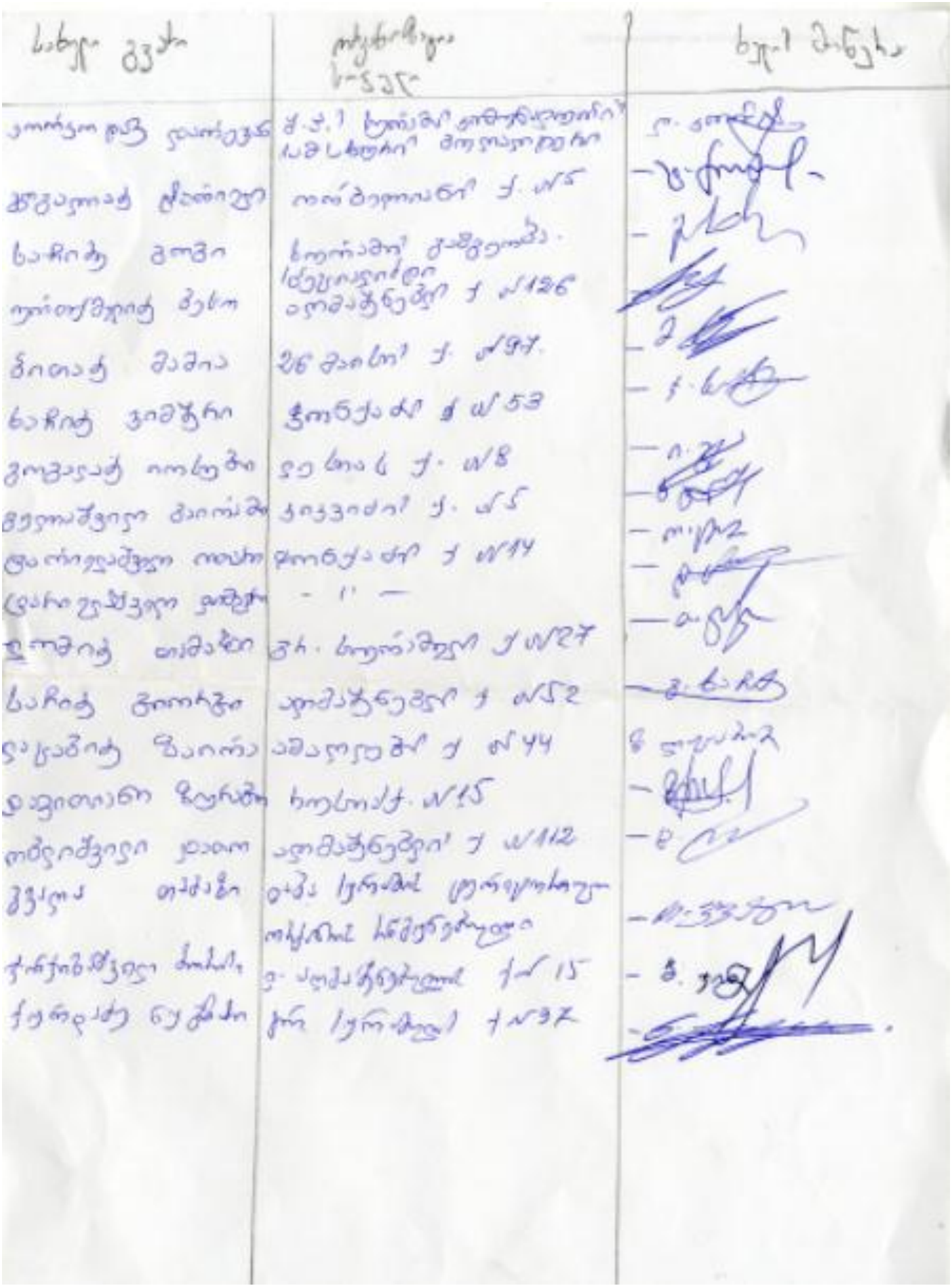
გ. წერეთელი

საავტომობილო გზების დეპარტამენტის თანამშრომლები:

