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RURAL ENERGY PROGRAM

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ENVIRONMENTAL MANAGEMENT PLAN FOR MACHAKHELA SMALL HYDROPOWER REHABILITATION PROJECT

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1. INTRODUCTION

The USAID-sponsored Rural Energy Program (formerly known as the Renewable Energy and Environment Development Program, or REED) in Georgia aims at developing in-country capacity to increase the utilization of small hydropower resources and realization of energy efficiency potential in rural Georgia.

The primary objectives of the Rural Energy Program include 1) increased supply of energy to rural areas (both grid connected and off-grid); 2) improved management of local energy production; 3) improved in-country capacity to develop and deploy renewable energy applications in rural communities; and 4) improved capacity to more efficiently utilize and protect the local energy resource base.

The Rural Energy Program envisions the implementation of a number of pilot projects in such areas as small, mini and micro hydropower installations, extensions of natural gas distribution networks, renewable energy systems (other than small, mini and micro hydro facilities), and natural resource management programs.

Rural Energy Program activities as funded by a federal government agency, USAID, are subject to applicable U.S. environmental laws, and regulations including USAID's environmental impact assessment procedures. These procedures intend to implement the requirements of the National Environmental Policy Act of 1970. Title 22 of the Code of Federal Regulations, Part 216 (so called 22 CFR 216), applies to all USAID programs, projects, activities and substantive amendments.

To comply with 22 CFR 216, the Rural Energy Program environmental team completed a Programmatic Environmental Assessment (PEA) for the Rural Energy Program in March of 2006. USAID approved the PEA for further implementation. The PEA scope contained (a) a definition of environmental screening criteria for a set of projects similar in size, range and magnitude of impacts, and (b) characterization of common mitigation measures for each project type to alleviate the recognized impacts. Projects that did not share common attributes (such as medium and large hydropower projects, projects located in national parks, or projects which raised substantial issues regarding wetlands or sensitive habitats that would require a separate Environmental Assessment) were not addressed in the PEA.

The PEA evaluated four types of projects considered for investment under the Rural Energy Program. These included the following project categories:

- Small-scale hydropower plants.
- Community natural gas (NG) distribution systems.
- Renewable energy/ energy efficiency projects.
- Natural resource management projects.

Work completed by the PA Environmental scoping team set the stage for the PEA. Issues identified during preparation of the Rural Energy Program Scoping Statement (Appendix E) were examined by the multidisciplinary PEA team through literature reviews, stakeholder interviews, multiple field evaluations and environmental screening analyses. Through a process of integrating issues identified through scoping with information collected in literature reviews, regulatory reviews, interviews, field and screening evaluations, the PEA team identified environmental aspects that had to be addressed in the PEA.

The environmental aspects presented in the PEA included the following subjects:

- Geology and Soils
- Water Resources
- Biological Resources
- Socioeconomics (including Public Health)
- Cultural Resources

The PEA also simplified environmental due diligence for the preparation of environmental management plans (including mitigation and monitoring plans) for a larger set of activities expected under the Rural Energy Program. Due to the completion of the Programmatic Environmental Assessment for the entire Rural Energy Program, it was unnecessary to define environmental significance ranking criteria for each individual environmental management plan. The unified significance criteria elaborated in the PEA were utilized for the environmental impact ranking presented in individual environmental management plans. An environmental management plan for each project is based on a specific environmental review conducted at each project site. The review process was designed to specify environmental impacts characteristic of each project site attributable to either construction or operational phases of project implementation. The mitigation options are aligned with the general mitigation recommendations specified in the PEA.

The Environmental Management Plans (EMP) consists of a set of mitigation, monitoring, and institutional measures to be taken into account during implementation and operation to eliminate adverse environmental and social impacts, offset them, or reduce them to acceptable levels. The plans also include actions needed to implement these measures. EMPs identify feasible and cost-effective measures that may reduce potentially significant adverse environmental impacts to acceptable levels. Specifically, the EMPs include the following:

(a) Summaries of all anticipated significant adverse environmental impacts (including those involving indigenous people or involuntary resettlement);

(b) Descriptions (with technical details) of each mitigation measure, including the type of impact to which it relates and the conditions under which it is required (e.g., continuously or in the event of contingencies), together with designs, equipment descriptions, and operating procedures, as appropriate;

(c) Estimates of any potential environmental impacts of these measures; and

(d) Linkages with any other mitigation plans (e.g., for involuntary resettlement, indigenous peoples, or cultural property) required for the project.

The monitoring section of the EMP provides the following information:

(a) A specific description and technical details of monitoring measures, including the parameters to be measured, methods to be used, sampling locations, frequency of measurements, detection limits (where appropriate), and definition of thresholds that will signal the need for corrective actions; and

(b) Monitoring and reporting procedures to ensure early detection of conditions that necessitate particular mitigation measures.

It was assumed that a legislative and regulatory framework is identical for all projects and was already discussed in the Programmatic Environmental Assessment for the Rural Energy Program. Obtaining accurate natural resource, ecological health and employment-related statistics in any part of Georgia is extremely difficult. Also, local hospitals and other institutions do not keep health records and are unwilling to discuss or acknowledge health problems. For these reasons, it was not been possible to analyze any data related to public health issues including environmental and occupational health statistics in the project communities.

2. SITE SPECIFIC ENVIRONMENTAL MANAGEMENT PLANS

The following section presents environmental management plans specified for each IPP project to be implemented in Year 1. As it was mentioned above, the Machakhela Small Hydropower Plant (SHP) was examined and included in the PEA report prepared in March 2006. The specific project environmental impact categories and mitigation recommendations were identified during a second site visit completed by the Rural Energy Program environmental team in December 2006. The proposed mitigation measures are in line with common recommendations outlined in the PEA.

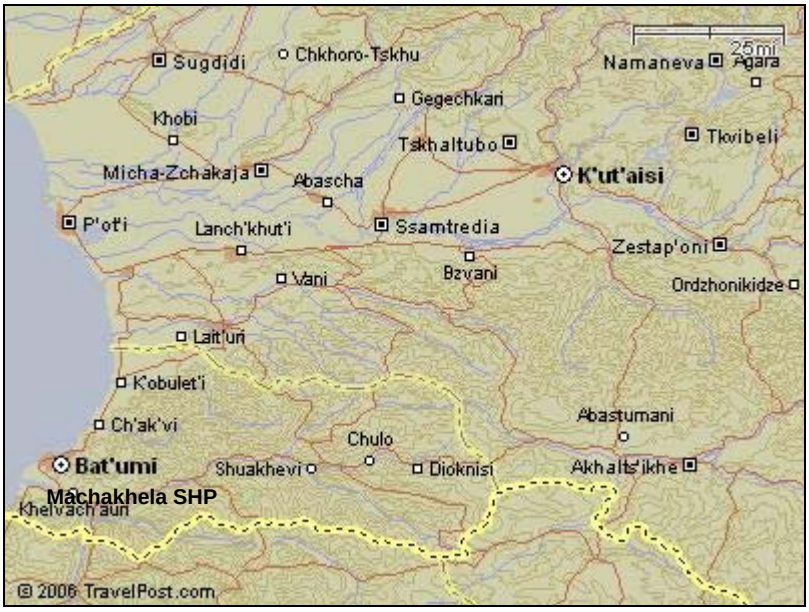
2.1. MACHAKHELA SMALL HYDROPOWER PROJECT

2.1.1. Project Activities Overview

The Machakhela SHP is located on the left bank of the Machakhela River in the village of Kedkedi in the Adjara Region in West Georgia.

Location of the Machakhela SHP is presented in Figure 1.

