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ZESKHO 1 HPP

PRE-FEASIBILITY STUDY

UPPER TSKHENISTSKALI RIVER BASIN

Friday, January 11, 2013

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Note to Reader: This document is based largely on existing information, and information gathered during field visits by a small group of professionals from Deloitte Consulting.

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Definition of Abbreviations

CAPEX	Capital Expenditure
EIA	Environmental Impact Assessment
EPCM	Engineering, Procurement, and Construction Management
EU	European Union
GEL	Georgian Lari
GSE	Georgian State Electrosystem
GW	Gigawatt
GWh	Gigawatt-hours
ha	Hectare
HEC-SSP	Hydrologic Engineering Center Statistical Software Package
HIPP	Hydropower Investment Promotion Project (USAID-funded)
HPP	Hydropower Plant/Hydropower Project
HV	High Voltage
kV	Kilovolt
kW	Kilowatt (a measure of power)
kWh	Kilowatt-hour (a measure of energy)
LS	Lump Sum
m^3/s	Cubic meters per second
masl	Meters above sea level
MENR	Ministry of Energy and Natural Resources of Georgia
MW	Megawatts
MWh	Megawatt-hours
SS	Substation
UNESCO	United Nations Educational, Scientific and Cultural Organization
US ¢	United States Cent (also USc)
US $	United States Dollar (also USD)
USAID	United States Agency for International Development
VAT	Value Added Tax

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EXECUTIVE SUMMARY

Project Description

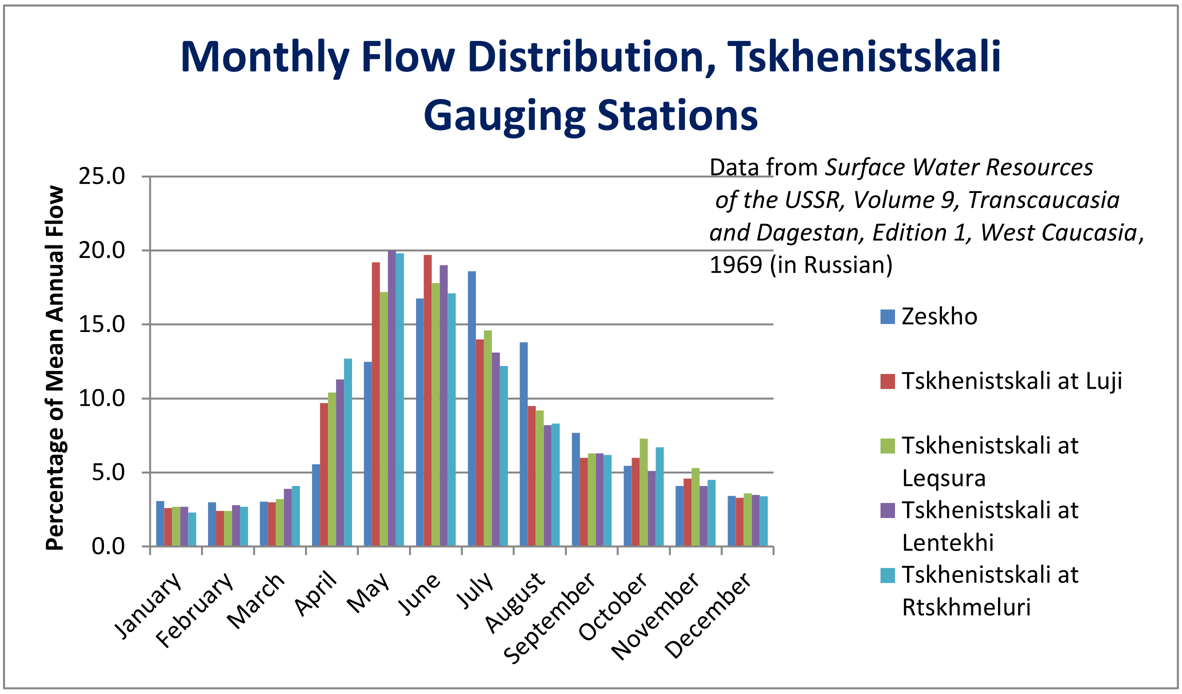
The site of the proposed Zeskho 1 Hydropower Plant Project (HPP) is located in Lentekhi district of western Georgia's Racha-Lechkhumi and Lower (Kvemo) Svaneti Region. The potential hydropower project involves construction of an approximately 25.3 Megawatt (MW) run-of-river Hydropower Plant (HPP) on the Zeskho and Koruldashi Rivers tributaries to the Tskhenistskali River.

The Zeskho 1 HPP will be the upstream plant in a possible six-HPP cascade in the upper Tskhenistskali River Watershed Area. The upper Tskhenistskali River basin lies between the north slopes of the Lechkhumi and the south slopes of the Svaneti Mountain Ranges. The landscape of the region is dominated by mountains that are separated by deep gorges. The average inclination of slopes is about 35^0-45^0 providing a good opportunity to develop a project that is expected to be financially attractive.

The Zeskho 1 Hydropower Plant site is located in the vicinity of the Zeskho and Koruldashi Rivers' confluence, located about 49 km upstream from the developed area of Lentekhi district of Lower Svaneti Region. The nearest settlements are Zeskho and Tsana villages, which are respectively 5.3 and 2.7 km away from the Zeskho 1 HPP powerhouse (See Appendices 1 and 2 for Location and Watershed maps).

The geologic conditions in the upper Tskhenistskali Basin are variable and are little different from the upper Enguri watershed geology. This area is in the extreme south of the folds and uplifts that create the Greater Caucasus Mountain Range. A number of minor regional faults are found in the Lower Svaneti region and earthquake probability is fairly high. Rock ranges from very strong and massive deposits, through metamorphic rock zones of all types, to poorly cemented conglomerates and deep glacial and river deposits. Detailed geologic studies and careful orientation and placement of structures will be required to develop a successful project (See Appendices 3, 4 and 5 for Geology, Geomorphology and Soils maps).

The river flows in Lower Svaneti are very seasonal. Discharges are low during winter months when most precipitation falls as snow, and are high during spring and summer when melt-water and rain runoff are combined. The variability is demonstrated in the following chart, which shows the seasonality of flow at gauging stations in the upper Tskhenistskali River basin:



The diversion points for Zeskho 1 HPP are on the Zeskho and Koruldashi Rivers, about 0.5 to 1.0 km downstream of Zeskho and Tsana villages respectively. Moderate flows and high head are available at this location, making an HPP of about 25.3 MW appear attractive.

The project layout, based on information available at this time, includes a low diversion dams with sluices and intakes, de-silting facilities, open canal section, a tunnel water conductor, pressure tank, penstock, and a surface powerhouse, as shown on the Arrangement Drawing, Figure 1. Two Pelton turbines could be used at this site (Appendix 6 depicts Preliminary Turbine –Generator Characteristics).

Project cost and construction schedule

The estimated cost of the Zeskho 1 HPP is US$ 37.8 million, or about US$ 1,493/kW of installed capacity, including VAT and a 25% contingency. The project is expected to have a 1-year pre-construction period and 3-year construction period. The critical path for the project may be controlled by the tunnel construction or by the procurement, manufacture, delivery and installation of major mechanical and electrical components.

Conclusions

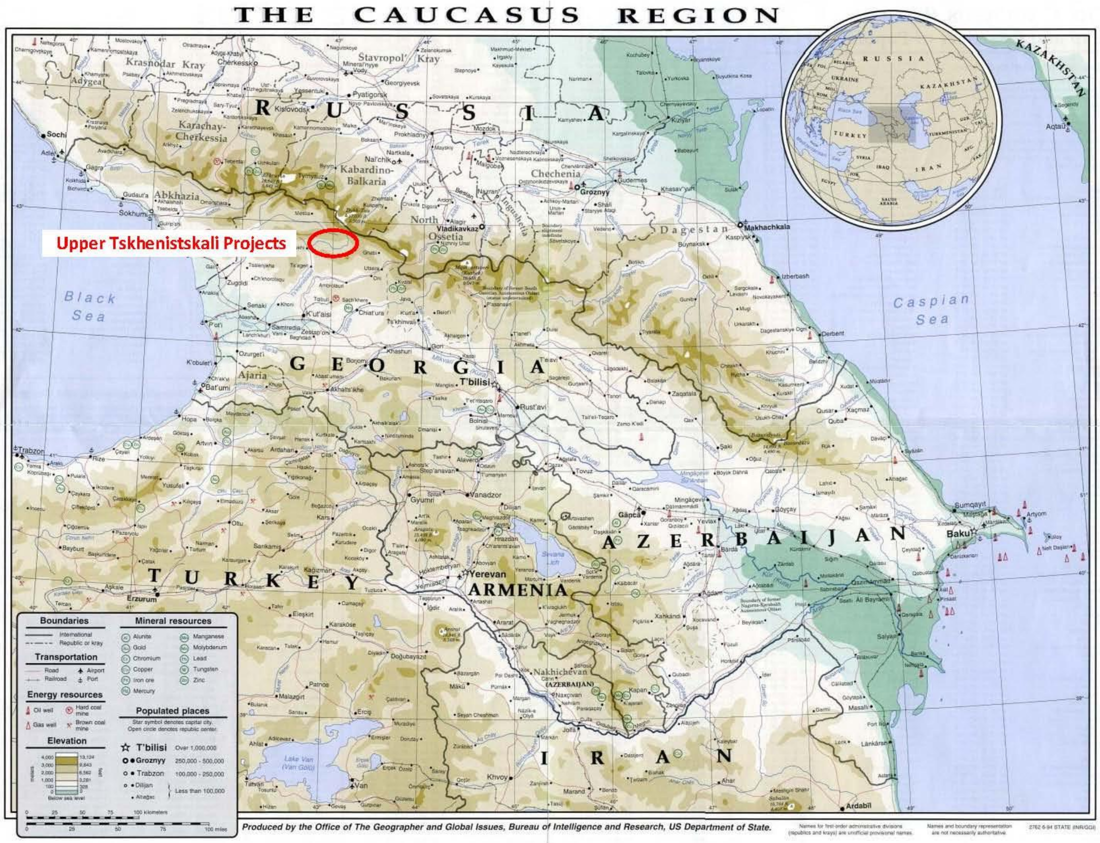
According to preliminary assessment, the plant offers a good potential opportunity to sell modest amounts of energy during three winter months inside Georgia, replacing (displacing) expensive thermal power; and to export energy during the remainder of the year to take advantage of the seasonal differentials in power prices between Georgia and its neighboring countries.

Table 1: Project Significant Data

General	
Project name	Zeskho 1 Hydropower Project
Project location (political)	Lentekhi District of northern Georgia's Racha-Lechkhumi – Lower (Kvemo) Svaneti Region
Nearest town or city	Lentekhi
River name	Zeskho and Koruldashi Rivers
Watershed name	Tskhenistskali River Watershed
Drainage area at diversion	67.0 km^2
Financial Estimates	
Estimated construction cost, including VAT	$ 37.8 Million
Estimated cost per kW capacity	$1,493/kW
Hydrological Data	
Stream gauge used	Zeskho gauging station
Years of record	1961-80
Gauge drainage area	44.8 km^2
Mean river flow at intakes (Zeskho and Koruldashi)	4.6 m^3/s; 3.6 m^3/s
Facility design discharge	13.0 m^3/s
Preliminary design flood (100 yr. return period) (Adjusted to Intake Locations: Zeskho and Koruldashi)	103 m^3/s; 81 m^3/s
Max. recorded flow (Zeskho gauging station)	63.8 m^3/s
Mean annual flood (Zeskho gauging station)	21.1 m^3/s
Diversion Facilities	
Normal operating level	1,750 masl
Approximate dams height	10 m
Approximate diversion pond area	1.2 ha
De-silting structure	Required
Sanitary or environmental bypass flow (assumed)	10% of mean monthly flow during low -water season and 10% of mean annual flow for the rest of the period
Power Tunnel	
Tunnel lengths	4,950 m; 150 m
Tunnel sections (horseshoe shape)	2.0x2.5 m; 2.5x4.0 m
Penstock	
Penstock length	650 m
Outside diameter	2,420mm
Powerhouse	
Type	Above-ground
Installed capacity	25.3 MW
Units, turbine output and turbine type	2 x 13.1 MW, 4-jet vertical Pelton units, with jet deflectors
Units and rated generator capacity	2 x 16.0 MVA at 0.90 Power Factor
Preliminary generator voltage	10 kV or 6.3 kV
Rated speed	333.3 rpm
Units, type and net capacity at high-voltage transformer	2; 35/10-20.0 MVA or 35/6.3-20.0 MVA
Tailrace	
Length	50 m
Width	4.5 m
Type	Open channel
Normal tail water elevation	1,510 masl
Transmission line	
Interconnection location	New 35 kV
Distance to interconnection (km)	5.4 km
Voltage	35 kV
Power & Energy	

Gross head	240 m
Total head loss at rated discharge	10.2 m
Net head at rated discharge	229.8 m
Estimated average annual generation	Approximately 119.0 GWh
Nominal installed capacity	25.3 MW
Preliminary annual plant factor	54 %
Construction Period	
Conceptual design, feasibility studies & EIA	1 year
Engineering, procurement and construction	3 years
Ongoing environmental monitoring	Some studies and data collection will extend throughout construction.
Environmental	
Critical environmental receptors	Racha-Lechkhumi and Lower Svaneti Planned Protected Areas

Project Location Map



1.0 GENERAL INTRODUCTION TO THE PROJECT

Table 2: Development Area Significant Data

Project Location (Political)	Northern Georgia's Racha-Lechkhumi-Lower Svaneti (Kvemo Svaneti) Region
Political Subdivisions	Lentekhi District
Area Population	8,400
Nearest Settlements	Zeskho and Tsana villages (Lentekhi District)
River Name	Zeskho and Koruldashi
Economic Activity in the Area	Primarily agriculture, logging and wood products for construction
Special Natural Resources	Timber, glaciers, mineral and building stone deposits
Special Cultural Resources	Churches, monasteries, defensive towers, hot and mineral springs, etc.
Critical Environmental Receptors	Racha-Lechkhumi-Lower Svaneti Planned Protected Area

1.1 PROJECT AREA SOCIAL CHARACTERISTICS

The Zeskho 1 Project area is located in Lentekhi Municipality, which is part of the Racha-Lechkhumi and Lower Svaneti Region Administrative Unit. The total area of Lentekhi equals to 1344,4 km^2 and it occupies the upper part of the Tskhenistkali River watershed area. Lentekhi district is located between the elevations of 450 m and 1,300 m above sea level. The population for the whole district is about 8,400, giving a population density of 6.7 people/km^2. Of the residents, 99.5% are Georgians (*Source: Lentekhi Municipality (District) Diagnostic Report, CARE Georgia, 2010*)

Representatives of the Tsana Community. Image taken by HIPP team

View of the Zeskho village. Image taken by HIPP team

Lentekhi District is mainly a mountainous area and the economy heavily depends on agriculture. Animal husbandary, vegetable (mainly potatoes, maze and beans) production, and forestry are developed in the region. Vine is also cultivated in some areas, especially in lowlands. Mineral springs are also found in the region.

Zeskho 1 HPP lies in Zeskho and Tsana villages (Tsana community). Tsana village is the community centre. The Tsana and Zeskho villiges are located at 1,800 msl in sub-alpine zone and is in 56 and 62 km from Lentekhi town repseclively. According to the last census (2002) Tsana has 57 inhabitants and 29 people make population of Zeskho village during summertime, while in winter due to the strict weather conditions local residents go for lowland residence and only one familiy is left. Local community mainly depends on subsistance farming (animal husbandary, vegetables: potatoe and maze). Revenues may be generated also from summer tourism. Summer camp is in 2 km from Zeskho village which is especially attractive for alpinists.

1.2 PROJECT AREA ENVIRONMENTAL CHARACTERISTICS

Sub-alpine meadows at Zeskho village. Image taken by HIPP team

Waterfall in the Lentekhi area. Image taken by HIPP team

Flora: The Tskhenistkali River watershed in the Lower Svaneti is rich in biological resources. Plants are distributed according to the vertical zoning here. The landscapes are mainly mountanious seperated by the deep gorges. Forests occupy considerable areas of the territory (See Appendix 7 - Land Cover). Mountain slopes are covered by mixed hardwood and coniferous forests, with sub-alpine and alpine meadows, rocky peaks, and glaciers above the tree line. Forests are characterized by a dominance of Alder (*Alnus Barbata*), Oak (*Quercus iberica, Q. hartwissiana*), Chesnut (*Castanea sativa*), Hornbeam (*Carpinus caucasicus*), and Beech (*Fagus orientalis*), and forests are rich with Colchic evergreen species. Within the deciduous forests there is interspersed Pine (*Pinus Kochiana*). The forest understory consists of Cherry-Laurel (*Laurocerasus officinalis*), Pontic Rhododendron (*Rhododendron ponticum*) and Boxtree (*Buxus colchica*). Lianas include Green Brier (*Smilax excelsa*) and Ivy (*Hedera sp.).*

The Tskhenistkali River watershed harbors endemic and “red-list” species. Yew tree (*Taxus baccata*), Chestnut (*Castanea sativa*), Imeretian oak (*Quercus imeretina*) and Hophornbeam (*Ostrya carpinifolia*) are among the plants of the Red List of Georgia.

Fauna: The Tskhenistkali watershed area shelters various fauna species. Most common mammals in the area are: Common Otter (*Lutra lutra*), Lynx (*Lynx lynx*) and Wild Boar (*Sus scrofa*). According to local residents, wolf and brown bear inhabit the area in autumn and winter; otters occur in the region each year from July through October. Avifauna of the region has previously been poorly studied. The following bird species have been observed in the vicinity of the HPP: Common Buzzard (*Buteo* buteo), Common Kestrel (Falco tinnunculus) and Golden Eagle (Aquila chrysaetos).