ლუიზა ბუბაშვილი

ოთარ ხატაშვილი

კითხვა/კომენტარის ავტორი	კითხვა/კომენტარის შინაარსი	კომენტარები
ხაჩიძე გიორგი	დასაშვებია თუ არა აგვილობრივი მოსახლეობა?	გვირაბის სარეაბილიტაციო სამუშაოები სპეციფიური ხასიათისაა, ამიტომ მოითხოვს კვალიფიციურ მუშა-მოსამსახურეების მონაწილეობას, თუმცა გარკვეული სამუშაოებისათვის შესაძლებელია ნაკლებად კვალიფიციური მუშა ხელის დაქირავებაც. კონტრაქტის პირობები ითვალისწინებს 70%-მდე აგვილობრივი მოსახლეობის დასაშვებას.
დავითაძე ზურაბი	არის თუ არა ჩადებული დოკუმენტში მოჭრილი ხეების სანაცვლოდ, ახალი ხეების დარგვა?	გზშ-ს დოკუმენტში ჩადებულია საკომპენსაციო სამუშაოები, რაც ითვალისწინებს რომ ერთი მოჭრილი ხის სანაცვლოდ დაირგვება ერთნახევარი ხე.
ჯანჯიხაშვილი ბორისი	პირველად რა სამუშაო დაიწყება?	პირველ რიგში მოხდება გვირაბის შემოვლითი გზის რეაბილიტაცია, ხოლო ამის შემდეგ თვითონ გვირაბის სარეაბილიტაციო სამუშაოები.
ჭურდაძე ნუგზარი	არის თუ არა შერჩეული ნაგავსაყრელის აგილი?	ამ ეტაპზე ნაგავსაყრელის აგილი უკვე შერჩეულია და ეს აგილი არის გვირაბიდან დაახლოებით 20 კმ-ში, რაც შემდგომში კონტრაქტორმა უნდა შეთანხმოს და მიიღოს სათანადო თანხმობა აგვილობრივი თვითმმართველობისაგან (თანახმად საქართველოს კანონმდებლობისა).



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

Minutes
of Public Consultation Meeting in Surami
on Environmental Impact Assessment and Environmental Management Plan
for Rehabilitation of
Rikoti Tunnel of E-60 Highway

Public consultation on Environmental Management Plan and Environmental Impact Assessment for rehabilitation of Rikoti Tunnel of E-60 Highway was held on 28 September 2009 at 11:00 in Surami Municipality office. The goal of public discussion was to inform the local communities about the purpose of the upcoming works, their timeline; temporary inconvenience expected from the construction works; and planned measures for mitigating negative environmental impact. Attendees had possibility to ask questions and express their opinion during the discussion, so that their comments could have been considered in the final version of the Environmental Impact Assessment report and the Environmental Management Plan.

The consultation meeting was chaired by Mr. Otar Khatiashvili, Head of Environmental Unit of the Technical Policy Division of the Roads Department of Georgia, and Mr. Otar Turmanidze, environmental specialist of the consulting company "Kocks Consult", hired by the Roads epartment of Georgia for preparing EIA.

Attendees:

Otar Khatiashvili, Head of Environmental Unit of the Technical Policy Division of the Roads Department of Georgia,
Luiza Bubashvili, Senior Specialist of the Environmental Unit of the Roads Department of Georgia,
Representatives of the local government of Surami,
Representatives of the local population of Surami (approximately 25 persons).

Mr. Otar Khatiashvili opened the meeting and informed the audience about upcoming works for road rehabilitation. Mr. Khatiashvili talked about the technical side of the project and provided detailed information on the issues of the public interest.

Mr. Otar Turmanidze made a presentation on the main findings of the Environmental Impact Assessment and introduced the Environmental Management Plan. He covered the scope of planned works, their possible impact on the natural environment and human health. Mr. Turmanidze overviewed mitigation measures proposed to reduce negative environmental impacts of the tunnel in the rehabilitation and operation phases.

George Tsereteli

Deputy Chairman, Roads Departments of Georgia (signed and sealed)

Staff of the Roads Department of Georgia:

Luiza Bubashvili (signed)

Otar Khatiashvili (signed)

Annex

Author of Question/Comment	Contents of Question/Comment	Remarks
Khachidze George	Will the local communities be employed?	Tunnel rehabilitation works are of specific nature, therefore it requires participation of qualified workers, but for some type of works it is possible to hire workers with low qualification. Contract conditions consider employment of 70% local communities.
Davitiani Zurab	Does the project foresee planting new trees instead of cut trees?	EIA provides compensation measures: each removed tree will be compensated by planting of one and half new trees.
Jinjikhashvili Boris	What is the sequencing of the construction?	The bypass road will be rehabilitated first. After that the tunnel rehabilitation works will start.
Kurdadze Nugzar	Is the place for construction waste already selected?	At this stage place for construction waste is already selected; it is located in approximately 20 km from the tunnel. According to the legislation in force, contractor will have to obtain formal permit from the local government for the disposal of waste in that site.