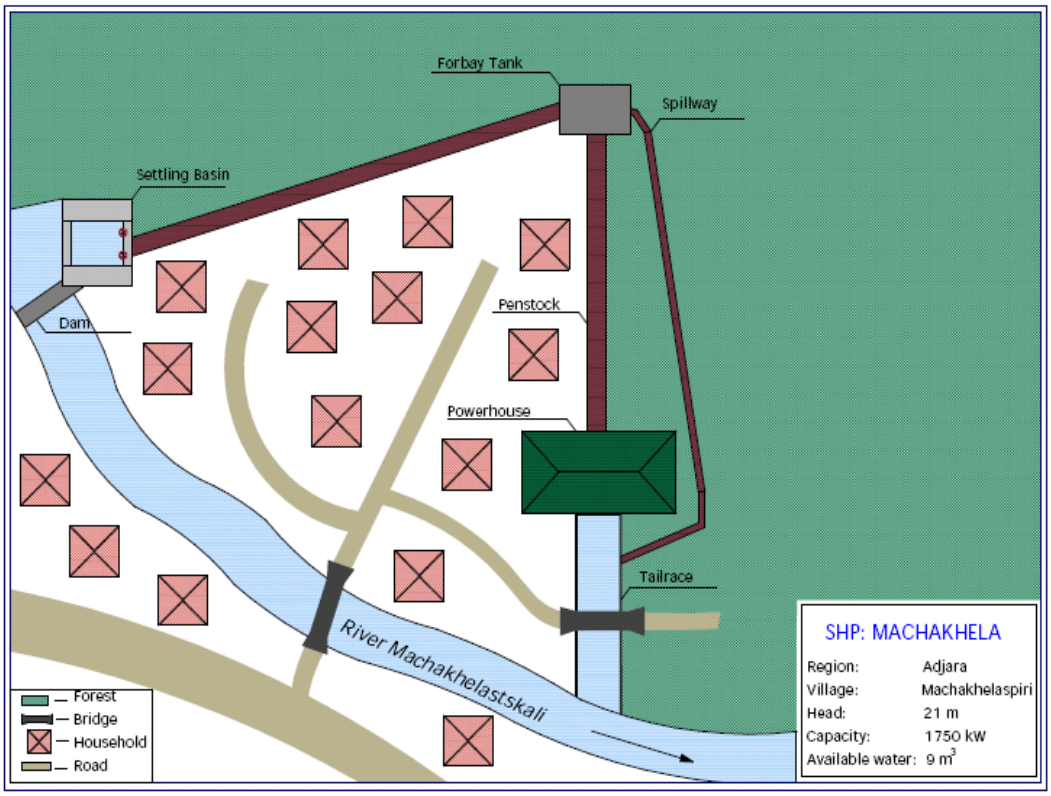
Figure 1. Location of the Machakhela SHP in West Georgia



The plant was built in 1956 and supplied electricity to the Kedi settlement and the adjacent villages. A private company Bakuri Ltd is the owner of the Machakhela SHP facility and the developer of the project. The plant presently generates about 700 kW; however, after completion of rehabilitation works, the plant will generate 1,480 kW.

The layout of the facility is presented in Figure 2:

Figure 2. Layout of the Machakhela Small Hydropower Plant



Headwork's

Powerhouse

Canal

The Rural Energy Program engineering team has visited the site numerous times and summarized the status of the hydropower infrastructure as follows:

- The low height diversion weir is 50 meters long.
- The settling basin and silt tank (15 meters X 57.5 meters) located on the left bank of the river. Intake is equipped with flow regulating and flushing gates.
- Water from the settling basin flows into the open rectangular form concrete canal which continues to the forebay tank. Canal is equipped with three emergency spillways.
- Water from the forebay tank flows into the 53.5 meters long and 1.300 mm in diameter double penstock, which conveys water to the two horizontal setting Francis turbines in the powerhouse.
- The used water is discharged back to the Machakhela River through tailrace.

The project design documents specify the following activities to be completed at the project site:

1. Construction of a low head diversion weir.
2. Rehabilitation of the settling basin and emergency and flow regulating gates.
3. Rehabilitation of the silt tank.
4. Rehabilitation of the open canal.
5. Rehabilitation of the forebay tank.
6. Rehabilitation of the penstock.
7. Rehabilitation of the spillway and the tailrace.
8. Rehabilitation of the powerhouse (repairing of the roof, walls and cleaning and improving the powerhouse yard).
9. Rehabilitation of the hydro-mechanical units.
10. Rehabilitation of electrical equipment.

Civil works associated with the rehabilitation of the low height diversion weir include the following activities:

- De-watering the intake pool using gabions or soil embankments. This action will allow drying of the section of the weir for the rehabilitation works.
- Removing debris from the de-watered section.
- On-site concrete mixing, forming; and gravel preparation.
- Constructing wooden forms for concrete and adding steel bars as required by the design.
- Removing wooden forms after concrete is dry and set.
- Testing the concrete using special testing equipment.
- Rehabilitating the intake and emergency spillway gates.
- Collecting and disposing all debris, construction waste, scrap and remaining construction materials in designated disposal sites.

The rehabilitation works will be conducted at the water intake which is a concrete pool equipped with a number of emergency and flow regulating gates.

- Removing debris from the water intake pool.
- Constructing wooden forms for concrete and adding steel bars as required in the design.
- Removing all gates and sending them for repairs.
- Removing wooden forms after concrete is dry and set.
- Performing concrete testing.
- Reinstalling the repaired water flow regulating gate.
- Conducting testing of the water intake pool for leaks by filling with water and closing the gate.
- In case of minor leaks, filling in the gaps with concrete.
- Disposing of all debris, scrap and left over construction materials in a designated disposal site.

The above-listed works shall be completed within the same timeframe as the diversion weir works. This measure will assure that, in the event of flooding during the repair of the diversion weir, the rehabilitated system will be able to absorb some of the flood flow.

Machakhea SHP diversion canal requires significant repair works. Pressure basin and sluice is located at the end of 2,163 m long diversion canal. The right wall of the canal between the first and second spillway is supported on the outside with buttresses. In some sections of the canal, the buttresses are missing and the canal walls are in danger of collapsing. Run of the water from the hill above the canal has damaged large sections of the canal. As a result there is significant leakage from the canal.

Three vehicle passages are constructed on the derivation canal; currently they are in poor condition and require rehabilitation. The work at the canal includes following activities:

- Removing debris and sedimentation from the canal and aqueduct.
- Constructing wooden forms for the concrete and adding steel bars as required in the design.
- Removing all water flow, emergency spillway and flushing gates from intake pool and sending them for repairs.
- Removing wooden forms after concrete is dry and set.
- Testing the concrete using special test equipment.
- Reinforce the support slabs at the aqueduct according the instructions in technical design.
- Reinstalling the repaired water flow, emergency spillway and flushing gates.
- Conducting the testing of the canal and aqueduct, checking for leaks by filling it with water and closing all gates.
- In case of minor leaks, patch the gaps with concrete.
- Disassembling of existing passages of the derivation canal and replacing it with the new one.
- Covering open sections of the canal with steel sheet.
- Dispose of all debris, scrap and left over construction materials in an approved manner.

The Machakhela SHP penstock also requires rehabilitation. The penstock is equipped with thermal expansion compensators, which are leaking and needs to be repaired. The quality of the metal in the penstock will be inspected and weaker sections replaced according to the instructions in the technical design. The penstock rehabilitation includes the following activities:

- Removing the damaged section of the penstock using gas-welding equipment.
- Welding of new sections using a mobile electric welding machine.
- Reinforcing the supports/saddles of the penstock according the instruction in the design
- After the completion of the above-mentioned works, re-watering the penstock and monitoring for a specific period of time (two days +/-) to identify and repair the leaks, giving special attention to the pipe joints.
- Painting the penstock using water-based anticorrosion paint.
- Disposing all debris, scrub and left over construction materials at a designated disposal site and in an approved manner.

The walls of the spillway and tailrace are leaking and require rehabilitation. The rehabilitation requires following activities:

- De-watering the joint section between the pipeline and canal gabions. This action will allow drying of the section for the rehabilitation works.
- Removing debris and sedimentation from the canal and tailrace.
- Constructing wooden forms for concrete and adding steel bars as required by the design.
- Removing wooden forms and waiting until concrete is dry and set.
- Testing concrete using special testing equipment.
- Filling the tailrace and canal with water and testing for leaks.
- In case of minor leaks, filling in the gaps with concrete.
- Disposing of all debris, scrap and left over construction materials at a designated disposal site and in an approved manner.

When all rehabilitation works are completed, the entire hydro system will be re-watered and monitored for a period of time specified in the design to identify and repair leaks.

The powerhouse at the site requires minor inside and outside repair works. The planned renovation involves the following activities:

- Replacing damaged sections of the roof.
- Repairing building walls (both inside and outside) and applying two coats of water-repellent painting.
- Removing debris and metal scrap from the powerhouse floor and repairing the floor as needed.
- Cleaning the powerhouse yard from litter, waste, and scrap materials.
- Disposing all debris, scrap and left over construction materials at a designated disposal site and in an approved manner.
- Securing the territory of the powerhouse with proper fencing and safety signs indicating types of potential hazards.