Some of the resident species are among the “red-list” species of Georgia, including Brown bear (En), Lynx (CR), Golden Eagle (VU), and others.

Among reptiles two rare species inhabit the area surrounding the HPP: the Transcaucasian Rat Snake (*Elphe longissima*) and Caucasian Viper (*Vipera kaznakovi*).

The following fish species are found in the Tskhenistskali River: Kolkhic Barbel (*Barbus tauricus escherichi*), Bream (*Abramis brama*), goby (*Gobius melanostomus*), trout (*Salmo fario*) and Khramulya (*Varicorhinus siedolbi*), each of which are common to the Tskhenistskali River (Elanidze, R. 1988). The Red Book of Georgia classifies the Khramulya as National Statute Vulnerable, so it needs to be protected.

Spawning periods for major fish species found in the river are noted in table below.

Table 3: Tskhenistskali River Fish Spawning Periods

Fish	Spawning Period
Kolkhic Barbel	May-August
Bream	April-June
Goby	March-September
Trout	September-October
Khramulya	May-June

Literature on fish composition of Tskhenistskali River dates back several decades, which was before any hydropower dams were built downstream of the town of Lentekhi. Therefore, it’s hard to determine if all the above species still inhabit the study area. The sampling of fish species should be included in detailed feasibility design (environmental assessment).

(Source: Racha-Lechkhumi-Lower Svaneti Protected Areas Management Plan, 2008)

1.3 TRANSMISSION

The current transmission and high voltage (HV) distribution system in Lentekhi District area is 35 kV and 110 kV. The distribution lines and all of the 35 kV lines in the area are owned and operated by Energo-Pro, the licensed distribution utility serving most of Georgia outside Tbilisi. Energo-Pro also owns the Lajanuri HPP and a 110 kV line from the Lajanuri Substation (SS) to the Jakhunderi SS, along the Tskhenistskali River east of Lentekhi, and the newly built 110 kV line from Jakhunderi to Mestia SS. A single-circuit 220-kV line, property of the government owned by Georgian State Electrosystem (GSE), connects the Lajanuri HPP Substation to the Tskaltubo Substation west of Kutaisi.

Mestia-Jakhunderi 110 kV line along the main road. Image taken by HIPP team

Mestia-Jakhunderi 110kV line across the ridge near Luji village. Image taken by HIPP team

The Zeskho 1 power plant will be located 2.7 km downstream from Tsana village. About 5.4 km of new 35 kV line will be needed to evacuate the power from the Zeskho 1 SS to the potential Zeskho 2 substation, which will be connected to the Jakhunderi SS.

If the proposed clusters of run-of-river HPPs are developed in Tsageri and Lentekhi Districts, there will be a large concentration of power generation in the Tskhenistskali watershed area. It would be worthwhile to consider building a new HV transmission lines and upgrade the existing Jakhunderi SS.

1.4 ACCESS TO THE AREA

Highway access to the towns of Tsageri and Lentekhi from Kutaisi has been rebuilt and repaved recently. Solely a 5 km section from Tskaltubo to Tsageri remains in need of upgrade. It is possible to drive from Tbilisi to Lentekhi in about 4 hours. The road to Lentekhi and surrounding villages is kept open during wintertime.

The main roads beyond Lentekhi and the local roads are unpaved, without exception. They are in fairly good condition and are regularly maintained, but are often passable only by trucks, buses, and 4-wheel-drive vehicles with adequate ground clearance. Roads to the upper villages (Zeskho, Tsana, etc.) are closed during the winter and are subject to temporary closure due to snow, avalanches, rockfalls and landslides. Not all minor stream crossings have bridges. A secondary road connects Lower and Upper Svaneti through the Zeskho gorge from the Village of Tsana to Ushguli and is very popular among the tourists.

Intake structure location at the Zeskho River. Image taken by HIPP team

Power house location near the Zeskho and Koruldashi Rivers Image taken by HIPP team

Some of the high-elevation intake areas (Tskhenistskali 1, Zeskho 1 and Zeskho 2) are accessible only on foot or horseback at this time. Access will have to be improved or developed for construction and project operation in those areas. To reach the Zeskho 1 HPP construction sites on the Zeskho and Koruldashi Rivers, about 5 km of rough road will have to be upgraded and a new road of about 2.0 km has to be built.

2.0 BASELINE CONDITIONS

2.1 DATA AVAILABILITY

Maps. Soviet-era topographic maps are available for the entire study area at 1:250,000; 1:100,000; and 1:50,000. Most of the area is covered by 1:25,000 topography that has been available to HIPP at no cost. This Soviet mapping has been used to prepare the Project Arrangement Drawing, Figure 1, and the River Profile, Figure 2.

Geologic mapping is available for the entire area at scales of 1:250,000, 1:50,000 and 1:25,000. Information from these maps has been used to prepare the Project Geologic Map, Figure 3 and Appendices 3 and 4.

Aerial and Satellite Imagery. Part of the area is covered by Google Earth imagery that shows useful detail, but the Google service has only low-resolution satellite imagery for most of the area. The local firm GeoGraphic has high-resolution, aerial color imagery, taken in 2010, for the entire area but funds are not available to purchase the material at this time.

2.2 HYDROLOGY AND WATER RESOURCES

Table 4: Hydrology Significant Data

Method of analysis	Monthly
Drainage area at gauge	44.8 km^2
Total drainage area for Zeskho 1 HPP	94.5 km^2
Adjustment factor (Zeskho and Koruldashi)	1.18; 0.93
Maximum plant discharge	15.0 m^3/s
Minimum plant discharge	As low as 0.3 m^3/s
Flood flows (Zeskho and Koruldashi)	Average Annual Flood 25.0 m^3/s*; 19.5 m^3/s *
Highest recorded flow	63.8 m^3/s
Calculated 100 year flood (Zeskho and Koruldashi)	103 m^3/s*; 81 m^3/s*, but based on a short period of record (20 years)
Records available	Mean monthly flows of the Zeskho River at Zeskho gauging station for 20 years, from publications of the Hydromet. Daily records exist, but could not be obtained for this study
Recommended additional data collection and study recommendations for feasibility and design	Re-establish a stream flow gauging station at the former location of the Zeskho gauging station and installation of the new one at the Koruldashi River's headwork. They would also be used for monitoring of suspended and bed load sediments, water quality parameters, water temperature, fish, etc.

**These flood flows are based on a simple drainage area ratio adjustment of the Zeskho gauge data. They are probably slight underestimations of flood flows at the diversion. That is due to the smaller drainage basins and steeper tributary areas, which results in shorter times of concentration.*

Table 5: Climate Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	
Data Type	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**mean**	**Annual Totals**
Average Monthly Air Temperature in °C	-1.4	-0.2	3.2	8.8	14	16.7	19	19.6	16	11.5	6	1.3	10	
Lowest Average monthly Air Temperature in °C	-4	-3.5	-0.6	4.9	9	12.3	15	15.4	12	7.2	2.3	-1.4	6	
Lowest Air Temperature in °C	-26	-22	-15	-5	0	5	8	7	1	-7	-20	-24	-26	-26
Highest Average Monthly Air Temperature in °C	2.6	4.5	8.2	14.4	19	22.4	25	25.2	22	16.9	11	5.4	15	15
Highest Monthly Air Temperature in °C	17	22	31	34	36	37	39	40	41	33	28	19	41	31
Average Relative Humidity in %	84	82	77	72	72	74	75	75	78	83	80	84	78	78
Average Monthly Precipitation in mm	99	103	101	105	109	110	93	84	106	116	101	108	103	1235
Average Monthly Wind Speed in meters/sec.	0.6	0.7	1.1	1.4	1.3	1.2	1.2	1.1	1	0.8	0.7	0.5	1	

Source: *Lajanuri HPP Environmental Impact Assessment Report (approved by the Ministry of Environmental Protection) reportedly from Meteorological Station Located in Lailashi village and town of Tsageri*

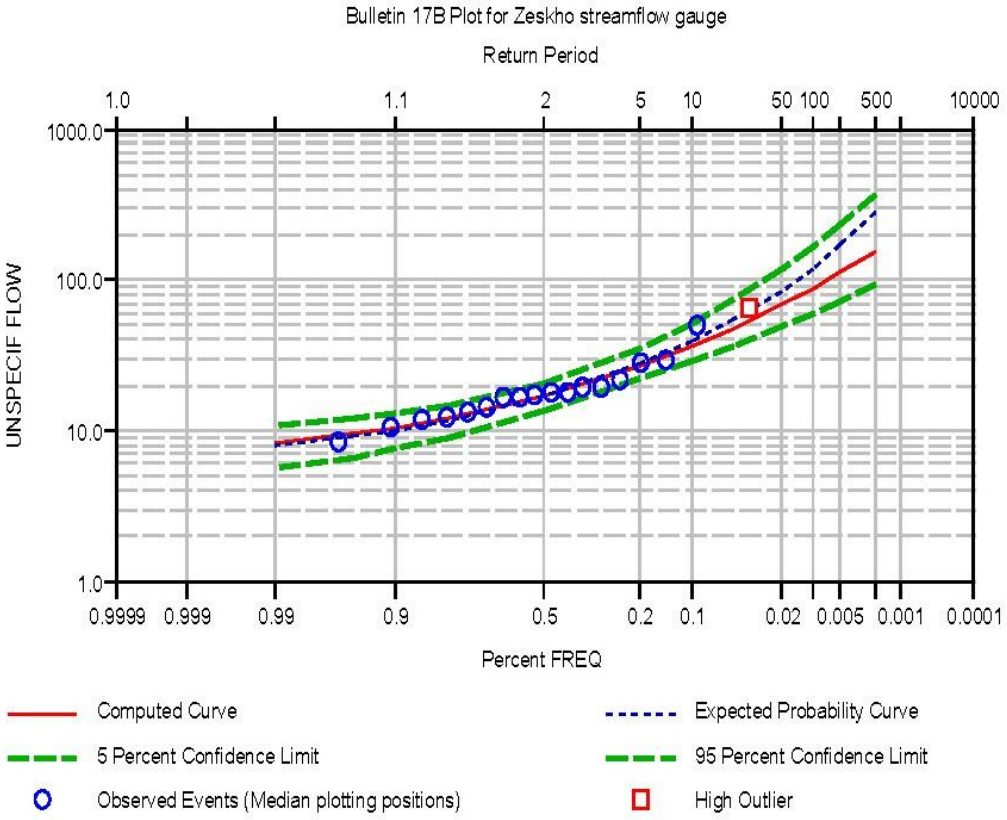
Also see Appendix 8 for the Map of the Mean Annual Precipitations.

2.3 FLOODING AND FLOOD RISK

Flooding occurs frequently in the project watershed and in the project vicinity. Steep slopes, deep gorges, significant areas of exposed rock and impervious surfaces, snowmelt runoff enhanced by warm temperatures and intense precipitation all contribute to major flooding risk for the project and the local environment.

Only 20 years of peak flood flow data are available for the Zeskho stream-flow gauge. These data points were analyzed using the U.S. Army Corps of Engineers Hydrologic Engineering Center - Statistical Software Package (HEC-SSP) computer program, Version 2.0. See: http://www.hec.usace.army.mil/

A Log-Pearson III analysis was prepared, following the procedures in United States Water Resources Council Bulletin 17B, *Guidelines for Determining Flood Flow Frequency:* http://water.usgs.gov/osw/bulletin17b/bulletin_17B.html. The results are shown on the following plot:



These flood flows were adjusted to the diversion location using a simple drainage basin area ratio.

The divergence of the green 5 and 95 percent confidence limit lines shows the greater uncertainties in floods larger than about the 10-year event. Further flood hydrology studies should be conducted during the feasibility phase of development to improve the understanding of rarer flood events.

Location of the former Zeskho gauging station. Image taken by HIPP team

Remnant from the gauging station at the Zeskho River. Image taken by HIPP team

2.4 SEDIMENT

The upper reaches of the Tskhenistskali River carry a very high concentration of suspended sediment and moves a large volume of bed load sediment. The watershed is steep-sloped generating a high-velocity surface runoff and river velocities. During high flow periods large volumes of suspended sediment turn the river a grayish brown color. The erosion of river banks and valley slopes also contributes to very large bed load movement of coarse sediment, large rocks and debris. If compared to the Tskhenistskali River its tributaries the Zeskho and Koruldashi Rivers have relatively low sediments, however new sediment data for Zeskho 1 HPP should be made during feasibility studies. Suspended solids, bedload, grain size distribution, and mineralogical data are needed for the design of the de-silting structure and to prepare turbine specifications that account for the erosive properties of particles that are not removed. Table 6 presents existing monthly annual sediment discharge in the Tskhenistskali River at the Luji Gauge.

Table 6: Tskhenistskali River at Luji Gauge Location: Sediment Load Data

Record years	Average Monthly Discharge of Sediment in kg/sec												Average Monthly Sediment Discharge in kg/s	Annual Sediment Discharge in Tonnes x1000
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**		
1976	7.55	7.44	8.32	28	60.4	59.1	44.9	28.9	16.4	13.4	10.4	7.36		
1977	5.92	5.46	6.85	20.9	44.9	53.1	31.8	33.9	27.7	28.5	18.6	14.8	24	758
1978	11.7	10.8	14.1	24.5	65.9	74.8	64.1	58.4	27.7	17	14.5	10.9	33	1022
1979	10	10.1	11.3	39.8	70.5	62.6	50.6	30	15.9	12.6	23.5	10.6	29	901
1980	8.03	7.73	8.22	29.8	69	52.8	37.7	25.1	17.5	22.3	14.9	11.1	25	788
Monthly Average	8.64	8.31	9.76	28.60	62.14	60.48	45.82	35.26	21.04	18.76	16.38	10.95	28	867
Monthly Maximum	11.70	10.80	14.10	39.80	70.50	74.80	64.10	58.40	27.70	28.50	23.50	14.80	N/A	N/A
Monthly Minimum	5.92	5.46	6.85	20.90	44.90	52.80	31.80	25.10	15.90	12.60	10.40	7.36	N/A	N/A
Assumed Daily Maximum	19.90	18.00	18.60	46.00	91.50	(121.00)	(66.00)	(62.30)	32.70	41.30	43.90	22.70	33	1022
Assumed Daily Minimum	3.40	3.70	4.54	13.30	31.00	24.20	20.20	11.60	8.42	9.20	6.69	5.20	24	758

Note 1: This data is unpublished and was provided by a consultant to the project team. It is presumed that the data was collected and originally processed by the predecessor agency to Hydromet, (The National Environmental Agency, Dept of Hydrometeorology, Government of Georgia).

Note 2: ( ) are data values open to apparent question, rather than negative values

2.5 GLACIATION AND CLIMATE CHANGE IMPACTS

The headwaters of the Tskhenistskali River are in the southern slopes of the Svaneti Range which is a branch of the Greater Caucasus Mountain Range. Most of the glaciers including the highest peak – Mount Lahili (4,010m) are located in the northern part of the Svaneti Mountains belonging to the Enguri Watershed Area. While the most important glacier of the Tskhenistskali River basin, Koruldashi, lies in the south-east of the Svaneti Range. Its elevation reaches 3,075 masl and the tongue descends to 2,480 masl. Other glaciers found within the Tskhenistskali basin are small and mainly feed Koruldashi Glacier.

View of Mt. Koruldashi. Image taken by HIPP team during the field visit

View of origin of the River Zeskho. Image taken by HIPP team during the field visit

During project feasibility studies and design, the possibility of unexpected events in the upper watershed must be considered. These would include formation of lakes on or above glaciers, avalanches or large landslides; short-term increases in sediment and debris discharges; sudden flood releases from lakes (glacial lake outflow floods); sudden flow disruption by avalanches or landslides, etc.

In the long term, a developer must consider whether changes in climate (global warming) might affect the amount and seasonal timing of discharges from the watershed. Since the life of a hydropower plant is typically 100 years or more, changes in operational requirements or the revenue stream could occur during the project lifetime.

3.0 GEOLOGY

3.1 GEOLOGICAL MAP

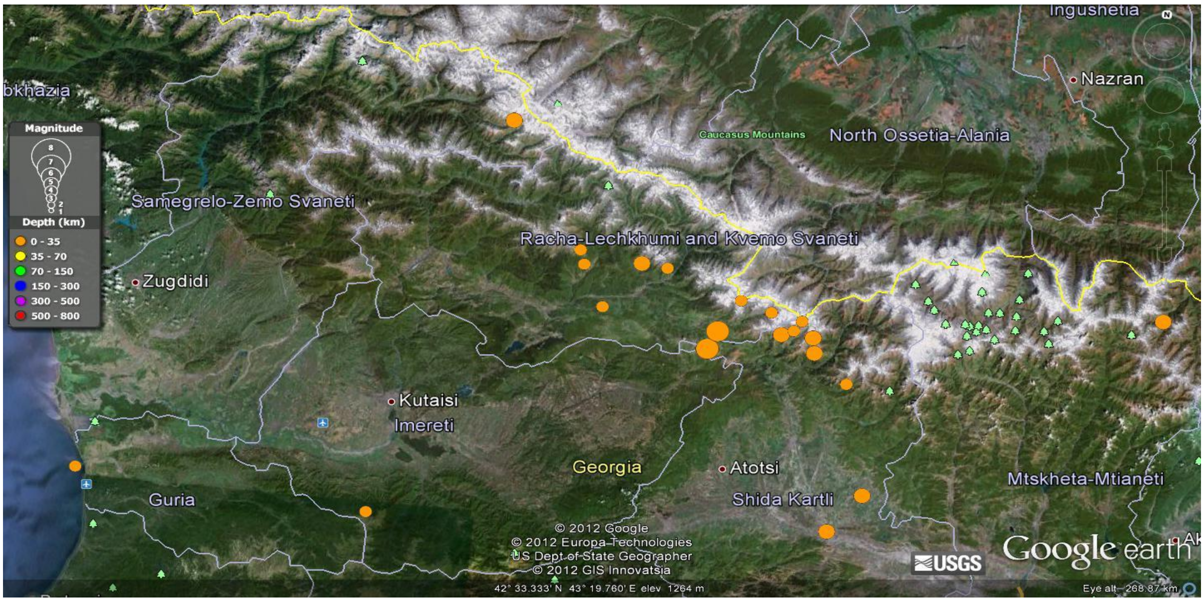
The geologic data available at the time of this study included geologic maps at the scales of 1:250,000, 1:50,000, and 1:25,000; and field reconnaissance notes by HIPP's consulting geologist. The Zeskho 1 HPP area has diverse geo-morphological structure, largely consisting of semi-rock and rock masses suitable for construction and operation of medium-sized HPPs. The proposed headworks lie within the area consisting of water-glacial and alluvial-proluvial deposits. The non-pressure tunnel mainly goes through semi-solid and solid masses (limestone, marls, marly limestones, sandstones and shales). The penstock crosses semi-rocks and poorly consolidated deposits: sandstones, sandy shales, cobbles and pebbles. The power house is located within an area of alluvial deposits (semi-consolidated rocks). No major faults and landslides are observed within the project area. This should be considered during the construction phase. Geological drillings need to be carried out during further geological studies before construction begins. A geological map of the project area is shown in Figure 3.