Installation of electrical equipment: The Machakhela SHP project envisages the rehabilitation of power distribution and control panels. The following works are planed to be conducted:

- Removing of the turbines and sending their parts for repairs: casing, runner, shaft, bearings, flywheel, and governor. The draft tube and base plate may require repair in the powerhouse. The generator may be removed and sent for rewinding.
- Removing of all old and non-functioning equipment and replacing it with modern, more efficient equipment. The automation system should be rehabilitated to increase the operation efficiency of the SHP.
- Repairing transformers, feeders, bus bars, transmission poles, and power lines.
- Posting high voltage signs to indicate a threat of electrocution in the switch yard.

Table 1. Electrical Equipment to be Installed at the Machakhela SHP Project

Stationary Equipment
Power transformers
Voltage transformer
Control DC board
Voltmeter
Unit control equipment
Exterior lighting in the SHP area

2.1.2. Environmental Review

The Rural Energy Program engineering team visited the site in December 2006. The purpose of the visit was to assess the current environmental conditions at the site and complete a screening analysis of potential environmental impacts. The following section contains an analysis of the significance of the various potential environmental impacts associated with the project, and, where applicable, describes mitigation measures (including monitoring) which are needed to address the identified impacts.

The results of the screening exercise at the Machakhela SHP project site are presented in Annex 1.

Issues which were determined to be insignificant or irrelevant following the screening analysis (in compliance with the significance criteria outlined in the PEA) are shown in Table 2 below.

Table 2: Potential Environmental Impacts Excluded From Further Analysis

Construction Phase	
Issues	**Reasons for Exclusion**
Disruption of the hydrological regime	Existing hydrological patterns will be maintained
Disruption of local movement and access to roads	Most works will be away from village roads and relatively of small-scale
Operational Phase	
Salt water intrusion	Not applicable
Impediment to movement of livestock and humans	Rehabilitation of the existing infrastructure, people will likely improve access to land
Threat to historic, cultural and aesthetic sites and features	Rehabilitation of the existing infrastructure, and no land acquisition
Disruption of fisheries	No significant fisheries present

2.1.3. Environmental Determination

Based on the conducted environmental review including the environmental screening of the Machakhela SHP project site, significant environmental impacts related to the assessed environmental aspects are identified and presented below.

It is necessary to note that some of the identified impacts have moderate to low probabiity for occurance. Thus such impacts are mitigated and prevented through following best management, construction and operational practices. The Mitigation Plan for the Machakhela SHP outlines major mitigation activities associated with each impact.

Below there is a list of environemntal impacts that were identified as moderate or significant for each environemtal aspect proposed in the PEA. The impact list is acoompanied with a set of measures recommended to mitigate the impacts.

1) Geology and Soil

(a) Construction:

Some geological hazards may occur during the construction of the Machakhela SHP. According available literature, there is an increasing trend of landslides and mudflows in the Khelvachauri region. In order to prevent the possible negtive impact on the Machakhela SHP it is reccomended to conduct a geologic study during the project design stage, including the following analysis:

(b) Mitigation measures:

- Classification of the soil layer's strength to assess potential for geological hazards (e.g. landslide).
- Provide recommendations on types of construction materials to be used.
- Provide recommendations on adequate river bank protection in the catchment area to prevent erosion

(c) Construction:

Moderate to low impacts from disturbance of topsoil and aggravation of erosion during the construction phase.

(d) Mitigation measures:

Proper landscaping of slopes and replanting vegetation.

(e) Operation:

Moderate to low impact of soil contamination during the opeartion activiites. This impact is realted to improper handling of chemicals, lubricants and transformer oils during the operation.

(f) Mitigation mesures:

- Regular checking for oil leaks in the machinery.
- No mashinery washing at the site.
- Subcontracting professional services for regular oil change in transformers.

2) Water Resource

(a) Construction:

- Increased Turbidity Downstream of the Headworks Construction. Construction activities require excavation, removal and movement of soil, gravel and rocks from the riverbed (in order to construct the dam and create embankments), and concrete mixing (i.e. a large constructed area). These activities will potentially generate high levels of suspended solids that will increase turbidity downstream of the weir.

(b) Mitigation Measures:

- Avoid blocking stream flow during construction to eliminate the potential for flooding upstream to the weir and to increase the level of suspended solids coming from the floodplain.
- Avoid stockpiling soils on the river banks and the floodplains to minimize soil moving through run-off.
- Use concrete blocks instead of soil (where feasible) for temporary stream diversion to reduce soil movement and stream sedimentation.

(c) Operation:

- Reduced conservational value of the Machakhela River. Water will be diverted to the SHPs during the operation, significantly reducing the flow between the water diversion point and tailrace. This reduction might cause changes in the flooding pattern as well as adverse impacts to the fish populations in this section of the river, especially during the dry section.

(d) Mitigation measures:

- Maintain a minimum level of water flow (a minimum ecological flow).
- Maintain a minimum wet channel perimeter at all control structures with a constant flow in the river throughout the year

3) Biological Resources

(a) Construction:

- Impact on fish spawning. Construction activities of the Machakhela SHP require temporary diversion of the stream from the weir. Blocking of the stream flow will dry the canal between the weir and the tailrace discharge, which might cause significant impact on the aquatic species. If the construction activities are scheduled for the spring till the end of the summer (April-August) and in the beginning of the fall season (September – October), these works can disrupt fish spawning in the area thus creating a negative effect on the fish population.
- Impact to the avifauna. The surrounding of the Machakhela SHP area is known for a diversity of nesting birds. The breeding season for nesting birds occurs in the spring (March-April-May) and summer (June). If the construction activities coincide with the bird nesting period, these works can disrupt the nesting process and create a negative effect on the nesting species.

(b) Mitigation measures:

- Maintain a minimal sustainable river flow (minimum ecological flow) to sustain the river hydrology, water quality, existing fish population and wildlife (according to seasonal fluctuations in flow levels).
- Maintain minimum wet channel perimeters at all control structures with a constant flow in the river throughout the year.
- Proper scheduling of the construction works. Avoid scheduling of the construction works during the fish spawning and bird nesting periods.

(c) Operation:

- The river flow from the weir to the powerhouse will be greatly reduced due to the operation of the Machakhela SHP project. A portion of the water will be diverted from the weir to the powerhouse, significantly reducing the river flow. Though, in order to maintain a sustainable fish population, the minimum flow would be released. Not maintaining the minimum river flow (especially in the dry season) would adversely affect the fish population.
- Loss of Fish. The planned hydro-electrical system diverts a portion of the Machakhela river flow to the penstock and the turbine. Juvenile fish that passes through the turbine (entrainment) may be caught killed in the turbine. Both juvenile and potentially some adult fish might be affected by impingement against water intake structures and fish screens. Migratory fish specie Black Sea trout (*Salmo fario morpha labrax)* listed in the Red Book of Georgia is present in the Machakhela River. Therefore, the operation phase of the Machakhela SHP project is anticipated to result in moderate and potentially significant impacts on juvenile fish.

(d) Mitigation measures:

- Install fish screens at the intake to the canal where water is diverted from the river's natural course. The mesh in such screens is about 3 mm x 3 mm. It will prevent all larger fish and most small fish from entering the canal and the penstock. The screens require periodic cleaning from dirt and debris by the operator.
- Maintain a minimal sustainable river flow (a minimum ecological flow) to sustain the river hydrology, water quality, existing fish population and wildlife (according to seasonal fluctuations in flow levels).
- Maintain a minimum wet channel perimeter at all control structures with a constant flow in the river throughout the year
- In order to ensure minimal loss of fish habitat fish leader/pass should be added in the design.

4) Human Resources

(a) Construction:

- Impact on the Khelvachauri Community from construction activities (including the presence of temporary workers on the site). The local population can be disrupted during the construction phase from the increased transport traffic and the presence of temporary employees working at the site.
- Increased probability of work related injuries to workers and local population during the construction activities.
- Exposure to construction materials that can endanger public health. During the construction such materials as asbestos can be used thus potentially presenting a threat to public health.

(b) Mitigation measures:

- Establish and adhere to construction timetables to minimize disruption to normal activities at or in the vicinity of the construction area.
- Coordinate truck trafficking and other construction activities to minimize noise, traffic disruption and dust.

(c) Operation:

Increased probability of work related injuries and death for the plant personnel and the general public in case operation safety measures are not implemented.

(d) Mitigation measures:

Follow state safety regulations and guidelines, and implement best management practices. The Rural Energy Program team has also prepared a list of safety equipment for mandatory installation at the SHP. The list is presented in Table 3.

5) Waste materials

Construction:

- Pollution of Environment with Construction Waste. Construction related activities such as excavation, removal and movement of soil and concrete mixing; installation of electrical equipments etc. will generate certain amount of construction wastes.

Mitigation measures:

- Segregate waste that can be re-used; If re-using of wastes is not feasible, take waste materials to appropriate, designated local disposal areas;
- Minimize burning of waste materials;
- If waste will be buried on site, avoid siting burial pits up-gradient of the drinking water sources such as wells. Pits should be lined with impermeable materials.

Table 3. Personal Safety Equipment

SAFETY EQUIPMENT – MANDATORY
Hard Hats
Eye Protection - Goggles
Safety Shoes
Work Gloves
Eye Wash Station
First Aid Kit (for 50 people)
Oil Absorbing Pads 15X19in minimum weight 100 per case ABS 24,7 gallons quantity boxes
Orange Vests
Harness for Personnel (inspections/dam work)

3. MITIGATION PLAN

ACTIVITY	POTENTIAL IMPACT	SIGNIFICANCE & PROBABILITY OF OCCURRENCE	MITIGATION MEASURES	RESPONSIBILITY FOR MITIGATION	MONITORING REQUIREMENTS	RESPONSIBILITY FOR MONITORING	RESIDUAL IMPACT
Repair of the intake pool and construction of the dam at the head-works	Injury to contractors workers and other persons during works	Moderate – Possible	Safe working procedures to be followed by contractor	Contractor, Khelvachauri Community Organization	Verify applicability of written safe working procedures. *Ad hoc* inspection of works	REP Program, Adjara Regional Environmental Office/ SHE Officers; REP Program	Negligible – Unlikely
	Injury to contractors workers and others from unsafe storage of waste	Moderate - Possible	All waste material to be stored in a secure, designated area prior to removal to a designated waste landfill site. Nearest legal landfill is located about 50 km from construction place	Contractor, Khelvachauri Community Organization	*Ad hoc* inspections	REP Program, Adjara regional Environmental Office / SHE Officers; REP Program	Negligible – Unlikely
	Soil contamination from spilled chemicals, liquid concrete, other liquid materials	Moderate – Possible	Best management practices are implemented by construction contractors	Khelvachauri Community Organization, Contractor	*Ad hoc* inspection of the construction site	REP Program	Negligible – Unlikely
	Water and soil pollution (visual and other) caused by improper disposal of waste materials	Moderate - Possible	Waste to be disposed of at a designated waste landfill site	Khelvachauri Community Organization, Contractor	*Ad hoc* inspections	REP Program, Adjara Regional Environmental Office; REP Program	Negligible – Unlikely
	Disturbance to residential areas caused by noise generated during installation	Moderate – Probable	Installation to be scheduled during normal weekday working hours only.	Khelvachauri Community Organization, Contractor	*Ad hoc* inspections	REP Program, Adjara Regional Environmental / SHE Officers; REP Program	Moderate – Unlikely

ACTIVITY	POTENTIAL IMPACT	SIGNIFICANCE & PROBABILITY OF OCCURRENCE	MITIGATION MEASURES	RESPONSIBILITY FOR MITIGATION	MONITORING REQUIREMENTS	RESPONSIBILITY FOR MONITORING	RESIDUAL IMPACT
	Increased downstream turbidity in the river	Moderate -- Probable	Avoiding blocking stream flow during construction, Using concrete forms rather than soil as temporary stream diversions, Avoiding stockpiling soils in river banks and the floodplain; Returning topsoil along the river bank and riparian ecosystem to its original location, and restoring land contours; Scheduling maintenance activities during dry seasons; sediment capture devises should be placed before the land disturbing activities are taking place	REP Program, Contractor	*Ad hoc* inspections	REP Program, Adjara Regional Environmental Office	Moderate – Possible

ACTIVITY	POTENTIAL IMPACT	SIGNIFICANCE & PROBABILITY OF OCCURRENCE	MITIGATION MEASURES	RESPONSIBILITY FOR MITIGATION	MONITORING REQUIREMENTS	RESPONSIBILITY FOR MONITORING	RESIDUAL IMPACT
	Increased Erosion of River Stream	Moderate -- possible	Avoiding blocking stream flows; Use concrete blocks rather than soil as temporary stream diversions; Avoiding stockpiling of soil; Scheduling maintenance activities during dry seasons; Using erosion control measures such as bales to prevent run—offs; Minimizing the use of heavy machinery	Khelvachauri Community Organization, REP Program, Contractor	*Ad hoc* inspections to the site	REP Program, Adjara Regional Environmental Office	Low – Unlikely
	Increased flooding	Moderate -- possible	Work schedules during dry seasons;	REP Program, Contractor	*Ad hoc* inspections, scheduled inspection	REP Program, Adjara Regional Amelioration of the Ministry of Agriculture	Moderate – Possible

ACTIVITY	POTENTIAL IMPACT	SIGNIFICANCE & PROBABILITY OF OCCURRENCE	MITIGATION MEASURES	RESPONSIBILITY FOR MITIGATION	MONITORING REQUIREMENTS	RESPONSIBILITY FOR MONITORING	RESIDUAL IMPACT
	Damage to fish stock including disruption of fish spawning	Moderate -- possible	Arrangement of fish by-passes for migrating fish; installation of net fish screens to prevent entrance to the supply canal and penstock; maintain a minimal ecological flow in the river.	REP Program, Contractor	REP Program, then periodic inspections by operator	REP Program, Adjara Regional Environmental Office	Moderate – Possible
Repair of the penstock	Pollution (visual and other) caused by improper disposal of waste materials	Moderate – Possible	Waste to be disposed at a designated waste landfill site	REP Program, Contractor	*Ad hoc* inspections	Adjara Regional Environmental Officer, REP Program	Negligible – Unlikely
	Injury to contractor workers from construction equipment	Moderate - Probable	Workers must follow safety guidelines and if necessary wear protective gear	REP Program, Contractor	*Ad Hoc* inspections	Adjara Regional Environmental Office/ SHE Officers, REP Program	Negligible – Unlikely
Modernization of powerhouse including replacement of auxiliary equipment	Injury to contractor workers and other persons during works	Moderate – Possible	Safe working procedures to be written and followed by contractor	Contractors, Khelvachauri Community Organization	Verify applicability of written safe working procedures. *Ad hoc* inspection of works	REP Program, Adjara Regional Environmental Inspectorate, SHE Officers	Negligible – Unlikely
	Injury to contractor workers and others from unsafe storage of waste	Moderate - Possible	All waste material to be stored in a secure, designated area prior to removal to a designated waste landfill site	Contractor	*Ad hoc* inspections	Adjara Regional Environmental Inspectorate/ SHE Officers	Negligible - Unlikely
	Pollution (visual and other) caused by improper disposal of waste materials	Moderate - Possible	Waste to be disposed at a designated waste landfill site	Khelvachauri Community Organization, Contractor	*Ad hoc* inspections	Adjara Regional Environmental Inspectorate	Negligible – Unlikely

ACTIVITY	POTENTIAL IMPACT	SIGNIFICANCE & PROBABILITY OF OCCURRENCE	MITIGATION MEASURES	RESPONSIBILITY FOR MITIGATION	MONITORING REQUIREMENTS	RESPONSIBILITY FOR MONITORING	RESIDUAL IMPACT
	Disturbance to occupiers and nearby residential areas caused by noise generated during installation of electrical equipment	Moderate - Probable	Installation to be scheduled during normal weekday working hours only.	Khelvachauri Community Organization ,Contractor	*Ad hoc* inspections	REP Program Adjara regional Environmental Inspectorate SHE Officers	Moderate – Possible
			Equipment to be installed only within suitable buildings/ powerhouse (not outside)	REP Program, Contractor	Inspection at commencement of works	Adjara Regional Environmental Inspectorate, SHE Officers	Negligible – Unlikely
Operation of the Machakhela SHP facility	Oil pollution of soil and water during SSHP operation	Moderate – Likely	Daily checks of machinery for leaking oil	Facility Operator	*Ad hoc* inspection	Adjara Regional Environmental Inspectorate	Minor – Possible
			No washing of machinery at the site, no oil change at the site	Operator	*Ad hoc* inspection	Adjara Regional Environmental Inspectorate	Minor – Possible
	Disruption of fish spawning and increased juvenile fish mortality	Moderate – Possible	Reduce plant load to maintain a minimal ecological flow in the river, during the spawning season; Installation of net fish screens to prevent entrance to the penstock	Operator	Periodic inspection	REP program, Adjara Regional Environmental Inspectorate	Negligible – Unlikely
Restoration of the switch yard and electrical lines	Damage to eco-systems, or habitats as a result of installation of new poles	Moderate – Possible	Selection of new line routes (if any) to avoid sensitive habitats	Design Consultant and contractor	Regular inspection of construction sites and operation zones	Adjara Regional environmental Inspectorate	Negligible – Unlikely
	Loss of topsoil leading to increased soil erosion	Moderate – Probable	Separation of topsoil and subsoil during pole installation, repair or replacement of topsoil after the poles are installed	Contractor	Regular inspection of trenching work and other operation zones	Adjara Regional environmental Inspectorate	Minor – Possible