3.2 SEISMOLOGY

The project site is within a very active seismic zone. The geology of the project area is within the Southern Fold System of the Greater Caucasus in Mestia-Tianeti Zone (Mestia-Shovi Sub-zone) as defined by I. Gamkrelidze (2000). As a result of its location on the boundary of colliding tectonic plates, according to the current Georgian seismic zoning classification the project is in hazardous zone 9 (the zone with greatest hazard). The design criteria for earthquake loads and resistance of structures must be defined in accordance with applicable standards and regulations.

The following Google Earth image shows the locations of earthquakes with a Magnitude of 5 and above, within Lower Svaneti region, taken from the United States Geological Survey databases of historic major earthquakes and of recent earthquakes.

Table 7: Significant Earthquake Data



Date	Name	Mag.	MMI	Deaths	Damage
April 14, 1275	Georgia	6.7		100-1000	Severe
1283		6.3			
1350	Adishi Area	6.5			
1688		5.3			
September 22, 1888		6.1			
December 31, 1899		5.6			
Feb 20, 1920	Gori, Tiflis	6.2		100-1000	Severe
May 7, 1940		6.0			
May 13, 1986		5.6			
April 29, 1991	Racha: Dzhava, Chiatura, Ambrolauri	7.3	9	270	Extreme
June 15, 1991	Dzhava, Tskhinvali, Ossetia	6.5	8	8	Severe
October 23, 1992		6.8			

Data are from the United States Geological Survey, National Earthquake Information Center, on-line Earthquake Database: http://earthquake.usgs.gov/earthquakes/eqarchives/epic/

3.3 FUTURE GEOLOGICAL INVESTIGATIONS

A site-specific geologic investigation will be required during the feasibility and design stages of project development. This will probably include core drilling, geophysical investigations, and detailed field mapping of the area. Rock testing for tunnel construction planning and support design will also be needed.

4.0 HYDROPOWER PROJECT DESCRIPTION

4.1 GENERAL

The Zeskho 1 HPP development is expected to include diversion weirs across the Zeskho and Koruldashi Rivers, intake structures, de-silting structures, two open canals, free-flow tunnel, pressure tank, penstock and surface powerhouse. A substation will be located near the plant. A 35 kV transmission line will connect Zeskho 1 SS to the potential Zeskho 2 SS.

A short, tailrace channel will convey water from the powerhouse to the Tskhenistskali River.

The power plant may be called on to work in island mode as well as in synchronization with the national power grid, allowing both direct and grid-connected supplies to consumers. To allow continuous operation of the Zeskho 1 plant, sufficient auxiliary backup power (probably a diesel generator) will be provided to allow black-starts when this plant is isolated from the national transmission network (island mode).

4.2 DIVERSION FACILITIES

The diversions for the run-of-river Zeskho 1 HPP will be located on the Zeskho and Koruldashi Rivers. They will include sluice gates and a short concrete overflow spillway section. One of the intake structures will be located on the right-bank of the Zeskho River and another one on the left-side of the Koruldashi River. Both of them will include bar racks to stop large debris, a bulkhead gate for maintenance purposes, and a hydraulically operated wheel gate to provide the normal shutoff capacity.

The flow from the intakes will enter a transition section leading to a de-silting structures controlled by gates. The de-silting structures will direct the flow into the free-flow tunnels through the open canal. It will be important to design the diversion facilities so that an ice cover will develop over the entire pond during the winter. That will minimize the likelihood of problems with frazil ice clogging the waterways. Gates should probably be insulated where exposed on the downstream sides, and heating the gates and gate seals may be needed to provide reliable operation during very cold periods.

4.3 WATER CONDUCTORS

The main water conductor will be a free-flow tunnel from the de-silting structure to the proposed powerhouse. It may be excavated using drill and blast methods or a tunnel boring machine, and the finished tunnel cross-section will depend on the method selected.

Based on the limited information available from existing geologic mapping and from field visits to the project location, it appears that most of the tunnel length can be supported during construction and long-term operation using rock bolts, steel mesh, and shotcrete.

A 2.4 m-diameter steel penstock, about 650 m long, is proposed to carry the flow from the pressure tank to the powerhouse below.

4.4 POWER PLANT

The powerhouse is expected to be a surface structure located in the north of the Zeskho and Koruldashi Rivers' confluence.

This installation will result in a maximum electric power output, at the high-voltage transformer terminals, of about 25.3 MW, as shown in the following table:

Table 8: Zeskho 1 HPP Power and Energy Calculations

Calculations for Average Monthly Flows												
Zeskho riv. Streamflow gauge Zeskho						F= 44.8 km^2			1961-80			
I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Average**
1.49	1.44	1.46	2.68	6.02	8.08	8.97	6.65	3.7	2.63	1.98	1.65	3.896
Zeskho riv. ▼1740						F= 52.86 km^2			K=1.1799			
2.24	2.16	2.19	4.02	9.03	12.12	13.46	9.98	5.55	3.95	2.97	2.48	5.84
Koruldashi riv. ▼1740						F= 41.59 km^2			K=0.928			
1.38	1.34	1.35	2.49	5.59	7.50	8.32	6.17	3.43	2.44	1.84	1.53	3.62
3.14	**3.04**	**3.08**	**5.65**	**12.69**	**17.03**	**18.91**	**14.02**	**7.80**	**5.54**	**4.17**	**3.48**	**8.21**

Zeskho 1 HPP																
Hydropower Calculations for Average Monthly Flows														Q_{HPP}=	13	m^3/sec
Months	Mean Monthly River flow Q_{riv}, m^3/sec	Percent of mean monthly flow, %	Bypassed Flow Q, m^3/sec	Extra Flow Q, m^3/sec	HPP Flow Q_{HPP}, m^3/sec	Diversion water level elevation ▼$_{upstream}$ m	Tailwater elevation, ▼$_{downstream}$ m	Gross head H_{gross}, m	Total head loss Sh, m	Net head, H_{net}, m	Turbine efficiency h_t, %	Turbine total capacity N_t, kW.	Generator efficiency h_g, %	Unit capacity N_u, kW.	Number of hours per month T h.	Generated Energy, GWh.
I	**3.14**	10	0.31	_	**2.83**	1,750	1,510	240	8.94	231.06	0.90	5,767	0.96	5,536	744	4.119
II	**3.04**	10	0.30	_	**2.73**	1,750	1,510	240	8.94	231.06	0.90	5,573	0.96	5,350	672	3.595
III	**3.08**	10	0.31	_	**2.77**	1,750	1,510	240	8.94	231.06	0.90	5,651	0.96	5,424	744	4.036
IV	**5.65**	10	0.56	_	**5.08**	1,750	1,510	240	9.08	230.92	0.90	10,366	0.96	9,951	720	7.165
V	**12.69**	6	0.82	_	**11.87**	1,750	1,510	240	10.02	229.98	0.90	24,102	0.96	23,137	744	17.214
VI	**17.03**	24	0.82	3.21	**13.00**	1,750	1,510	240	10.24	229.76	0.90	26,371	0.96	25,316	720	18.228
VII	**18.91**	31	0.82	5.09	**13.00**	1,750	1,510	240	10.24	229.76	0.90	26,371	0.96	25,316	744	18.835
VIII	**14.02**	7	0.82	0.20	**13.00**	1,750	1,510	240	10.24	229.76	0.90	26,371	0.96	25,316	744	18.835
IX	**7.80**	10	0.78	_	**7.02**	1,750	1,510	240	9.27	230.73	0.90	14,299	0.96	13,727	720	9.883
X	**5.54**	10	0.55	_	**4.99**	1,750	1,510	240	9.08	230.92	0.90	10,173	0.96	9,766	744	7.266
XI	**4.17**	10	0.42	_	**3.76**	1,750	1,510	240	8.99	231.01	0.90	7,661	0.96	7,355	720	5.295
XII	**3.48**	10	0.35	_	**3.13**	1,750	1,510	240	8.95	231.05	0.90	6,385	0.96	6,130	744	4.561
Gross average annual generation including losses														**119.032**	GWh	
Estimated energy losses from outages, substation losses 5%														**5.952**	GWh	
Average annual energy for sale														**113.080**	GWh	
HPP operation duration per year														**4,702**	h	
Capacity usage ratio/efficiency (plant factor)														**0.54**		

5.0 POWER AND ENERGY STUDIES

5.1 AVAILABLE FLOW DATA

Monthly streamflow data were used for this study. Daily data exists, but only part of it was available to us. The following table lists the gauging station data that is believed to be available, and the current status of data collection:

Table 9: Stream Gauges in the Tskhenistskali Watershed

River	Location	Drainage Area, km^2	Period of Record	Gauge Owner	Comments
Zeskho	Zeskho	44.8	1961-80	HydroMet	have monthly
Koruldashi	Tsana	44.4	1935-40	HydroMet	very limited monthly data
Tskhenistskali	Luji	506	1932-43;1947-51;1953-80	HydroMet	have monthly, daily flows 1955-93
Tskhenistskali	Leqsura	760	1934-41	HydroMet	have monthly
Tskhenistskali	Lentekhi	1200	1955-65	HydroMet	have monthly
Tskhenistskali	Rtskhmeluri	1450	1935-37;1939-41,1949-53;1958-80	HydroMet	have monthly, daily flows 1935-37;1939-41;1959-90
Tskhenistskali	Gautskinari	1950	1960-80	HydroMet	have monthly

Note: data from the shaded station are being used in this study.

Drainage areas for the sub-basins have been computed using a digital terrain model of the upper Tskhenistskali River basin, developed from Soviet topography. These numbers have been supplemented and checked using areas measured from Soviet-era topographic maps using AutoCAD.

5.2 BYPASS (SANITARY) FLOWS

Georgian regulations require a part of the total flow in a stream to remain in that stream when water is diverted for hydroelectric power generation, irrigation, water supply, or other use. This bypass flow is often referred to as a "sanitary" flow, since a major purpose of the rule is to ensure that human and other waste products entering the stream bypass reach are diluted. In practice, sanitary flow is set as a 10 percent of the mean annual flow for the majority of studies in Georgia.

Modern hydroelectric practice considers biological habitat needs (and, sometimes, aesthetic and recreational concerns) when determining bypass flow. In-stream flow requirements to maintain healthy conditions for fish and other inhabitants are generally higher than the sanitary flows. They must generally be determined by environmental studies conducted during the feasibility or design stages of project development. In this study, assumed levels of bypass flow that vary from month to month have been adopted to estimate the flow actually available for the power generation. During low flow season, sanitary flow is set at 10% of the mean monthly flow, while for the rest of the period sanitary flow could be calculated as 10% of the mean annual flow, as is shown in Table 8. In practice, sanitary flow would probably be higher between the intake structure and the powerhouse due to the added inflow from the tributaries. However, it is recommended to carry out further detailed study of the bypass flow during the Feasibility Study.

6.0 ENVIRONMENTAL AND SOCIAL STUDIES

6.1 ENVIRONMENTAL RECEPTOR IMPACTS & MITIGATION PRACTICES

General Categories for Environmental Receptors:

Surface Water Resources (Quantity, Water Quality, Flood Risk)
Land Cover
Air Quality
Geology and Soils
Cultural Heritage and Recreational Resources
Biodiversity (flora, fauna, etc.)
Community and Socio-Economic

Appendix 9 contains a detailed series of tables that have been created to help development team members identify and evaluate the environmental, social, cultural, and other impact categories that are likely to be important when considering a small- to medium-size, run-of-river development in Georgia.

This material is necessarily preliminary, since detailed studies of the project and the affected environment have not been started yet, but can provide general guidance when developing a study program. As noted in the Appendix, the material is based on procedures adopted by the European Union (EU).

Affected Environment Assessment: The Zeskho 1 HPP has two hydropower development activity periods that will impact environmental receptors, over different time horizons, and at different risk or impact levels. The following are the activity periods of interest:

Construction: Compared to the lifecycle of the facility this is a short term impact period of approximately 3 years. It includes all phases of construction from initial land and water resource disturbance to startup of plant operations.

Operations: The time horizon for full operational lifecycle before major component replacement is 30 to 40 years.

Risks to an environmental receptor from the activities (development and operation of the Zeskho 1 HPP) are expected to be relatively low, based on information that is available at this time. The entirety of the Zeskho 1 HPP lies within the boundaries of the Planned Protected Areas. Having said this, it is also worthy of note that the boundaries of the Planned Protected Areas are not yet legally approved (see map of the Cultural Resources and Recreation Areas in the Appendix 10).

One impact category that will be very important for most of the hydro project developments in the upper Tskhenistskali River basin is the protection and preservation of historic and cultural monuments and artifacts. Appendix 11 is a list of the many areas and specific sites in Lower Svaneti that have been officially recognized by the National Agency for Cultural Heritage Preservation of Georgia, in the Ministry of Culture. The area also includes many other un-listed resources.

In the specific case of the Zeskho 1 HPP, there are no listed or known cultural or archeological sites within or near the development area. However, during the construction period unknown archeological sites could be revealed due to the cultural and archeological diversity of the region.

From an affected natural environmental perspective, the Tskhenistskali HPP can be developed so that the project overall minimizes its construction and operations impacts on the local and watershed environment.

7.0 PROJECT COST ESTIMATE AND CONSTRUCTION SCHEDULE

7.1 ASSUMPTIONS

Our cost estimates do not include any customs duties that may be the responsibility of the contractors and/or the project owner.

The price level is September 2012. All costs were developed in US$ or were converted to US$ at exchange rates effective in September 2012.

Prices in this estimate are not based on detailed layouts or designs for project structures. Quantity takeoffs were not possible for most items. Overall costs for major works were estimated using figures from projects now under construction in Georgia and from pre-feasibility and feasibility reports recently prepared for projects that are under development at this time, adjusted to account for differences in project head, design flow, river conditions, geology, inflation, etc. Sources have included the twenty-seven pre-feasibility studies completed by HIPP, the Mtkvari HPP Feasibility Report prepared by Verkis, and the contracted prices for the Bakhvi Project construction work, among others.

Electrical and mechanical equipment prices are based on single-source procurement for supply and installation of turbines, generators, governors, inlet valves, plant protection, control, and communication systems, station AC service, station DC system, air, fire protection, cooling water, potable water, and other auxiliaries; and main power transformers, breakers, arrestors, and other substation equipment. The contracted supplier is assumed to be one of the larger, more-capable Chinese hydro equipment companies. This assumption is based solely on the lower cost usually available from China. European and American equipment will probably be more expensive, based on recent experience. It will be a developer's responsibility to select the right balance of cost versus efficiency, reliability, and support when selecting an equipment supplier.