ACTIVITY	POTENTIAL IMPACT	SIGNIFICANCE & PROBABILITY OF OCCURRENCE	MITIGATION MEASURES	RESPONSIBILITY FOR MITIGATION	MONITORING REQUIREMENTS	RESPONSIBILITY FOR MONITORING	RESIDUAL IMPACT
	Oil pollution of soil and water at construction site	Moderate – Likely	Daily checks of machinery for leaking oil No washing of machinery at construction site	Contractor Contractor	*Ad hoc* inspection *Ad hoc* inspection	Adjara Regional environmental Inspectorate Adjara Regional environmental Inspectorate	Minor – Possible Minor – Likely
	Noise pollution in village	Moderate – Definite	Works performed strictly during normal weekday working hours	Contractor	*Ad hoc* inspection	Adjara Regional environmental Inspectorate	Major – Unlikely
	Visual impact (lines are installed above ground)	Major - Definite	Route alignment to minimize areas of above ground line installation	Design consultant	*Ad hoc* inspection	Regional Environmental Officer	Negligible – Unlikely
	Reduced amenity values of the area	Moderate – Possible	Landscaping and replanting of construction area after completion of line installation works	Contractor	Regular inspection of completed sections of the pipeline	Regional Environmental Officer	Negligible – Unlikely
Connection of electrical lines to homes / apartments	Damage to Poisoning or explosion due to gas leaks	Major - Possible	Only fully trained personnel to carry out installations according to industry best practice guidance and standards	Utility Company / Contractor	Regular inspections by regulatory authority	Inspector from regulatory authority	Major – Unlikely
		Major - Possible	Safety information to be given to householders	Utility Company / Contractor	Regular inspections	Inspector from regulatory authority	Major – Unlikely
			Trained professional to inspect, clean, and adjust equipment every year	Utility Company / Contractor	Follow up inspections	Inspector from regulatory authority	

4. MONITORING PLAN

The Monitoring Plan presents a number of criteria against which monitoring indicators are set.

Criteria	Descriptor	Evidence
Regulatory Compliance: The facility complies with the requirements of national environment, health and safety laws and regulations.	The facility has all the necessary permissions and permits required under Georgian national laws and regulations.	• The project owners have obtained all required construction and operation permits and licenses including an environmental permit. • The REP Program in cooperation with the project owner prepared the Programmatic Environmental Assessment and developed an environmental management plan per requirement of the project sponsors (USAID, EBRD).
Water Flow: The facility maintains a minimum ecological flow in the river that is adequate for the existing fish population, wildlife and water quality taking into account seasonal fluctuations in flow levels.	• Maintain minimum wetted channel perimeters, at all control structures, with a constant flow in the river throughout the year. • Facility operation schedules to be based on the minimum ecological flow required to sustain the existing environment.	• The project owner has obtained a water use permit • Ecological-sanitary flow of the Machakhela River is equal to Q_{san}=2.0 m^3/sec) • Periodic measuring of the water flow rate to assure that the minimal ecological flow is maintained.
Water Quality: The facilities operations do not contribute to the deterioration of water quality either upstream or downstream of the facility.	The facility has minimal impact on water quality at the head-works, canal, tailrace and diversion dam.	Best management practices on hydropower construction are followed. The facility will not contributed to the deterioration of water quality after the completion of the construction activities.
Fish Passage and Protection: The facility has minimal impact on local fish populations, provides effective fish passage for local and migrating fish species and also protects fish from entrainment.	• There should be minimal loss of fish or fish habitat. • Facility preserves fish population. • Facility construction and operation do not limit fish movement, migration and spawning. • Flows at the intake and downstream of the tailrace are adequate to support aquatic and riparian species in facility area.	• Information has been gathered on both the local and migratory fish populations; • The project design includes fish screens; • The project design includes adequate mitigation measures to ensure that fish protection criteria are met.

Criteria	Descriptor	Evidence
Watershed Protection: The facility does not negatively impact environmental conditions in the watershed.	• The facility does not affect the integrity of the existing ecosystem either upstream or downstream of the facility. • Facilities components and infrastructure (e.g. access roads, power lines, and generation facilities) have minimal impact on the riparian environment.	• An assessment of impacts associated with additional components has been made. • An assessment of upstream and downstream impacts has been made. • Adequate mitigation measures have been provided to ensure the eligibility criteria are met.

Monitoring Categories

Threatened & Endangered Species Protection: The facility does not negatively impact any threatened or endangered species nor any areas designated for their protection.	• The facility is not constructed on a protected or sensitive river. • The facility does not threaten or harm the habitat or migratory routes of endangered species. • The facility has no significant impact on the existing wildlife habitat and populations.	• Sensitive or protected areas on or around the river have been identified. • Endangered or threatened species present in the area of or downstream from, the facility have been identified. • The REP environmental team has assessed the potential impact of the facility on any such areas or species. • The project design provides for adequate mitigation measures to ensure that the criteria are met.
Recreation: ***The facility does not stop or limit recreational uses of the river.***	Access to the water remains unchanged with the facility and accommodates recreational activities on the river.	Identification of any current recreational uses of the river around the site and confirmation that these uses will not be affected by the development of the facility.
Cultural Issues: ***The facility does not inappropriately impact cultural property***	Cultural property includes sites having archaeological (prehistoric), paleonthological, historical, religious and unique natural values. Cultural property includes remains left by previous human inhabitants and unique natural features such as canyons and waterfalls.	No cultural sites or property in the vicinity of the facility has been identified.
Community Issues: ***The facility does not reduce local community use of either the river or the surrounding lands.***	The facility does not prevent or limit the local community from access to the river as a communal leisure amenity, and the irrigation facility	• Local community uses of the river have been identified. • The locally affected community has been notified and consulted prior to the development of the facility. • Adequate mitigation measures have been agreed to ensure that eligibility criteria are met.

ANNEX A. ENVIRONMENTAL SCREENING OF THE MACHAKHELA PROJECT SITE

1) General Information

Project Name	Machakhela SHP
Type of project	Rehabilitation
Location (district / region)	Region – Adjara; District - Khelvachauri
Ownership	Private (L.T.D. Bakuri)
Surrounding Present Land Use	[X] Agriculture [X] Residential [X] Tourism [ ] Industrial [X] Forest Land [X] Institutional [ ] Commercial [ ] Open Spaces [ ] Others, pls. Specify :
Installed Capacity (kW)	1 600
Project Cost (USD)	$600, 000

2) General Construction Activities

Is there and impact because / to	**Construction**	**Operation and Maintenance**
Construction / rehabilitation of structures and buildings?	Y	N
Construction / rehabilitation of access roads?	N	N
Construction / rehabilitation of transmission lines?	N	N
Temporary sites used for construction works or housing of construction workers?	Y	N
Significant risk associated with waste transport?	N	N
Inadequate waste disposal facilities?	Y	N
Include grading, trenching, or excavation > 1.0 hectares	N	N
Conducted near geologic hazards (faults, landslides, liquefaction, un-engineered fill, etc)?	N	Y
Require offsite overburden / waste disposal or borrow pits >1.0 ton?	N	N
Cause loss of high quality farmlands > 10 hectares	N	N
Require the use of dangerous / hazardous substances (e.g. oil, lubricants, chemicals; pls. Specify)?	Y	Y
Require an oil / lubricants collection and disposal system?	Y	Y
Increase vehicle trips > 20% or cause substantial congestion?	Y	N
Cause or contribute to safety hazards?	Y	Y
Inadequate access or emergency access for anticipated volume of people or traffic?	N	N
Produce solid wastes during construction or operation or decommissioning?	Y	N
Involve actions that will cause physical changes in the locality (topography, land use, changes in water bodies, etc)?	Y	Y

3) Geology and Soils

Is there and impact because / to	Construction	Operation and Maintenance
Earthquakes, subsidence, landslides or erosion?	N	Y
Movement of soil?	Y	N
Rates of erosion or siltation by wind or water?	N	Y
Management of excess soil or spoil material (from mining)?	N	N
Physical degradation of the local environment?	N	N

4) Water Resources

Is there and impact because / to	Construction	Operation and Maintenance
Risks of contamination of land or water from releases of pollutants onto the ground or into sewers, surface waters, groundwater, coastal waters or the sea?	Y	N
Run-off as a result of the hardening of surfaces, or loss of the sponge effect of vegetation?	N	N
Flooding or extreme or adverse climatic conditions?	Y	Y
Ability to absorb run-off?	N	Y
Changes to flood plains?	N	N
Quantity of surface water, groundwater or public water supplies?	N	Y
Threats to hydrological functioning through existing or altered water extraction?	N	N
Withdrawals from or discharges to surface or ground water?	N	Y
Threats through existing or altered impoundment construction?	N	N
Conservational or recreational value of rivers, streams, lakes, wetlands, dams or islands?	N	Y
Threats through existing or altered pollution?	N	N
Threats through existing or altered turbidity?	Y	Y
Threats through existing or altered agricultural run-off?	N	N
Threats through existing or altered chemical processes or nutrient balances?	N	N
Threats through existing or altered changes in sediment flows and siltation rates?	N	N
Changes through existing or altered canalization?	N	N
River, stream or lake onsite or within 30 meters of construction?	Y	Y
Excavation or place of fill, removing gravel from a river, stream or lake?	Y	Y
Onsite storage of liquid fuels or hazardous materials in bulk quantities?	N	N
Decreased water flow that may change the flooding regime, resulting in the destruction of wetlands?	N	N
Decrease in downstream water flow that may affect downstream users (human, fisheries, and wildlife)?	N	Y

5) Biological Resources

Is there and impact because / to	Construction	Operation and Maintenance
Important, high quality or scarce resources that could be affected by the project?	N	Y
Located in a Protected Area or Wildlife Corridor?	N	N
Inundate or remove wetland habitats?	N	N
Survival of rare or endangered plant species?	N	N
Diversity of plant communities?	N	N
Vegetation communities of conservation or scientific importance?	N	N
Natural replenishment of existing species?	N	Y
Firewood collection?	N	N
Overexploitation of biological resources?	N	Y
Survival of rare or endangered animals?	N	N
Diversity of animal communities?	N	N
Natural migration of species?	N	Y
Introduction of alien species?	N	N
Loss of native species or genetic diversity?	N	N
Vegetation removal or construction in wetlands or riparian areas > 1.0 hectare?	N	N
Use of pesticides / rodenticides, insecticides, or herbicides > 1.0 hectare?	N	N
Construction in or adjacent to a designated wildlife refuge?	N	N
Decreased water flow that may change the flooding regime, resulting in the destruction of wetlands?	N	N
Decrease in downstream water flow that may affect downstream users (human, fisheries, and wildlife)?	N	Y
Re-entry pipe cause increased scouring of stream bank where water is returned to the stream?	N	N
Flora and / or fauna of ecological or commercial significance to be found?	N	Y

6) Socioeconomic Issues

Is there and impact because / to	Construction	Operation and Maintenance
Existing settlements in the vicinity of the proposed project?	Y	Y
Existing land uses on or around the project that could be affected by the project?	N	N
Areas on or around the location of the project that are already subject to pollution or environmental damage?	N	N
Permanent or temporary change in land use, land cover or topography including increases in intensity of land use?	N	N
Social infrastructures located in or near the project area (e.g., schools, health canters / clinics, places of worship, others?	N	N
Be affected by natural disasters causing environmental damage (e.g. floods, earthquakes, landslide etc)?	N	Y
Social acceptability of the project (community, government, non-governmental organizations)?	Y	Y
Visual and odor effects of waste sites?	N	N
Risk to the community and the local environment should the facility break down?	N	Y
Potential conflict with adjacent land uses?	N	N
Non-compliance with existing codes, plans, permits or design factors?	N	N
Construction in national park or designated recreational area?	N	N
Relocation of >10 individuals for +6 months?	N	N
Interrupt necessary utility or municipal service > 10 individuals for + 6 months?	N	N
Loss or inefficient use of mineral or non-renewable resources?	N	N
Noise levels > 5 decibels for + 3 months?	N	N
Adverse visual impact when compared to the surrounding natural landscape?	N	N
Affect future land uses on or around the location?	N	N
Are there any areas on or around the location that are densely populated or built-up, which could be affected by the project?	N	N
Highly visible to many people?	N	N
Lead to pressure for consequential project that could have significant impact on the environment (e.g. more housing, new roads, new supporting industries or utilities, etc)?	N	Y
Cumulative effects due to proximity to other existing or planned projects with similar effects?	N	N
Social changes, for example, in demography, traditional lifestyles, and employment?	Y	Y

7) Cultural Issues

Is there and impact because / to	Construction	Operation and Maintenance
Prehistoric, historic, or paleontological resources within 30 meters of construction?	N	N
Unique cultural or ethnic values at the site?	N	N

8) Public Health issues

Will the project affect…	Construction	Operation and Maintenance
Human or community health or welfare?	Y	Y
The quality or toxicity of air, water, foodstuffs and other products consumed by humans?	N	N
Morbidity or mortality of individuals, communities or populations by exposure to pollution?	Y	Y
Occurrence or distribution of disease vectors including insects?	N	Y
Vulnerability of individuals, communities or populations to disease?	N	Y
Individuals' sense of personal security?	Y	N
Community cohesion and identity?	N	N
Cultural identity and associations?	N	N
Minority rights?	N	N
Housing conditions?	N	N
Employment and quality of employment?	Y	Y
Economic conditions?	Y	Y
Social institutions?	Y	Y
Cause accidents that could affect human health or the environment?	Y	Y
- From explosions, spillages, fires etc?	Y	Y
- From storage, handling, use or production of hazardous or toxic substances?	Y	Y
Be affected by natural disasters causing environmental damage (e.g. floods, earthquakes, landslip, etc)?	N	Y
Vulnerable groups of people who could be affected by the project (e.g. hospital patients, the elderly)?	Y	Y

9) Air Quality

Is there and impact because / to	Construction	Operation and Maintenance
Onsite air pollutant emissions?	Y	N
Violation of applicable air pollutant emissions or ambient concentration standards?	N	N
Vehicle traffic during construction or operation?	Y	N
Demolition or blasting for construction?	N	N
Odor during construction or operation?	N	N
Alteration of microclimate?	N	N
Release pollutants or any hazardous, toxic or noxious substances to air?	Y	N
- Emissions from combustion of fossil fuels from stationary or mobile sources?	Y	N
- Emissions from materials handling including storage or transport?	N	N
- Emissions from construction activities including plant and equipment?	Y	N
- Dust or odors from handling of materials including construction materials, sewage and waste?	Y	N
- Emissions from burning of waste in open air (e.g. slash material, construction debris)?	N	N

10) Noise and Vibration

Is there and impact because / to	Construction	Operation and Maintenance
Noise and vibration or release of light, heat energy or electromagnetic radiation?	Y	Y
- From operation of equipment (e.g. engines, ventilation plant, crushers)?	Y	Y
- From construction or demolition?	Y	N
- From blasting or piling?	N	N
- From construction or operational traffic?	Y	N
- From sources of electromagnetic radiation?	N	N

ANNEX B. PHYSICAL AND SOCIO-ECONOMIC ENVIRONMENT

Physical Environment

Geology

The village of Ked-kedi lies at the Machakhelas Tskali River (Chorokhi River Basin) of Adjara region in West Georgia. The region is surrounded by the Black Sea (West), the Guria region (North), the Samtskhe-Javakheti region (East) and Turkey (South). The main orographic segments of the district are Meskheti, Sashay and Arsiani Ridges (average altitude is 2,000 to 2,500 meters). Kobuleti-Chakvi Ridge divides Adjara into two main parts: coastal and mountainous. Geologically the region is constructed with volcanoes layers of the middle and upper Eocene (Atlas of Georgia, 1964).

Geo Hazards

The seismicity rating of the region is “seven“(7) on the MKS scale (Map of Seismic Hazard Assessment of Georgia, 2006). Due to strong anthropogenic influence (forest logging) there is an increasing trend of landslides and mudflows in the region. The majority of landslides occur in the middle mountain zone of the region (Department of Monitoring and Prognosis, Ministry of Environment and Natural Resources Protection, 2005).

Soils

Soils vary throughout the region according to elevation and degree of specific location. A narrow beach is covered by sandy and sandy-alluvial soil. In some parts of the region marsh and meadow alluvial bog soils exists. Red soils predominate in the upper part of the mountain (Map of Soil Types of Georgia, 1999).