7.2 PROJECT COST ESTIMATE

Table 10: Zeskho 1 HPP Estimated Capital Expenditure

ZESKHO 1 HPP CAPEX				
	Units	Amt	Unit Cost US$	Total US$
Land purchase	ha	5.4	$12,000	$64,800
Preparatory & infrastructure works	LS			$780,000
New access road (8 m wide gravel)	m	2,000	$91	$181,200
Improvement of existing access road	m	5,000	$23	$113,000
Stream diversion and cofferdams	LS			$273,000
Main Dams & Intake Structures	LS			$2,840,000
De-silting Structures 2 Units	m	50		$810,730
Canal	m	1,000		$717,780
Tunnel including rock bolts & shotcrete	m	5,120		$5,320,380
Pressure Tank	LS			$154,480
Steel Penstock (D=2.42m)	m	650	$2,130	$1,384,500
Above ground power house	LS			$1,450,000
Tailrace canal	m	60	$1,090	$65,400
Turbines, Generators, Governors, Auxiliaries, etc. *	MW	25.3	$200,000	$5,060,000
Transformers and Switchyard equipment*	MW	25.3	$85,000	$2,150,500
Grid connection transmission line @ 35 kV	km	5.4	$80,000	$432,000
Subtotal of Schedule Items				**$21,797,770**
Geology (investigation field, lab and office) @ 1.5%	LS			$327,000
Feasibility study @ 1%	LS			$218,000
EIA @ 1%	LS			$218,000
EPCM @ 14%	LS			$3,052,000
Contingencies (Assumptions Variable) @ 25%	LS			$6,403,190
Subtotal				**$32,015,960**
VAT 18%				**$5,751,210**
Total				**$37,767,170**
MW Capacity	**25.3**		**CAPEX/kW**	**$1,493**

**Equipment pricing is based on supply and installation by one of the better-quality Chinese companies.*

List of Figures

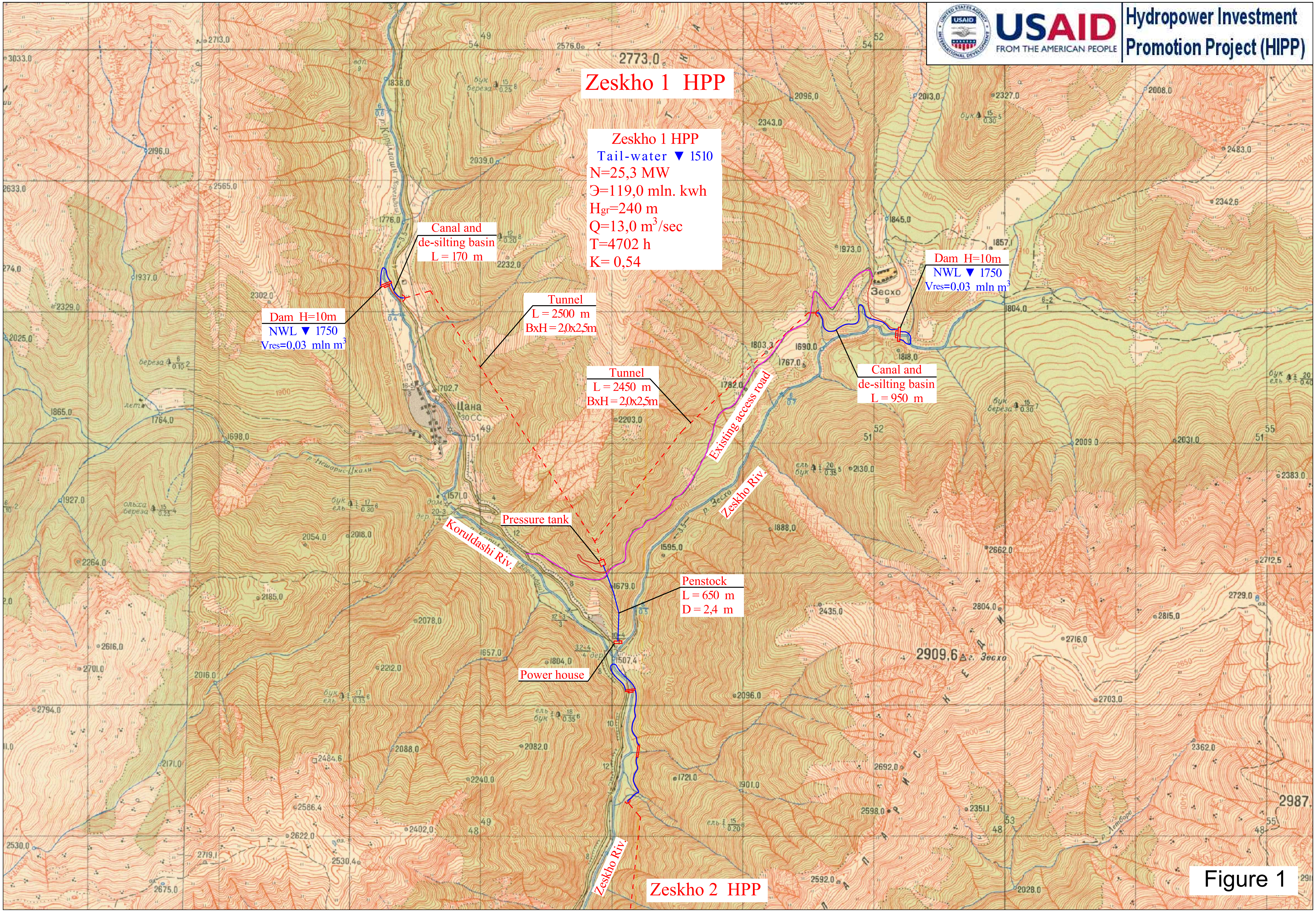

USAID
FROM THE AMERICAN PEOPLE
Hydropower Investment Promotion Project (HIPP)
Zeskho 1 HPP
Zeskho 1 HPP
Tail-water ▼ 1510
N=25,3 MW
Э=119,0 mln. kwh
Hgr=240 m
Q=13,0 m3/sec
T=4702 h
K= 0,54
Canal and de-silting basin L = 170 m
Dam H=10m
NWL ▼ 1750
Vres=0,03 mln m3
Tunnel L = 2500 m BxH = 2,0x2,5m
Tunnel L = 2450 m BxH = 2,0x2,5m
Existing access road
Dam H=10m
NWL ▼ 1750
Vres=0,03 mln m3
Canal and de-silting basin L = 950 m
Pressure tank
Koruldashi Riv.
Zeskho Riv.
Penstock L = 650 m D = 2,4 m
Power house
Zeskho Riv.
Zeskho 2 HPP

Figure 1

Figure 2

USAID FROM THE AMERICAN PEOPLE | Hydropower Investment Promotion Project (HIPP)

Upper Tskhenistskali Basin
Run-of-River Hydro Sites

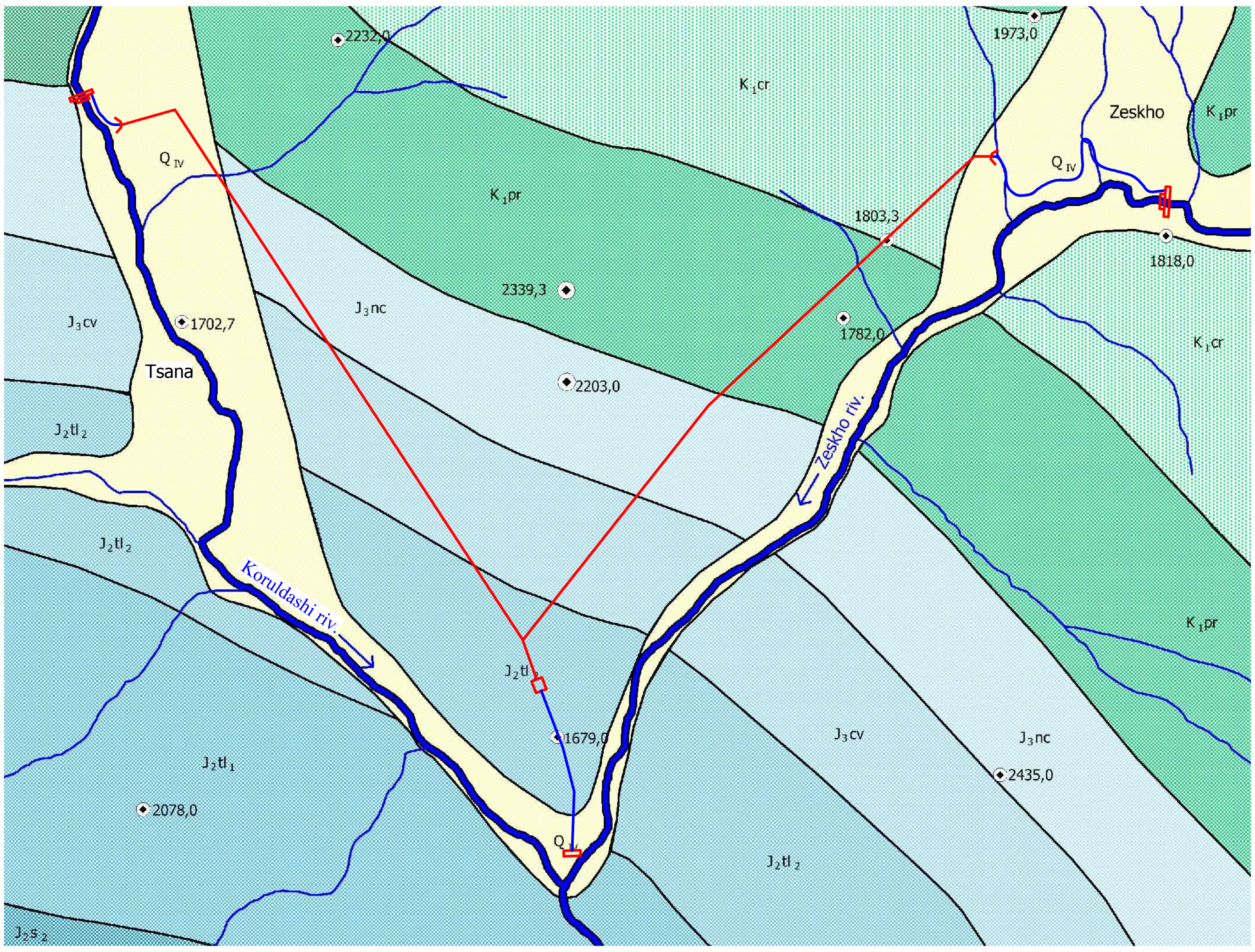
Tskhenistskali River Profile

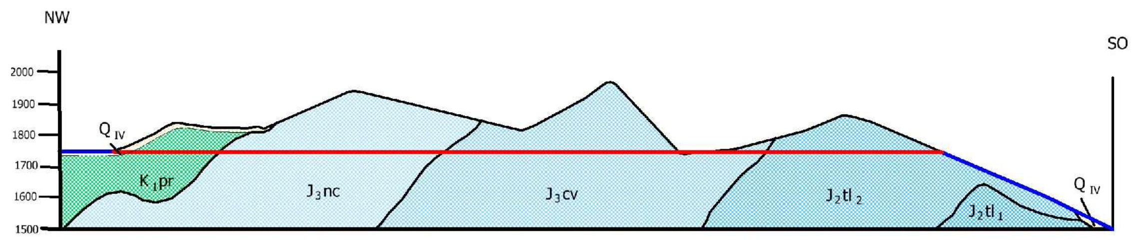
October 2012

Zeskho 1 HPP

Geological map

Scale 1:25 000





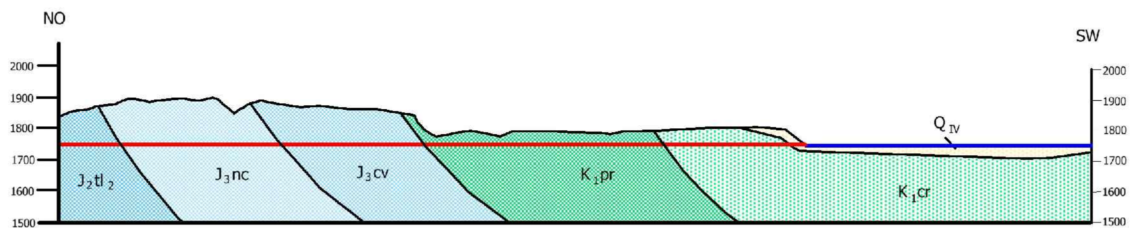


Figure 3

Figure 3A

LEGEND

System	Series	Symbol	Description
Quaternary System		Q_{IV}	Recent Sediments - Glacial and water-glacial sediments: boulders, pebbles, cobbles, proluvial - deluvial sediments (unconsolidated and semi-consolidated rocks)
Cretaceous System		$K_1\check{c}r$	Tchiora Suite: marly limestones, marls, carbonate clayshales
		K_1pr	Cretaceous System. Porkhishuli Suite - limestones, sandy and marly limestones, carbonate and micaceous shales, marls (rock mass).
Jurassic System	Upper	J_3nc	Notsarauli Suite: limestones, marls, carbonate sandstones, carbonate shales, rarely micro-conglomerates (rock mass)
		J_3cv	Chveshuri Suite: marls, carbonate shales, limestones, carbonate sandstones, sandstones, micro-conglomerates (Semi - rock and rock mass)
	Middle	J_2tl_2	Bathian stage; Upper-talakhiani Sub-suite: sandstones, sandy shales. (semi-rock mass)
		J_2tl_1	Bajocian stage; Lower-talakhiani Sub-suite: clay-sandy shales, arcosee sandstones, tuffogenic sandstones, tuffs, diabase cover layers. (Semi - rock and rock mass)
		J_2S_2	Aalenian stage; Upper Sori Suite: sandstones and clay-shales (semi-rocky mass)
	Lower	$J_1^3S_1$	Toarcian stage; Lower Sori Suite: clay-shales, sandstones (semi-rock mass)
		$J_1^2ms_2$	Muashi Suite. Upper sub-suite: clayshales, aspid shales, quarts sandstones (semi-rock and rock mass)
		$J_1^2ms_1$	Muashi Suite. Lower sub-suite: aspid shales, clayshales, quarts sandstones, argillites, diabase layered veins (rock and rock-free mass)
		$J_1^1mr_2$	Morgouli Suite upper sub-suite: clayshales, sandstones, diabases layered veins (semi-rock and rock mass)
		$J_1^1mr_1$	Morgouli Suite tower sub-suite: clayshales, sandstones, gravelites and conglomerates
Carbon System		C_1^2Tch	Carbon System, Tskhenistskali Suite - Clay and phyllite shales, sandstones, gravelites, conglomerates (Rock and Semi-rock Mass)
		C_1^1KZ	Carbon System, Kazakhstvibi Suite - Phyllite shales, sandstones, marbleized limestones (Rock Mass)
		BN	Neogene diabases

პირობითი ნიშნები

სისტემა	განყოფილება	ინდექსი	აღწერა
მეოთხეული სისტემა		Q_{IV}	თანამედროვე ნალექები - მყინვარეული და წყალმყინვარეული ნალექები: ლოდები, კაჭარი, კენჭნარი, პროლუვიურ-დელუვიური ნალექები (შეუკავშირებელი და ნახევრადშეკავშირებული ქანები)
ცარცული სისტემა		$K_1\check{c}r$	ჭიორას წყება - მერგელოვანი კირქვები, მერგელები, კარბონატული თიხაფიქლები
		K_1pr	ცარცული სისტემა - პორხიშულის წყება: კირქვები, ქვიშიანი და მერგელოვანი კირქვები, კარბონატული და ქარსიანი ფიქლები, მერგელები (კლდოვანი ქანები)
იურული სისტემა	ზედა	J_3nc	ნოცარაულის წყება - კირქვები, მერგელები, კარბონატული ქვიშაქვები, კარბონატული ფიქლები, იშვიათად მიკროკონგლომერატები (კლდოვანი ქანები)
		J_3cv	ქვეშურის წყება - მერგელები, კარბონატული ფიქლები, კირქვები, კარბონატული ქვიშაქვები, ქვიშაქვები, მიკროკონგლომერატები (ნახევრად კლდოვანი და კლდოვანი ქანები)
	შუა	J_2tl_2	ბათის იარუსი - ზედატალახიანის ქვეწყება: ქვიშაქვები, ქვიშიანი ფიქლები. (ნახევრადკლდოვანი ქანები)
		J_2tl_1	ბაიოსის იარუსი - ქვედატალახიანის ქვეწყება: თიხაქვიშიანი ფიქლები, არკოშული ქვიშაქვები, ტუფოგენური ქვიშაქვები, ტუფები, დიაბაზის განფენები. (ნახევრადკლდოვანი და კლდოვანი ქანები)
		J_2S_2	აალენის იარუსი - ზედა სორის წყება: ქვიშაქვები და თიხაფიქლები (ნახევრადკლდოვანი ქანები)
	ქვედა	$J_1^3S_1$	ტოარის იარუსი - ქვედა სორის წყება: თიხაფიქლები, ქვიშაქვები (ნახევრადკლდოვანი ქანები)
		$J_1^2ms_2$	ზედა ქვეწყება - თიხაფიქლები, ასპიდური ფიქლები, კვარცული ქვიშაქვები (ნახევრადკლდოვანი და კლდოვანი ქანები)
		$J_1^2ms_1$	ქვედა ქვეწყება: ასპიდური ფიქლები, თიხაფიქლები, კვარცული ქვიშაქვები, არგილიტები, დიაბაზების ფენებრივი ძარღვები (კლდოვანი და არაკლდოვანი ქანები)
		$J_1^1mr_2$	მორგოულის წყების ზედა ქვეწყება: თიხაფიქლები, ქვიშაქვები, დიაბაზების ფენებრივი ძარღვები (ნახევრადკლდოვანი და კლდოვანი ქანები)
		$J_1^1mr_1$	მორგოულის წყების ქვედა ქვეწყება: თიხაფიქლები, ქვიშაქვები, გრაველიტები და კონგლომერატები
კარბონული სისტემა		C_1^2Tch	კარბონული სისტემა: ცხენისწყალის წყება - თიხა და ფილიტიზებული ფიქლები, ქვიშაქვები, გრაველიტები, კონგლომერატები (კლდოვანი და ნახევრადკლდოვანი ქანები)
		C_1^1KZ	კარბონული სისტემა: კაზახტვიბის წყება - ფილიტიზებული ფიქლები, ქვიშაქვები, გამარმარილოებული კირქვები (კლდოვანი ქანები)
		BN	ნეოგენის ასაკის დიაბაზები

Figure 3B

	Recent exogenic geological processes
	Active landslide in surface sediments
	Complex active landslide
	Mudflow source area
	Mudflow
	Avalanche risky zone
	Side erosion
	Landslide spreading area

	თანამედროვე ექზოგენური გეოლოგიური პროცესები
	აქტიური მეწყერი ზედაპირულ ნალექებში
	რთული აქტიური მეწყერი
	ღვარცოფული კერა
	ღვარცოფული ნაკადი
	ზვავსაშიში, ნამქერსაშიში უბანი
	გვერდითი ეროზია
	მეწყრების გავრცელების უბანი

	Base rocks weathering degree
	Boulder-bed
	Boulder-debris
	Debris - crushed
	Crushed-clayey
	Clayey-crushed

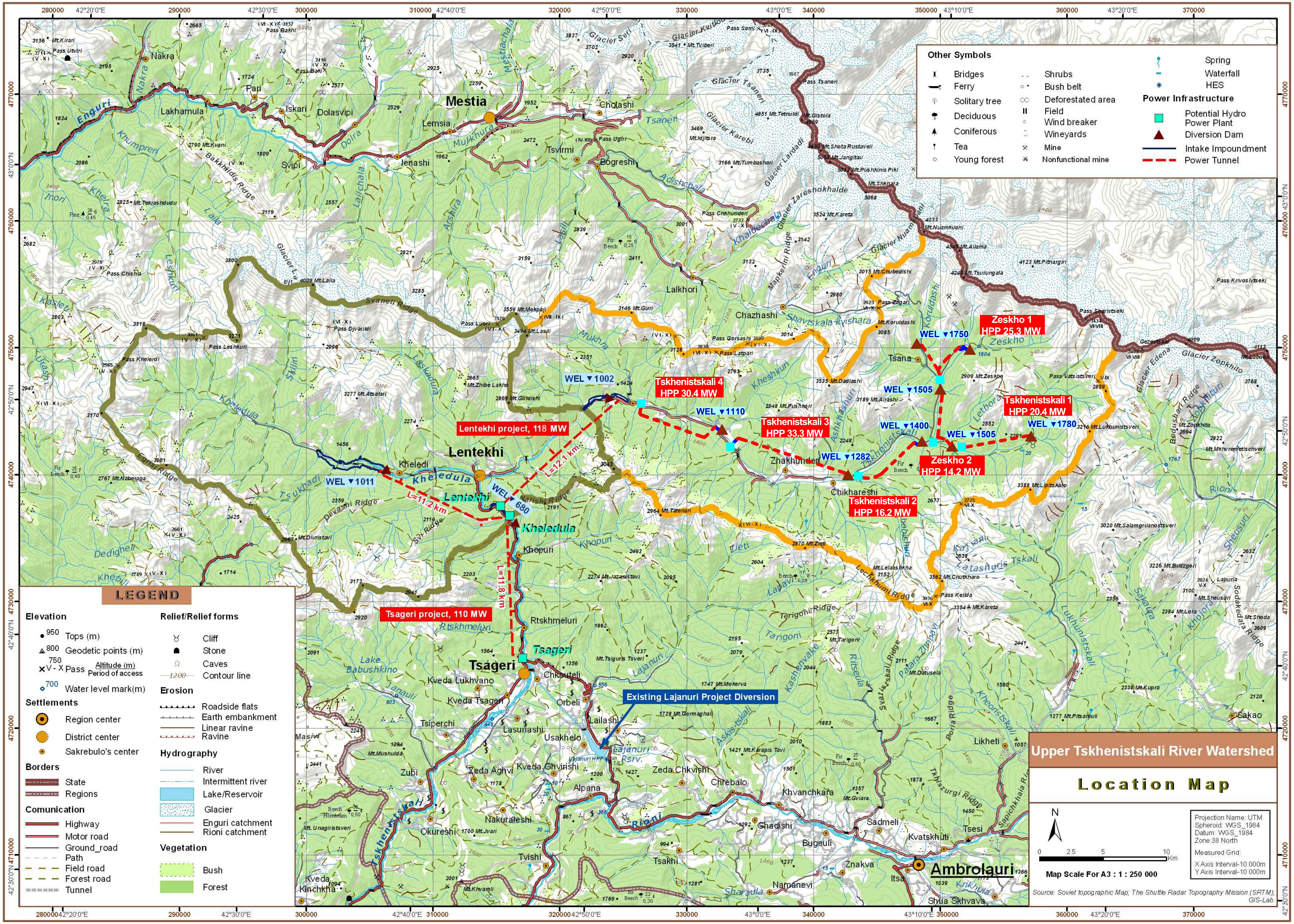
	ძირითადი ქანების გამოფიტვის ხასიათი
	ლოდნარი
	ლოდნარ - ნატეხოვანი
	ნატეხოვან - ღორღიანი
	ღორღიან - თიხიანი
	თიხიან - ღორღიანი

	Tectonic contacts
40	Thickness of quaternary system sediments in meter

	ტექტონიკური კონტაქტები
40	მეოთხეული სისტემის ნალექების სიმძლავრე მეტრებში

APPENDIX 1

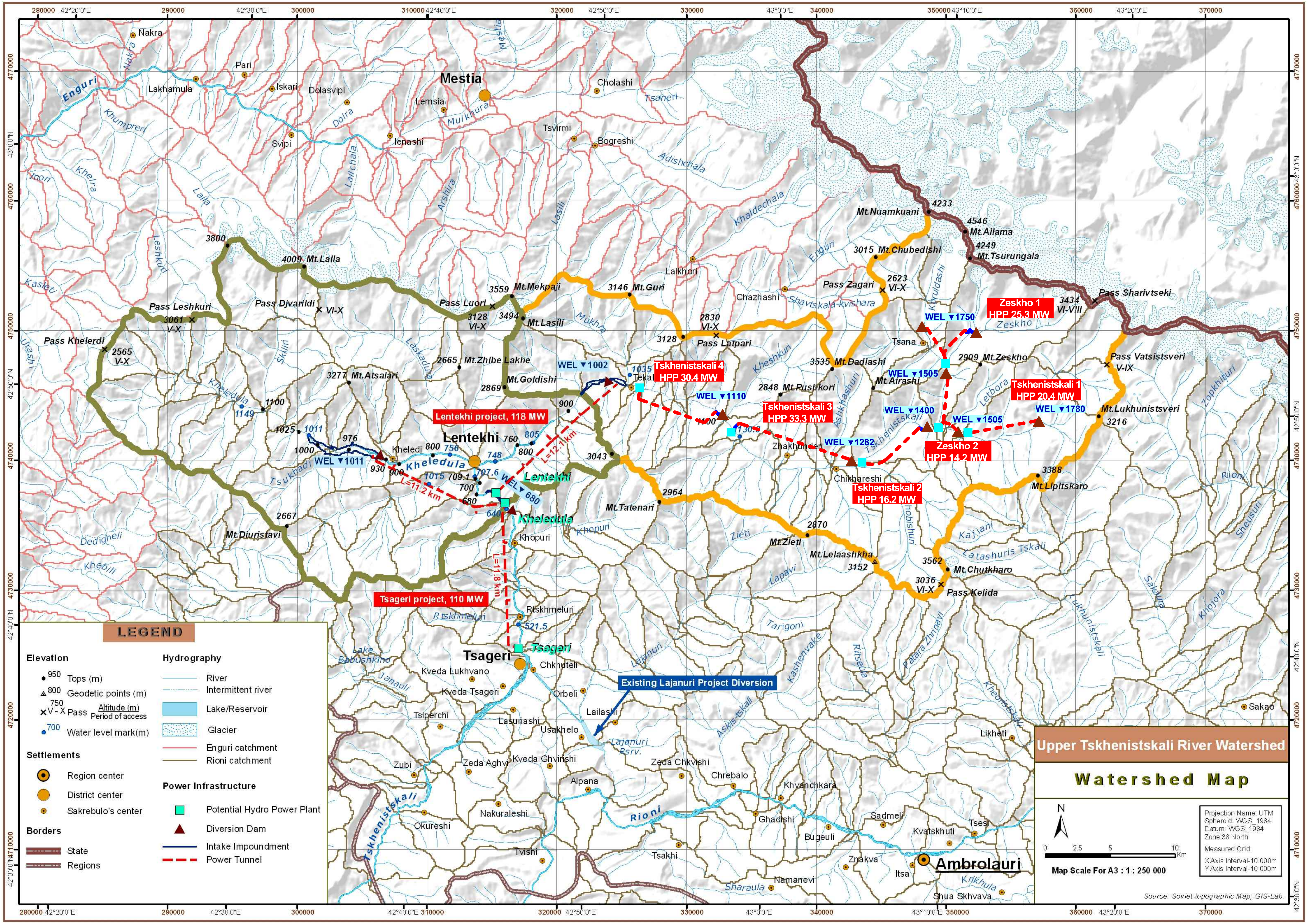
Location Map



Upper Tskhenistskali River Watershed
Location Map
Other Symbols
Bridges
Ferry
Solitary tree
Deciduous
Coniferous
Tea
Young forest
Shrubs
Bush belt
Deforested area
Field
Wind breaker
Wineyards
Mine
Nonfunctional mine
Spring
Waterfall
HES
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Intake Impoundment
Power Tunnel
LEGEND
Elevation
Tops (m)
Geodetic points (m)
Pass
Altitude (m)
Period of access
Water level mark(m)
Settlements
Region center
District center
Sakrebulo's center
Borders
State
Regions
Comunication
Highway
Motor road
Ground_road
Path
Field road
Forest road
Tunnel
Relief/Relief forms
Cliff
Stone
Caves
Contour line
Erosion
Roadside flats
Earth embankment
Linear ravine
Ravine
Hydrography
River
Intermittent river
Lake/Reservoir
Glacier
Enguri catchment
Rioni catchment
Vegetation
Bush
Forest
Zeskho 1 HPP 25.3 MW
Tskhenistskali 4 HPP 30.4 MW
Tskhenistskali 3 HPP 33.3 MW
Tskhenistskali 1 HPP 20.4 MW
Zeskho 2 HPP 14.2 MW
Tskhenistskali 2 HPP 16.2 MW
Lentekhi project, 118 MW
Tsageri project, 110 MW
Existing Lajanuri Project Diversion
WEL ▼1750
WEL ▼1505
WEL ▼1002
WEL ▼1110
WEL ▼1400
WEL ▼1282
WEL ▼1780
WEL ▼1011
WEL ▼680
L=11.2 km
L=12.1 km
L=11.8 km
Mestia
Lentekhi
Tsageri
Ambrolauri
Map Scale For A3 : 1 : 250 000
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m
Source: Soviet topographic Map; The Shuttle Radar Topography Mission (SRTM), GIS-Lab.

APPENDIX 2

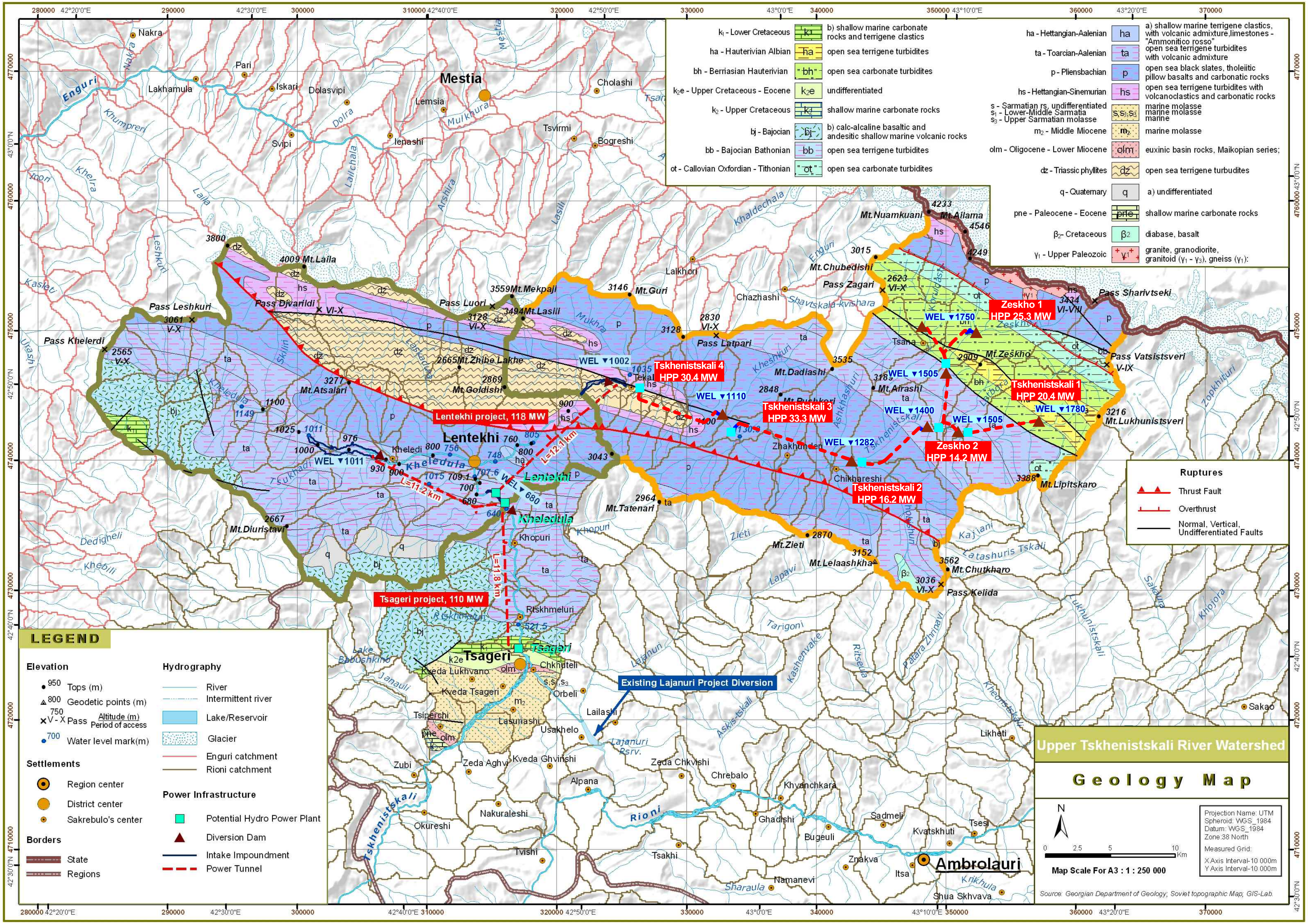
Watershed Map



Upper Tskhenistskali River Watershed
Watershed Map
LEGEND
Elevation
950 Tops (m)
800 Geodetic points (m)
750 V - X Pass Altitude (m) Period of access
700 Water level mark(m)
Settlements
Region center
District center
Sakrebulo's center
Borders
State
Regions
Hydrography
River
Intermittent river
Lake/Reservoir
Glacier
Enguri catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Intake Impoundment
Power Tunnel
Lentekhi project, 118 MW
Tsageri project, 110 MW
Tskhenistskali 4 HPP 30.4 MW
Tskhenistskali 3 HPP 33.3 MW
Tskhenistskali 2 HPP 16.2 MW
Tskhenistskali 1 HPP 20.4 MW
Zeskho 1 HPP 25.3 MW
Zeskho 2 HPP 14.2 MW
Existing Lajanuri Project Diversion
L=11.2 km
L=12.1 km
L=11.8 km
WEL ▼1011
WEL ▼680
WEL ▼1002
WEL ▼1110
WEL ▼1282
WEL ▼1400
WEL ▼1505
WEL ▼1750
WEL ▼1780
Lentekhi
Kheledula
Tsageri
Mestia
Ambrolauri
Enguri
Rioni
Tskhenistskali
Mt.Laila
Mt.Mekpaji
Mt.Guri
Mt.Dadiashi
Mt.Nuamkuani
Mt.Ailama
Mt.Tsurungala
Mt.Chubedishi
Mt.Zeskho
Mt.Airashi
Mt.Pushkori
Mt.Lukhunistsveri
Mt.Lipitskaro
Mt.Chutkharo
Mt.Lelaashkha
Mt.Zieti
Mt.Tatenari
Mt.Diuristavi
Mt.Atsalari
Mt.Zhibe Lakhe
Mt.Goldishi
Mt.Lasili
Pass Leshkuri
Pass Djvaridi
Pass Kheledi
Pass Luori
Pass Latpari
Pass Zagari
Pass Sharivtseki
Pass Vatsistsveri
Pass Kelida
N
0 2.5 5 10 Km
Map Scale For A3 : 1 : 250 000
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m
Source: Soviet topographic Map; GIS-Lab.