Climate

The climatic conditions that prevail within and around the Machakhela River Catchment are determined by the distance from the Black Sea and the area orographical conditions. Since there are no meteorological stations within the Machakhela River Catchment, data on the temperature regime is collected from multi-annual observations of meteorological stations (Kapandiba and Charnali) located close to the catchment area.

Average monthly and annual air temperatures as well as extreme temperatures t^0 C is shown in Table 1.

Table 1. Average Monthly, Annual And Extreme Air Temperatures

Met. Stat.	Temp.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Charnali	Average	5.7	5.9	7.7	11.2	15.0	18.5	20.9	21.5	18.8	16.1	12.0	8.6	13.5
	Absolute maximum	24	26	31	36	37	40	41	43	37	34	30	28	43
	Absolute minimum	-10	-10	-8	-2	2	9	11	12	6	2	-4	-7	-10
Kapandiba	Average	6.5	6.8	8.9	12.2	16.2	20.0	22.5	22.7	19.8	16.5	12.5	8.8	14.4
	Absolute maximum	24	28	32	38	38	40	40	41	39	36	30	29	41
	Absolute minimum	-8	-8	-7	-1	3	10	13	13	6	2	-3	-6	-8

The total annual precipitation is high, reaching 2000 millimeters. Snow cover appears by December 25 and melts in some 29 days by March 17. According to multi-annual observations, the maximum average monthly wind-speed of 7.9m/sec is registered near the Kanadiba station in winter months (XII-I).

Hydrology

The source of the Machakhela River is located on the Southern slopes of the Mountain Mereti at the height of 2662. The Machakhela River originates in Turkey and flows into the Chorokhi River from the right side at the height of 2200 m near the village of Machakhela, in Georgia.

The length of the Machakhela River is 37 km; and the catchment's basin area is 369 km^2. The river regime is characterized by floods in spring, high water in autumn, an unstable low water level of in summer and a relatively stable low level of water in winter.

Vegetation

The village of Ked-kedi is surrounded by several types of wetland areas, especially waterfowl habitat (Ramsar), categorized according to the Convention on Wetlands of International Importance as the following types: F,E,K,L,M,N,R,Y,1,4,9. (Chorokhy Delta Management Plan, 2006). Current plans are to establish the Mtirala Protected Area approximately 10 kilometers from the village (Map of Protected Areas of Georgia, 2005); however, the protected area is as of this writing not yet a reality.

The area is strongly affected by anthropological activities; however, there are still fragments of virgin Colchic forests in the area (Chorokhy Delta Management Plan, 2006). The main flora of the region is comprised of the following formations: *Trapeta-Ti, LIunceta Parviunceta, Hydrophyta herbosa, Hydatophytes, Ceratophullata demers,* and *Hygrophyta fruticosa* (Chorokhi Delta Management Plan, 2006)

The village of Ked-kedi is surrounded with foothills covered by Colchic-type forests. Dominant trees are: chestnut (*Castanea sativa*), beech (*Fagus orientalis*), elm (*Ulmus foliacea*), and maple *(Acer campestre*). The sub-forest is dominated by evergreen specie of rhododendron (*Rhododendron ponticum*). In the vicinity of the village are found lianas listed in the Red Book of Georgia including the higuera *(Ficus carica)* and Persian mulberry (*Morus nigra).*

Surrounding meadows are represented mainly by secondary cenosis, adventive species: crown grass *(Paspalum thunbergii),* woundwort *(Prunella vulgaris), lesser* Caucasian stonecrop *(Sedum stoloniferum),* stonecrop *(Sedum hispidum),* strawberry *(Fragaria viridis),* yellow avens *(Geum urbanum),* medick *(Medicago falcate),* trefoil *(Trifolium subterranum),* reversed clover *(Trifolium resupinatum),* white Dutch clover *(Trifolium repens),* garden bird's foot trefoil *(Lotus corniculatus),* eastern buttercup *(Ranunculus chius),* crowfoot *(Ranunculus trachycarpus),* etc. (Nakhutsrishvili G., 1999)

Mammals

Large mammals found nearby the village are: badger *(Meles meles)*, jackal (*Canis aureus*), fox (*Vulpes vulpes*) and different species of small mammals including the mole (*Talpa caucasica),* and shrew *(Neomys shelkownikowi* and *Crocidura spp.)* (Chorokhi Delta Management Plan, 2006).

Avifauna

Khelvachauri district is known for diversity of almost 40 nesting species, 30 wintering species, 50 migratory species and 30 species of non-regular migratory birds Among them: black-throated diver (*Gavia arctica*), red-throated diver (*Gavia stellata*), red-necked grebe (*Podiceps grisegena*), black-necked grebe (*Podiceps nigricollis*), mute swan (*Cygnus olor*), whooper swan (*Cygnus cygnus*), mallard (*Anas platyrhynchos*), shoveler (*Anas clypeata*), teal (*Anas crecca*), ducks (*Anas querquedula, Anser anser, Anser albifrons*), tufted duck (*Aythya fuligula*), pochard (*Aythya ferina*), herons (*Ardea cinerea and Ardea purpurea*), little egret (*Egretta garzetta*), little bitten and big bitten (*Ixobrichus minutus; Botaurus stellaris*), glossy ibis (*Plegadis falcinellus*), spoonbill (*Platalea leucorodia*), black-winged pratincole (*Glareola nordmanni*), black-winged stilt *(Himantopus himantopus*), great snipe (*Gallinago media*), curlew (*Numenius arquata*), marsh-harrier (*Circus aeruginosus*), and kingfisher (*Alcedo atthis*) (Jordania R, Boeme B, Kuznetsov A, 1999).

Reptiles

areacommon tree frog (*Hyla arborea),* lake frog *(Rana ridibunda)*, smooth newt *(Triturus vulgaris)* and slow warm *(Anguis fragilis).*

The following snakes are found in the Adjara region: ring snake (*Natrix natrix*), water snake (*Natrix tesselata*), and Aesculapian snake (*Elaphe longissima*). Only sand lizard (*Lacerta agilis*) is regularly in the regionAsia Minor triton (*Triturus vittatus*) and Turkish lizard (*Darevskia clarcorum*; IUCN Red List; Category Endangered) also (Chorokhy Delta Management Plan, 2006).

Fish

In the past migratory fish such as Black Sea trout (*Salmo fario morpha labrax,* Red Book of Georgia, Statute-Vulnerable*)* in the Machakhelas Tskali River; however, surveys carried since the mid-1990s. As a result, the current fish population is unknown.

The following species also occur in the Machakhelas Tskali River: Barbell (*Barbus tauricus escherichi*, riffle minnow (*Alburnoides jetteles*), and trout (*Salmo fario)* (river form, Red Book of Georgia, Statute-Vulnerable) (Elanidze R., 1988). Spawning periods for major fish species the river are in Table 5-13.

Table 2. Machalhelas Tskali River Fish Spawning Periods

Fish	Spawning Period
Barbell	May-August
Riffle Minnow	April-August
Trout	September-October

Socio-Economic Environment

Population and Settlements

The Machakhela sakrebulo is a community of 10 villages with 669 households with 3,269 persons. The vast majority of the population is Muslim. (Aliosha Kakhidze, the Machakhela sakrebulo chairman).

Land Use

The total land area managed by landholdings within the Khelvachauri district equals 5,113 hectares, out of which 92.p% is privately owned land, and 7.1% is state-owned. Agricultural lands account for 4,540 hectares of which 1,518 hectares are arable lands, and 2,978 hectares are allocated for permanent crop cultivation and 45 hectares are permanent pastures and meadows. The composition of agricultural produce is as follows: citrus plantations (2,629 hectares), vineyards (three hectares), orchards (37 hectares), and berry farms (two hectares) (Aliosha Kakhidze, Machakhela sakrebulo chairman).

The Khelvachauri district has approximately 24,400 cattle, and 1,800 sheep and goats.

Income and Employment

The absolute majority of the community is self-employed, oriented to subsistence farming. Two hundred persons are wage employees of which 15 work at the SHP.

Social Infrastructure

There are two snack bars, one kiosk and five grocery stores in the community. In the community there are 10 secondary schools, three village clubs, one library and one museum. One ambulatory clinic is under construction. (Aliosha Kakhidze, Machakhela sakrebulo chairman).

The community has two sources of power supply: 1) the hydro plant itself (direct supply) and 2) the Adjarian Energy Company. The community is not connected to NG networks. The population uses kerosene, wood fuel, and petrol, for cooking and power generation. (Aliosha Kakhidze, Machakhela sakrebulo chairman).