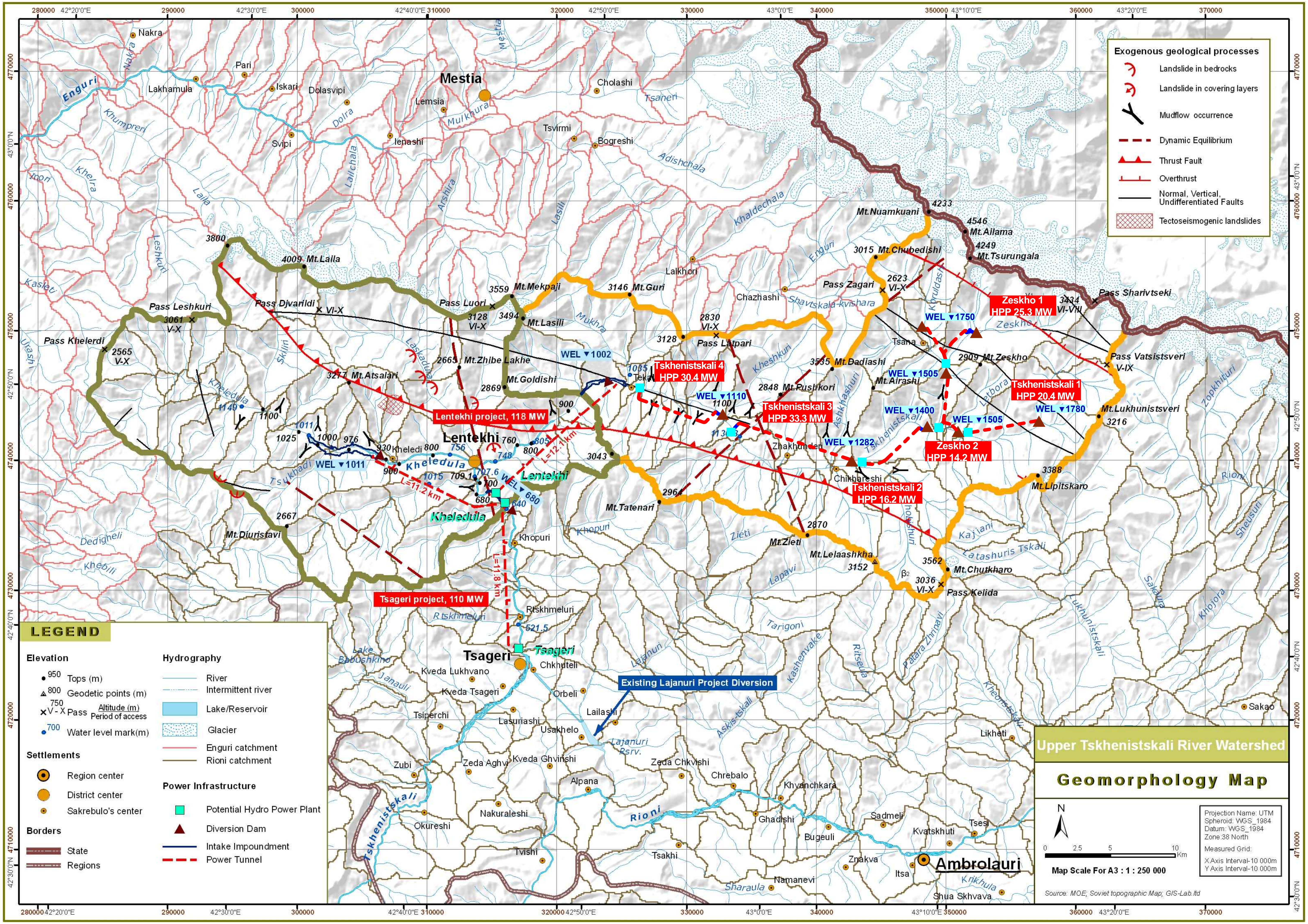
APPENDIX 3

Geology Map


Upper Tskhenistskali River Watershed
Geology Map
LEGEND
Elevation
950 Tops (m)
800 Geodetic points (m)
750 V - X Pass Altitude (m) Period of access
700 Water level mark(m)
Settlements
Region center
District center
Sakrebulo's center
Borders
State
Regions
Hydrography
River
Intermittent river
Lake/Reservoir
Glacier
Enguri catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Intake Impoundment
Power Tunnel
k1 - Lower Cretaceous: b) shallow marine carbonate rocks and terrigene clastics
ha - Hauterivian Albian: open sea terrigene turbidites
bh - Berriasian Hauterivian: open sea carbonate turbidites
k2e - Upper Cretaceous - Eocene: undifferentiated
k2 - Upper Cretaceous: shallow marine carbonate rocks
bj - Bajocian: b) calc-alkaline basaltic and andesitic shallow marine volcanic rocks
bb - Bajocian Bathonian: open sea terrigene turbidites
ot - Callovian Oxfordian - Tithonian: open sea carbonate turbidites
ha - Hettangian-Aalenian: a) shallow marine terrigene clastics, with volcanic admixture, limestones - "Ammonitico rosso"
ta - Toarcian-Aalenian: open sea terrigene turbidites with volcanic admixture
p - Pliensbachian: open sea black slates, tholeiitic pillow basalts and carbonatic rocks
hs - Hettangian-Sinemurian: open sea terrigene turbidites with volcanoclastics and carbonatic rocks
s - Sarmatian rs. undifferentiated; s1 - Lower-Middle Sarmatia; s3 - Upper Sarmatian molasse: marine molasse
m2 - Middle Miocene: marine molasse
olm - Oligocene - Lower Miocene: euxinic basin rocks, Maikopian series;
dz - Triassic phyllites: open sea terrigene turbudites
q - Quaternary: a) undifferentiated
pne - Paleocene - Eocene: shallow marine carbonate rocks
β2 - Cretaceous: diabase, basalt
γ1 - Upper Paleozoic: granite, granodiorite, granitoid (γ1 - γ3), gneiss (γ1):
Ruptures
Thrust Fault
Overthrust
Normal, Vertical, Undifferentiated Faults
Lentekhi project, 118 MW
Tsageri project, 110 MW
Tskhenistskali 1 HPP 20.4 MW
Tskhenistskali 2 HPP 16.2 MW
Tskhenistskali 3 HPP 33.3 MW
Tskhenistskali 4 HPP 30.4 MW
Zeskho 1 HPP 25.3 MW
Zeskho 2 HPP 14.2 MW
Existing Lajanuri Project Diversion
L=12.1 km
L=11.2 km
L=11.8 km
Mestia
Lentekhi
Tsageri
Ambrolauri
Enguri
Rioni
Tskhenistskali
Kheledula
Lajanuri Rsrv.
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m
0 2.5 5 10 Km
Map Scale For A3 : 1 : 250 000
Source: Georgian Department of Geology; Soviet topographic Map; GIS-Lab.

APPENDIX 4

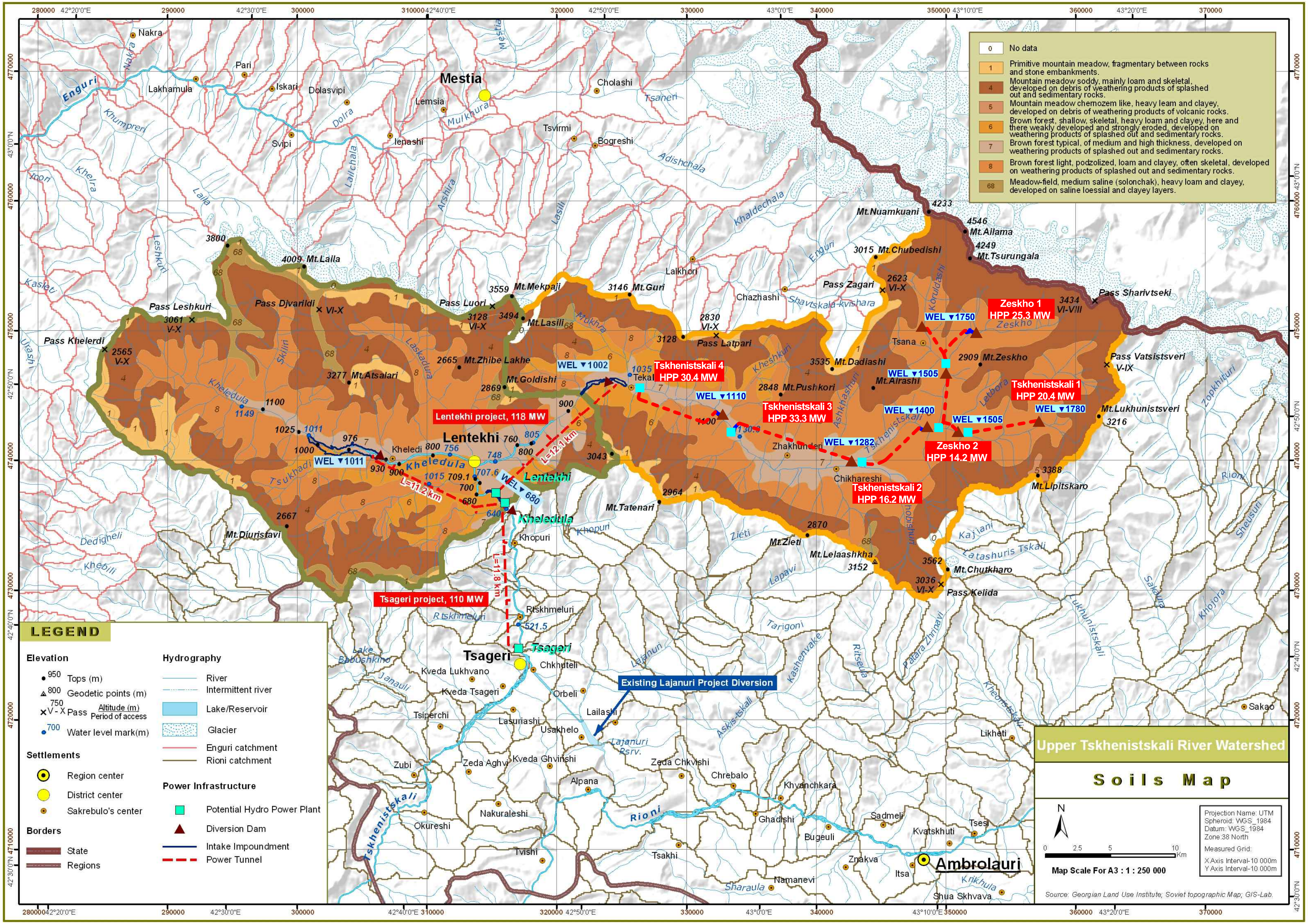
Geomorphology Map



Upper Tskhenistskali River Watershed
Geomorphology Map
LEGEND
Elevation
950 Tops (m)
800 Geodetic points (m)
750 V - X Pass Altitude (m) Period of access
700 Water level mark(m)
Settlements
Region center
District center
Sakrebulo's center
Borders
State
Regions
Hydrography
River
Intermittent river
Lake/Reservoir
Glacier
Enguri catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Intake Impoundment
Power Tunnel
Exogenous geological processes
Landslide in bedrocks
Landslide in covering layers
Mudflow occurrence
Dynamic Equilibrium
Thrust Fault
Overthrust
Normal, Vertical, Undifferentiated Faults
Tectoseismogenic landslides
Lentekhi project, 118 MW
Tsageri project, 110 MW
Tskhenistskali 4 HPP 30.4 MW
Tskhenistskali 3 HPP 33.3 MW
Tskhenistskali 2 HPP 16.2 MW
Tskhenistskali 1 HPP 20.4 MW
Zeskho 1 HPP 25.3 MW
Zeskho 2 HPP 14.2 MW
Existing Lajanuri Project Diversion
L=12.1 km
L=11.2 km
L=11.8 km
Mestia
Lentekhi
Tsageri
Ambrolauri
Mt.Laila
Mt.Mekpaji
Mt.Guri
Mt.Dadiashi
Mt.Zeskho
Mt.Lukhunistsveri
Mt.Lipitskaro
Mt.Chutkharo
Mt.Zieti
Mt.Tatenari
Mt.Diurstavi
Mt.Atsalari
Pass Leshkuri
Pass Kheleridi
Pass Djvarildi
Pass Luori
Pass Latpari
Pass Zagari
Pass Sharivtseki
Pass Vatsistsveri
Pass Kelida
Enguri
Rioni
Tskhenistskali
Kheledula
Lentekhi
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m
0 2.5 5 10 Km
Map Scale For A3 : 1 : 250 000
Source: MOE; Soviet topographic Map; GIS-Lab.ltd

APPENDIX 5

Soils Map



Upper Tskhenistskali River Watershed
Soils Map
0 No data
1 Primitive mountain meadow, fragmentary between rocks and stone embankments.
4 Mountain meadow soddy, mainly loam and skeletal, developed on debris of weathering products of splashed out and sedimentary rocks.
5 Mountain meadow chernozem like, heavy leam and clayey, developed on debris of weathering products of volcanic rocks.
6 Brown forest, shallow, skeletal, heavy loam and clayey, here and there weakly developed and strongly eroded, developed on weathering products of splashed out and sedimentary rocks.
7 Brown forest typical, of medium and high thickness, developed on weathering products of splashed out and sedimentary rocks.
8 Brown forest light, podzolized, loam and clayey, often skeletal, developed on weathering products of splashed out and sedimentary rocks.
68 Meadow-field, medium saline (solonchak), heavy loam and clayey, developed on saline loessial and clayey layers.
LEGEND
Elevation
950 Tops (m)
800 Geodetic points (m)
750 V - X Pass Altitude (m) Period of access
700 Water level mark(m)
Settlements
Region center
District center
Sakrebulo's center
Borders
State
Regions
Hydrography
River
Intermittent river
Lake/Reservoir
Glacier
Enguri catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Intake Impoundment
Power Tunnel
Lentekhi project, 118 MW
Tsageri project, 110 MW
Tskhenistskali 4 HPP 30.4 MW
Tskhenistskali 3 HPP 33.3 MW
Tskhenistskali 2 HPP 16.2 MW
Tskhenistskali 1 HPP 20.4 MW
Zeskho 1 HPP 25.3 MW
Zeskho 2 HPP 14.2 MW
Existing Lajanuri Project Diversion
L=11.2 km
L=12.1 km
L=11.8 km
WEL ▼1011
WEL ▼680
WEL ▼1002
WEL ▼1110
WEL ▼1282
WEL ▼1400
WEL ▼1505
WEL ▼1505
WEL ▼1750
WEL ▼1780
Mestia
Lentekhi
Tsageri
Ambrolauri
Map Scale For A3 : 1 : 250 000
0 2.5 5 10 Km
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m
Source: Georgian Land Use Institute; Soviet topographic Map; GIS-Lab.

APPENDIX 6

Preliminary Turbine – Generator Characteristics

TURBNPRO Version 3 - PELTON TURBINE SOLUTION SUMMARY

Solution File Name: d:₩projects₩database₩turbin~1₩zes1-4xp

TURBINE SIZING CRITERIA

Rated Discharge:	229.5	cfs	/	6.50	m3/s
Net Head at Rated Discharge:	753.9	feet	/	229.8	meters
Gross Head:	787.4	feet	/	240.0	meters
Efficiency Priority:			5		
System Frequency:			50 Hz		
Minimum Net Head:	753.9	feet	/	229.8	meters
Maximum Net Head:	769.1	feet	/	234.4	meters

PELTON TURBINE SOLUTION DATA

Arrangement: VERTICAL WITH RUNNER ON TURBINE SHAFT
Intake Type: 4 - JET
Runner Pitch Diameter: 72.2 inches / 1834 mm
Unit Speed: 333.3 rpm
Multiplier Efficiency Modifier: 1.000
Flow Squared Efficiency Modifier: 0.0000

	(US Cust.)	(SI Units)
Specific Speed at Rated Net Head (turbine) -		
At 100% Turbine Output:	11.2	42.7
At Peak Efficiency Condition:	10.2	39.0
Specific Speed at Rated Net Head (per jet) -		
At 100% Turbine Output:	5.6	21.3
At Peak Efficiency Condition:	5.1	19.5

SOLUTION PERFORMANCE DATA

At Rated Net Head of: 753.9 feet / 229.8 meters

% of Rated Discharge	Output (KW)	Efficiency (%)	cfs	m3/s
** 116.6	15215	89.0	267.7	7.58
100	13135	89.6	229.5	6.50
* 83.3	10965	89.8	191.3	5.42
75	9853	89.7	172.1	4.88
50	6492	88.6	114.8	3.25
25	3185	86.9	57.4	1.63

** - Overcapacity
* - Peak Efficiency Condition

At Maximum Net Head of: 769.1 feet / 234.4 meters

Max. Output (KW)	Efficiency (%)	cfs	m3/s
15673	89.0	270.4	7.66

At Minimum Net Head of: 753.9 feet / 229.8 meters

Max. Output (KW)	Efficiency (%)	cfs	m3/s
15220	89.0	267.7	7.58

Solution File Name: d:₩projects₩database₩turbin~1₩zes1-4xp

MISCELLANEOUS DATA

Maximum Runaway Speed (at Max. Net Head):	586 rpm
D/B Ratio (Runner Pitch Dia./Bucket Width):	2.89
Maximum Hydraulic Thrust (at Max. Net Head):	18403 lbs / 8365 kg
Hydraulic Thrust per Jet (at Max. Net Head):	13015 lbs / 5916 kg
Estimated Axial Thrust:	25298 lbs / 11499 kg
Approximate Runner and Shaft Weight:	23274 lbs / 10579 kg

DIMENSIONAL DATA

Intake Type: 4 - JET

	inches	mm
Inlet Diameter:	39.9	1013
Nozzle Diameter:	23.6	600
Jet Orifice Diameter:	7.5	192
Needle Stroke:	7.2	182
Inlet Piping Spiral Radius:	161.0	4089
Jet to Jet Included Angle:	90 Degrees	

Housing/Discharge Geometry:

	inches	mm
Centerline to Housing Top:	50.8	1290
Housing Diameter:	240.3	6104
Discharge Width:	180.2	4578
Tailwater Depth:	37.3	947
Discharge Ceiling to T.W.:	43.3	1100
Centerline to Tailwater:	118.3	3004