There is no central drinking water system in the community. The majority of the population uses spring waters (Aliosha Kakhidze, Machakhela sakrebulo chairman).

The central village road of about 40 kilometers is an important local artery. There are about 20 kilometers of unpaved In-village roads. (Aliosha Kakhidze, Machakhela sakrebulo chairman).

ANNEX C. GEOLOGICAL EVALUATION OF THE MACHAKHELA SHP SITE

1. Foreword

In compliance with a Terms of Reference provided by the Rural Energy Program, the engineering team undertook to conduct visual inspection of the construction site of the hydroelectric power plant on the Machakhela River and revise the results of geotechnical investigation of the same construction site carried out by the Georgian Office of the Association of Energy Engineers in 2002.

The group of independent engineers has conducted geotechnical investigation of the Machakhela HPP rehabilitation area. Particle-size analysis of water samples from the Machakhela River was carried out on the spot.

2. Geological and Hydrological Features

The Machakhela River originates from the junction of mountain springs on the southern slopes of the Mountain Mereti (2662.7m) in Turkey. It joins the Chorokhi River from the right side at the height of 2200m above sea level near the village of Machakhela in Georgia.

The Machakhela length is 37 km; catchment area – 369 km^2. The Georgian section length is 21km. The main tributary in this section is the Skurdidi River (11km); length of other tributaries does not exceed 5-6km.

The catchment has hilly sharply-contoured terrain with some bare peaks reaching the height of 800-1000m from the floor of the gorge. The slopes are steep and dissected

Geologically the catchment is constituted by sandstone, malm, and young igneous rocks with basalt, andasites and porphirites. The main stratums are covers with forest and meadow soils. Alpine meadows cover the slopes above and mixed forest below 2000-2200 meters. Gardens and arable lands are located in the lower part of the catchment.

The river gorge on the territory of Georgia is V-shaped. The gorge floor width ranges from 60 to 130 meters. The gorge slopes join the slopes of adjacent mountains. The floodplain is located only near the mouth of the river. Floodplain length is 5-6km, width – 40-50m, elevation – 0.5m. During the floods water level covering the floodplain reaches 0.3-0.5m.

About 1.5-2.0 km downstream from the state border the river divides forming 10-meter-wide and 20-meter-long graveled isles. The stream width ranges between 10 and 16 meters; depth – 04-08 meters; flow velocity ranges from 0.5-0.8m/sec to 2.5m/sec. The bottom is uneven, covered with big stones and gravel.

The riverbanks are graveled and erodible with rocky sections.

The river is fed by melt water, rainwater and groundwater. The groundwater plays secondary role in river feeding. The river regime is characterized by floods in spring, high water in autumn, unstable low level of water in summer and relatively stable low level of water in winter.

35% of annual runoff falls for spring, 18% for summer, 28% for autumn, and 19% for winter.

Observations of the river runoff were conducted in the period from 1941 to 1990 in the area of the Sindieti Village near the Machakhela HPP diversion canal. The river water is used only for energy needs.

By order #42 of the Ministry of Architecture and Building of Georgia (June 7, 1991) the rehabilitation area belongs to 6-point seismic zone in compliance with the Seismic Zoning Map of Georgia.

3. Geotechnical Characteristic of the Rehabilitation Area

The study area includes the Machakhela floodplain and the adjacent territory.

Loose unconsolidated soil - geotechnical element (GE-1) - has been identified in the study area as a result of visual examination.

GE-1: cobbles – 30%; gravels – 20%, boulders – 15%; fine sand matrix – 35%.

The HPP area surface is composed of well-rounded alluvial cobbles and gravel material.
Two shallow test pits (0.5m) have been made to define particle-size distribution of soil (GE-1) in the floodplain. The results of particle-size analysis of the soil from the test pits are given in Table 1.

The table also shows mean values of particle-size distribution: boulders – 8.9%, cobbles – 18.51%, gravel – 39.91%, sand – 23.22%, dust– 9.23%, clay – 0.25%.

Table 2 shows results of laboratory examination of water samples. According to them, the water contains hydrogen carbonate, sulphate, magnesium and calcium. The water is colorless, odorless and tasteless; its total hardness is 2.81 mg/equivalent.

The water belongs to non-aggressive type (Tables 3 and Table 4).

Table 1. Particle Size Distribution

##	Sample #		Location of Sampling		Type of Sample	Particle Size Distribution, %																						
	Lab.	In Situ	Pit #	Depth, m		Clay	Silt	Sand							Gravel									Cobbles				Boulders
								Fine	Medium				Coarse		Fine			Medium			Coarse							
						<0.002	0.002-0.063	0.063-0.15	0.15-0.25	0.25-0.3	0.3-0.425	0.425-0.6	0.6-1.18	1.18-2.0	2.0-3.35	3.35-5.0	5.0-6.3	6.3-10.0	10.0-14.0	14.0-20.0	20.0-28.0	28.0-37.5	37.5-50.0	50.0-63.0	63.0-75.0	75.0-100.0	100.0-120.0	120.0-200.0	200.0-400.0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Boulders 10%, cobbles 35-40%, gravels 20-215% with sand																													
1	1	1	1	0,5	m	0,21	8,59	6,47	1,34	3,47	1,56	2,84	4,58	1,31	7,95	6,87	4,23	4,31	3,38	2,65	4,25	3,33	4,11	1,45	3,47	4,23	6,11	4,64	8,65
						0,21	8,59	21,57							42,53										18,45				8,65
2	2	1	2	0,5	m	0,29	9,88	4,69	2,41	4,67	3,64	4,08	3,88	1,49	5,31	5,94	2,47	6,84	3,78	1,48	4,21	2,69	3,36	1,20	4,82	3,10	4,18	6,47	9,12
						0,29	9,88	24,86							37,28										18,57				9,12
Average						0,25	9,23	23,22							39.91										18.51				8.88

Table 2. Groundwater Chemical Testing – Laboratory Data

#	River	Unit	Content per 1 liter							PH
			Anions				Cations			
			Dry residual	HCO_3^{--}	CL^-	SO_4^{--}	Ca^{++}	Mg^{++}	$Na^+ + K^+$	
1	Machakhela	mg-l	40.8	36.1	4.21	11	9.1	3.8	3.5	7.1
		mg-equiv.		0.57	0.11	0.24	0.46	0.31	0.21	
		% mg-equiv.		62.42	11.98	23.15	47.25	32.87	20.05	

Table 3. Groundwater Aggressiveness To Structures

No.	River	Sampling depth, m	Aggressiveness:	Groundwater aggressivity to structures					
				In soils Kf>0.1m/24h			In soils Kf<0.1m/24h		
				Concrete grade per permeability					
				W4	W6	W8	W4	W6	W8
1	Machakhela	0.00	Bicarbonate hardness mg_eq/l	No	No	No	No	No	No
			Hydrogen ion	No	No	No	No	No	No
			Aggressive carbon dioxide content, mg/l	-	-	No	-	-	No
			Magnesia salt content, mg/l	No	No	No	No	No	No
			Ammonia salt content, mg/l	-	-	-	-	-	-
			High alkalinity content, mg/l	No	No	No	No	No	No
			Sulfates for concrete						
			Portland cement (ГОСТ10178-76)	No	No	No	No	No	No
			Portland blast-furnace (slag) cement	No	No	No	No	No	No
			Sulfate-resistant cement	No	No	No	No	No	No

Table 4. Water Aggressiveness On Metal

No.	River	Sampling depth, m	Water aggressivity impact on reinforced concrete metal parts		Soil aggressivity to hydrocarbon steel, below groundwater level with infiltration rate >0.1m/24h
			If in water	If periodically subject to water	
1	Machakhela	0.00	No	feebly	No

Conclusions and Recommendations

1. One geotechnical element (GE-1) has been identified in the study area; the study shows that:
a) No hazardous geological processes, such as landslides, rock falls and others able to hinder exploitation of the facility have been observed in the area;

b) The groundwater is of non-aggressive type and not dangerous for any kind of concrete;

c) Side and bottom erosions are typical for the study area; In order to prevent future erosion it is recommended to construct adequate bank protection in the catchment area (e.g. maintenance vegetation), extract coarse materials from the riverbed and use sediment trapping devises;

d) In compliance with the Seismic Zoning Map of Georgia the rehabilitation area belongs to 6 point seismic zone;

e) Geological engineer's participation in rehabilitation process is preferable to make timely corrections in case of need.