Shafting Arrangement: VERTICAL WITH RUNNER ON TURBINE SHAFT

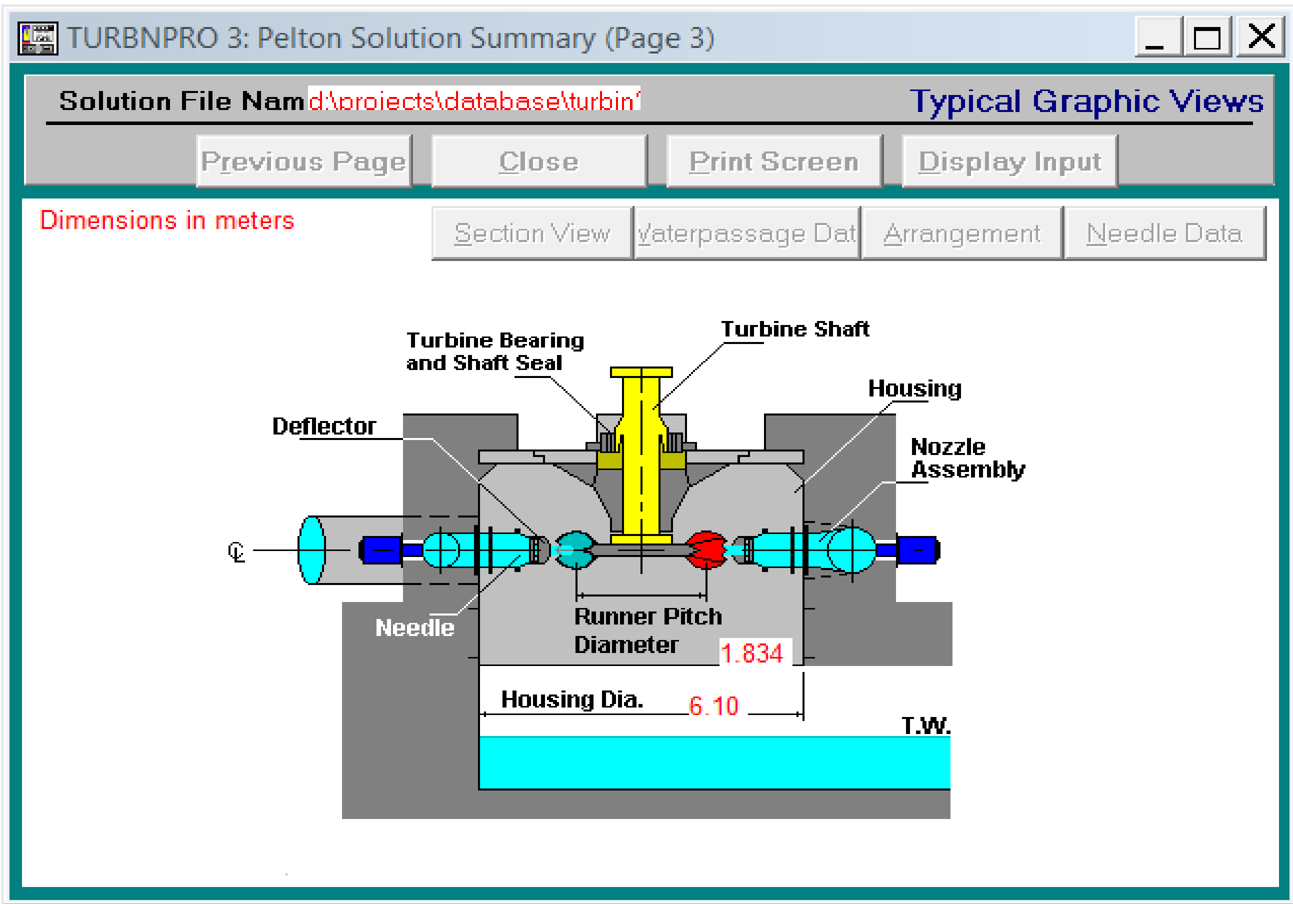
	inches	mm
Centerline to Shaft Coupling:	101.6	2580
Turbine Shaft Diameter:	17.6	447

Miscellaneous:

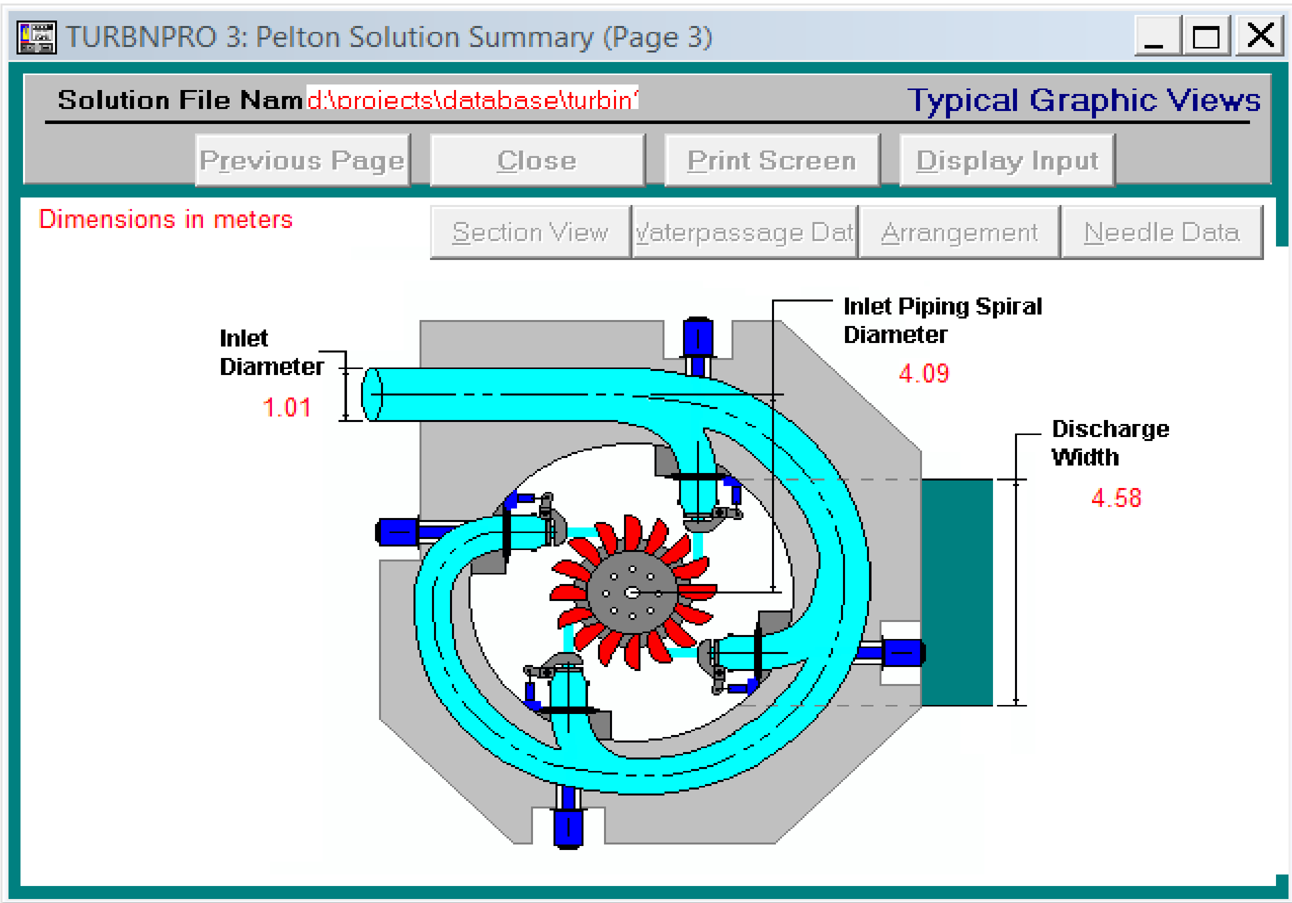
	inches	mm
Runner Outside Diameter:	97.2	2468
Runner Bucket Width:	25.0	634

**** All information listed above is typical only. Detailed characteristics will vary based on turbine manufacturer's actual designs.

Solution File Name: d:₩projects₩database₩turbin~1₩zes1-4xp
Intake Type: 4 - JET
Runner Diameter: 1834 mm
Net Head at Rated Discharge: 229.80 meters
Unit Speed: 333.3 rpm



Solution File Name: d:₩projects₩database₩turbin~1₩zes1-4xp	
Intake Type:	4 - JET
Runner Diameter:	1834 mm
Net Head at Rated Discharge:	229.80 meters
Unit Speed:	333.3 rpm



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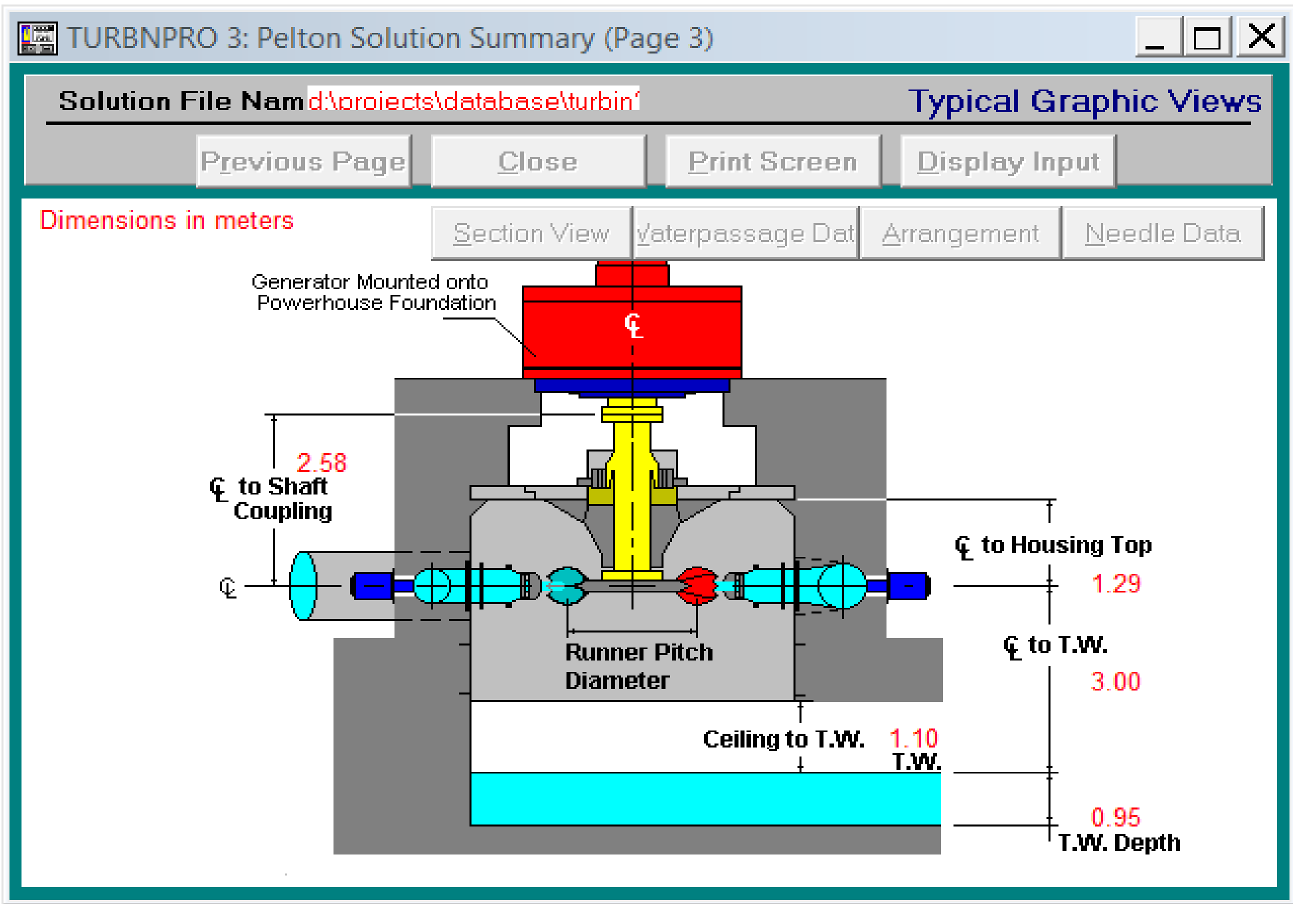
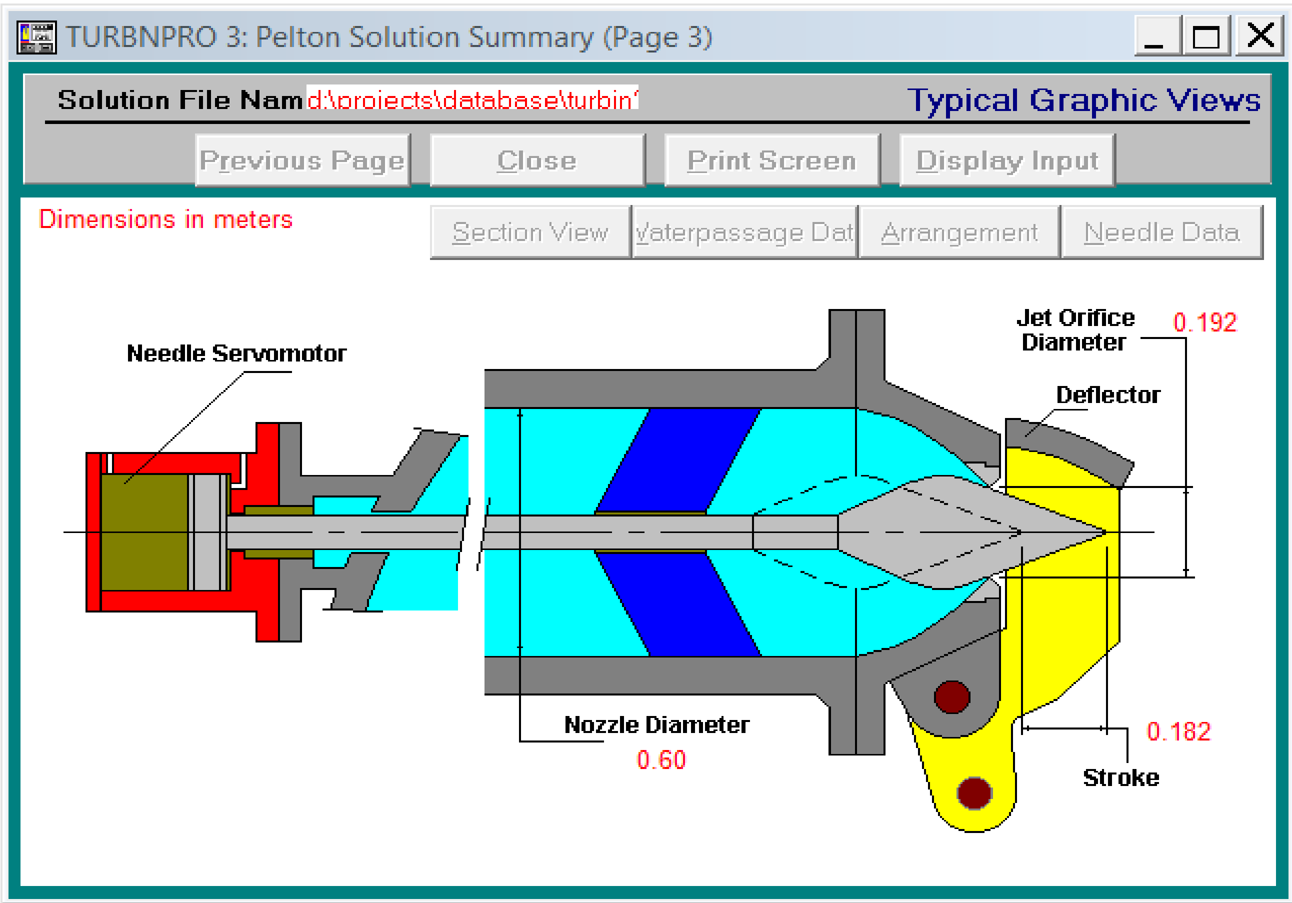
Solution File Name: d:\projects\database\turbin~1\zes1-4xp
Intake Type:                    4 - JET
Runner Diameter:                1834  mm
Net Head at Rated Discharge:    229.80  meters
Unit Speed:                     333.3  rpm
```



TURBNPRO Version 3.0 - PELTON TURBINE SOLUTION GRAPHICS

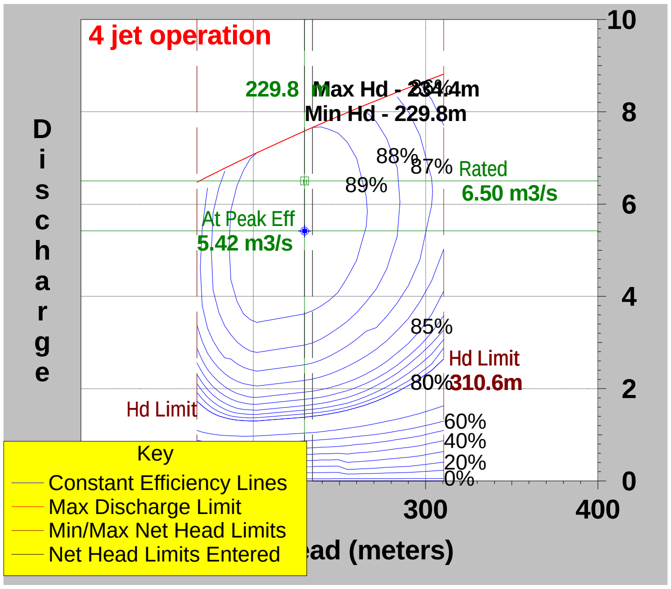
Solution File Name: d:₩projects₩database₩turbin~1₩zes1-4xp
Intake Type: 4 - JET
Runner Diameter: 1834 mm
Net Head at Rated Discharge: 229.80 meters
Unit Speed: 333.3 rpm



TURBNPRO Version 3 - PELTON TURBINE HILL CURVE

Solution File Name: d:₩projects₩database₩turbin~1₩zes1-4xp

Intake Type:	4 - JET
Runner Pitch Diameter:	1834 mm
Net Head at Rated Discharge:	229.80 meters
Unit Speed:	333.3 rpm
Peak Efficiency:	89.8 %
Multiplier Efficiency Modifier:	1.000
Flow Squared Efficiency Modifier:	0.0000



NOTE: Discharge is in cubic meters per second

TURBNPRO Version 3 - PELTON TURBINE HILL CURVE

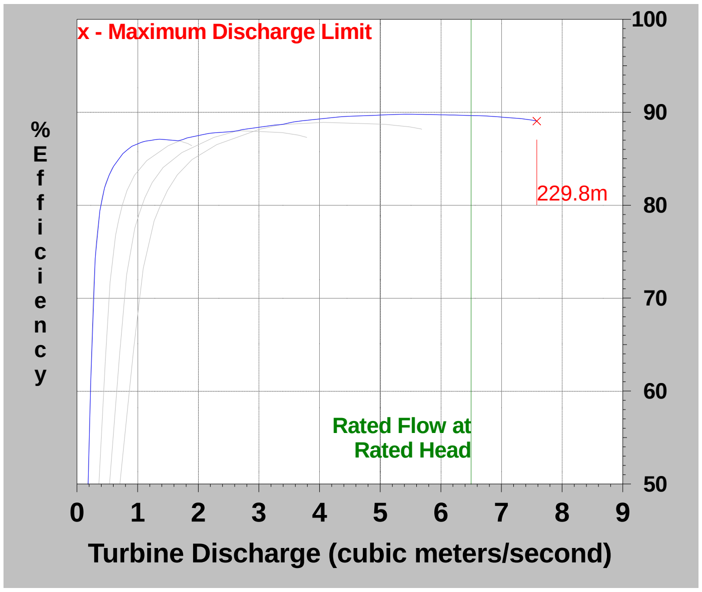
Solution File Name: d:₩projects₩database₩turbin~1₩zes1-4xp
Intake Type: 4 - JET
Runner Pitch Diameter: 1834 mm
Net Head at Rated Discharge: 229.80 meters
Unit Speed: 333.3 rpm
Multiplier Efficiency Modifier: 1.000
Flow Squared Efficiency Modifier: 0.0000

Performance Data Shown is for a Net Head of: 229.8000

Power (KW)	Efficiency (%)	Discharge (m3/s)	Operating Jets	Notes
15220	89.04	7.58	4	Max Discharge Limit
14943	89.21	7.43	4	Additional Output Capability
14659	89.33	7.28	4	Additional Output Capability
14366	89.41	7.13	4	Additional Output Capability
14072	89.48	6.98	4	Additional Output Capability
13778	89.56	6.82	4	Additional Output Capability
13479	89.61	6.67	4	Additional Output Capability
13176	89.63	6.52	4	Additional Output Capability
13135	89.64	6.50	4	Rated Flow/Head Condition
12874	89.66	6.37	4	-
12571	89.69	6.22	4	-
12267	89.71	6.07	4	-
11963	89.73	5.91	4	-
11659	89.75	5.76	4	-
11355	89.77	5.61	4	-
11051	89.79	5.46	4	-
10964	89.79	5.42	4	Best Efficiency at Net Head
10741	89.77	5.31	4	-
10429	89.73	5.16	4	-
10118	89.69	5.00	4	-
9807	89.65	4.85	4	-
9497	89.61	4.70	4	-
9186	89.57	4.55	4	-
8876	89.53	4.40	4	-
8561	89.44	4.25	4	-
8246	89.33	4.09	4	-
8140	88.90	4.06	3	Best Efficiency for 3 Jet Operation
7931	89.23	3.94	4	-
7617	89.12	3.79	4	-
7303	89.01	3.64	4	-
6984	88.83	3.49	4	-
6667	88.65	3.34	3	-
6357	88.55	3.18	3	-
6045	88.41	3.03	3	-
5733	88.26	2.88	3	-
5423	88.12	2.73	3	-
5372	88.00	2.71	2	Best Efficiency for 2 Jet Operation
5110	87.93	2.58	2	-
4806	87.86	2.43	2	-
4501	87.78	2.27	2	-
4195	87.65	2.12	2	-
3886	87.44	1.97	2	-
3579	87.23	1.82	2	-
3269	86.92	1.67	1	-
2975	87.02	1.52	1	-
2680	87.10	1.36	1	-
2659	87.10	1.35	1	Best Efficiency for 1 Jet Operation
2378	86.96	1.21	1	-
2076	86.76	1.06	1	-
1771	86.34	0.91	1	-
1462	85.54	0.76	1	-
1151	84.19	0.61	1	-
839	81.84	0.45	1	-

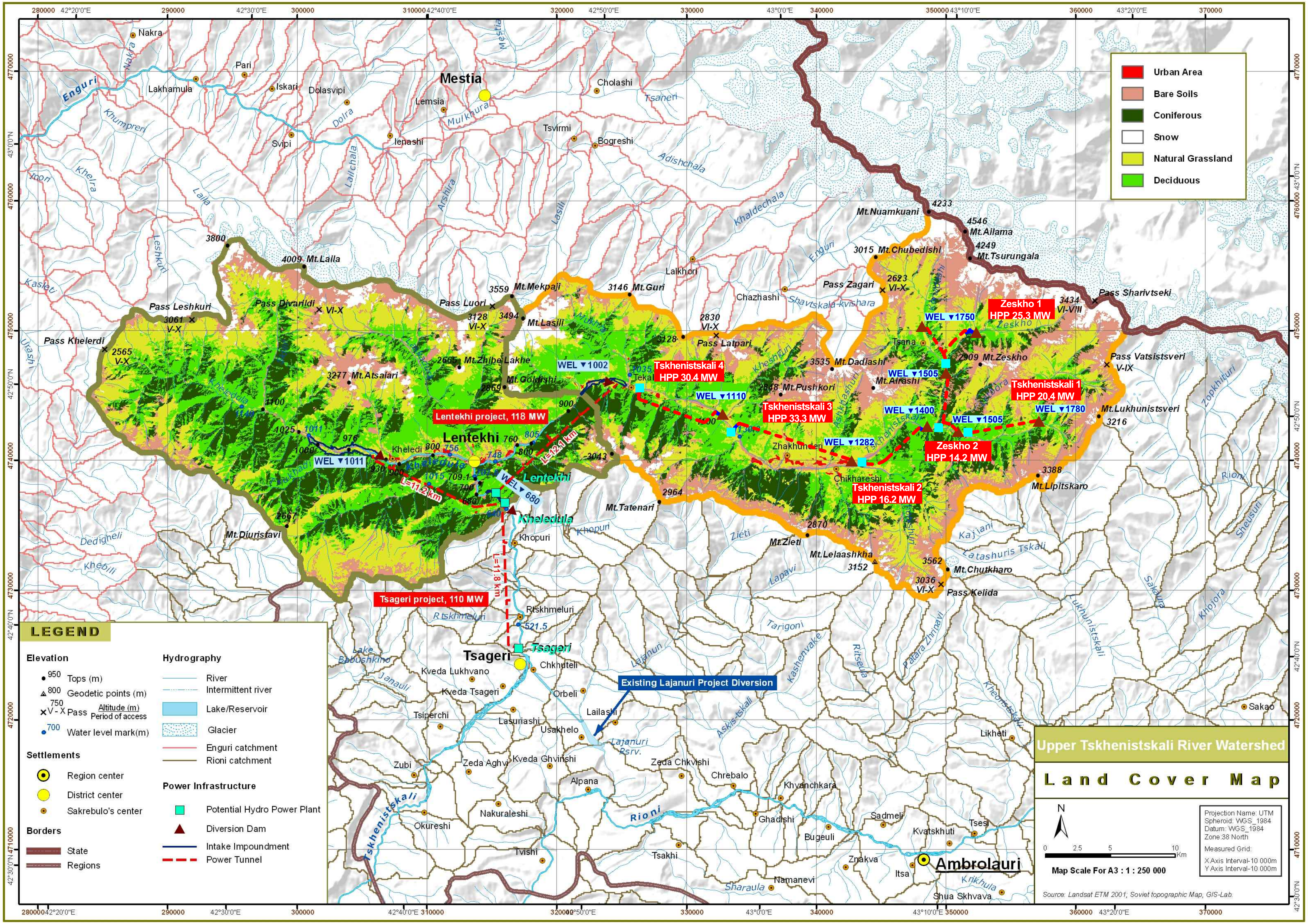
TURBNPRO Version 3 - PELTON TURBINE HILL CURVE

Power (KW)	Efficiency (%)	Discharge (m3/s)	Operating Jets	Notes
508	74.30	0.30	1	-
142	41.46	0.15	1	Low efficiency; not used in energy calculation



APPENDIX 7

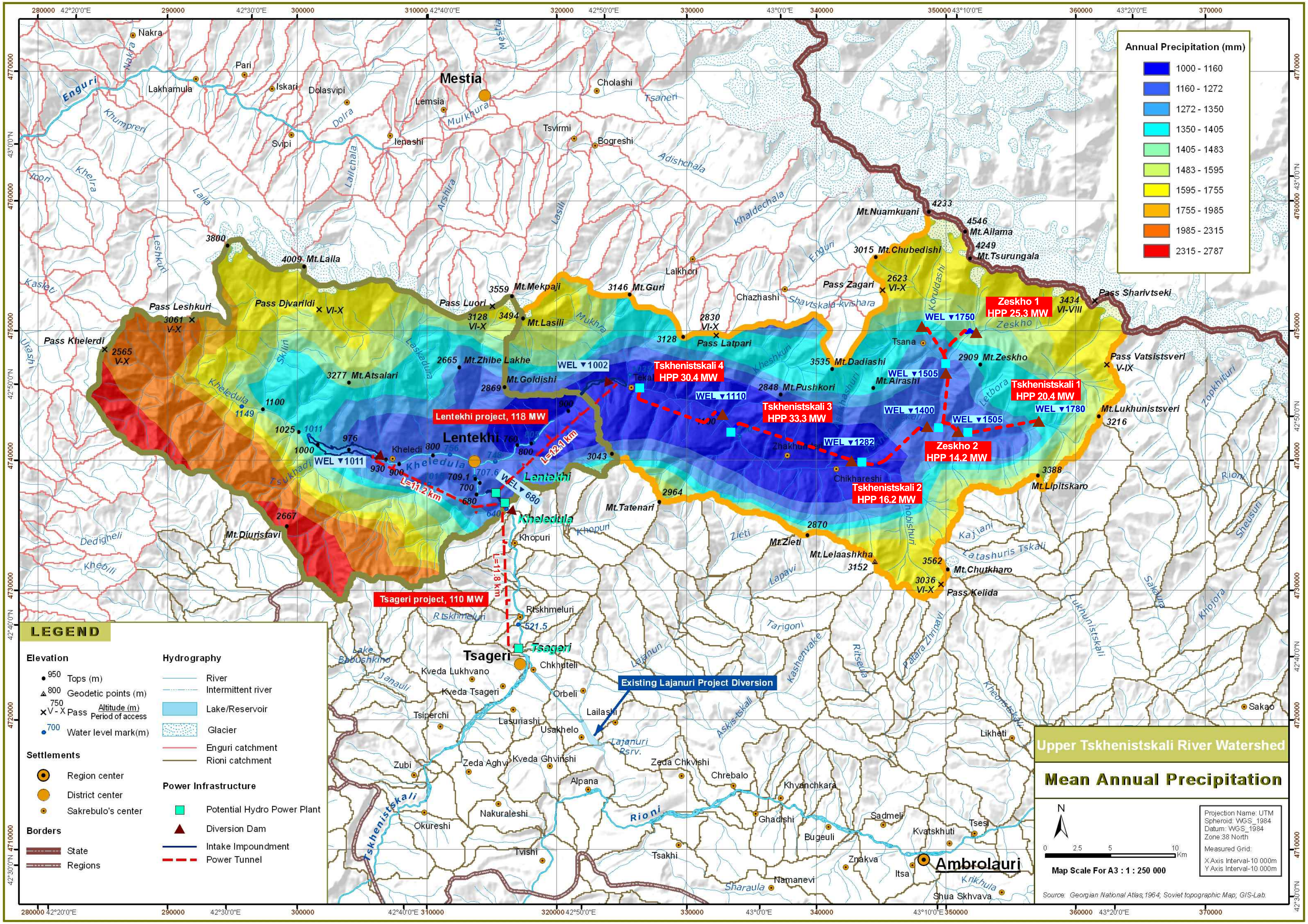
Land Cover Map



Upper Tskhenistskali River Watershed
Land Cover Map
Urban Area
Bare Soils
Coniferous
Snow
Natural Grassland
Deciduous
LEGEND
Elevation
950 Tops (m)
800 Geodetic points (m)
750 V - X Pass Altitude (m) Period of access
700 Water level mark(m)
Settlements
Region center
District center
Sakrebulo's center
Borders
State
Regions
Hydrography
River
Intermittent river
Lake/Reservoir
Glacier
Enguri catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Intake Impoundment
Power Tunnel
Lentekhi project, 118 MW
Tsageri project, 110 MW
Tskhenistskali 4 HPP 30.4 MW
Tskhenistskali 3 HPP 33.3 MW
Tskhenistskali 2 HPP 16.2 MW
Tskhenistskali 1 HPP 20.4 MW
Zeskho 1 HPP 25.3 MW
Zeskho 2 HPP 14.2 MW
Existing Lajanuri Project Diversion
L=12.1 km
L=11.2 km
L=11.8 km
WEL ▼1002
WEL ▼1011
WEL ▼680
WEL ▼1110
WEL ▼1282
WEL ▼1400
WEL ▼1505
WEL ▼1750
WEL ▼1780
Mestia
Lentekhi
Tsageri
Ambrolauri
Mt.Laila
Mt.Mekpaji
Mt.Guri
Mt.Lasili
Mt.Dadiashi
Mt.Pushkori
Mt.Nuamkuani
Mt.Ailama
Mt.Tsurungala
Mt.Chubedishi
Mt.Zeskho
Mt.Lukhunistsveri
Mt.Lipitskaro
Mt.Chutkharo
Mt.Lelaashkha
Mt.Zieti
Mt.Tatenari
Mt.Diuristavi
Mt.Atsalari
Mt.Goldishi
Pass Kheledi
Pass Leshkuri
Pass Divanldi
Pass Luori
Pass Latpari
Pass Zagari
Pass Sharivtseki
Pass Vatsistsveri
Pass Kelida
Enguri
Rioni
Tskhenistskali
Kheledula
Lajanuri Rsrv.
N
0 2.5 5 10 Km
Map Scale For A3 : 1 : 250 000
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m
Source: Landsat ETM 2001; Soviet topographic Map, GIS-Lab.

APPENDIX 8

Mean Annual Precipitation


Upper Tskhenistskali River Watershed
Mean Annual Precipitation
Annual Precipitation (mm)
1000 - 1160
1160 - 1272
1272 - 1350
1350 - 1405
1405 - 1483
1483 - 1595
1595 - 1755
1755 - 1985
1985 - 2315
2315 - 2787
LEGEND
Elevation
950 Tops (m)
800 Geodetic points (m)
750 V-X Pass Altitude (m) Period of access
700 Water level mark(m)
Settlements
Region center
District center
Sakrebulo's center
Borders
State
Regions
Hydrography
River
Intermittent river
Lake/Reservoir
Glacier
Enguri catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Intake Impoundment
Power Tunnel
Lentekhi project, 118 MW
Tsageri project, 110 MW
Tskhenistskali 4 HPP 30.4 MW
Tskhenistskali 3 HPP 33.3 MW
Tskhenistskali 2 HPP 16.2 MW
Tskhenistskali 1 HPP 20.4 MW
Zeskho 1 HPP 25.3 MW
Zeskho 2 HPP 14.2 MW
Existing Lajanuri Project Diversion
L=11.2 km
L=12.1 km
L=11.8 km
WEL ▼1011
WEL ▼680
WEL ▼1002
WEL ▼1110
WEL ▼1282
WEL ▼1400
WEL ▼1505
WEL ▼1750
WEL ▼1780
Mestia
Lentekhi
Tsageri
Ambrolauri
Enguri
Rioni
Tskhenistskali
Kheledula
Zeskho
Mt.Laila
Mt.Mekpaji
Mt.Guri
Mt.Dadiashi
Mt.Pushkori
Mt.Zeskho
Mt.Nuamkuani
Mt.Ailama
Mt.Tsurungala
Mt.Chubedishi
Mt.Lukhunistsveri
Mt.Lipitskaro
Mt.Chutkharo
Mt.Lelaashkha
Mt.Zieti
Mt.Tatenari
Mt.Diuristavi
Mt.Atsalari
Mt.Zhibe Lakhe
Mt.Goldishi
Mt.Lasili
Mt.Airashi
Pass Leshkuri
Pass Khelerdi
Pass Djvarildi
Pass Luori
Pass Latpari
Pass Zagari
Pass Sharivtseki
Pass Vatsistsveri
Pass Kelida
N
0 2.5 5 10 Km
Map Scale For A3 : 1 : 250 000
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m
Source: Georgian National Atlas,1964; Soviet topographic Map; GIS-Lab.

APPENDIX 9

Environmental and Social Impacts, Affected Environment

Appendix 1: Description of Tables

This appendix presents a tabular summary of potential environmental and social receptor impacts from the development of a hydropower project. These tables are based on the “EU Strategic Environmental Assessment Principles” that uses a subset of categories developed that best fits this level of analysis (Ref: http://ec.europa.eu/environment/eia/home.htm). Sections 2 and 3 and Section 6 of this document present a description of environmental and social baseline conditions. Section 6.2 presents environmental and social impacts and mitigation practices for each impacted receptor. The tables include a range of qualitative values for impacts and recommendations for mitigation practices that are considered standards of practice today. This prefeasibility report does not go into any detail with respect to recommended mitigation practices and should be used as a guideline with respect to the types of practice to be incorporated during a feasibility study for the different phases of the project (construction or operations. Decommissioning has not been included at this time).

The table column
headers are described as follows:

Column 1: Receptors

Receptors are the environmental and social category that an impact is evaluated for. For this prefeasibility report these include:

- Water Resources
    - Surface Water Resources
    - Surface Water Quality
    - Flood Risk
- Soils, Geology, and Landscape
- Air Quality
- Biodiversity
    - Terrestial Flora
    - Terrestial Fauna
    - Fisheries
- Community, Socio-Economic, and Public Health
    - Cultural and Historic Assets
    - Population
    - Recreation
    - Public Health

Receptors are evaluated with a Sensitivity level that is defined as follows:

Sensitivity of receptors, based on Value and Vulnerability

Classification	Sensitivity Level			
Vulnerability	**High (H)** *e.g.* potential pathways exist for environmental change in receptors as a result of project, receptor is in a declining condition, and/or dependent on a narrow range of environmental conditions	**Medium (M)** *e.g.* few pathways exist for environmental change in receptors as a result of project, receptor is only expected to recover from disturbance over a prolonged period of time, if at all, or impact potential is high but duration is short	**Low (L)** *e.g.* limited or no pathways exist for environmental change in receptors as a result of project, receptor is in stable or favorable condition &/ or dependent on wide range of environmental conditions	**None (N)** *e.g.* no pathways exist between environmental changes and receptors, receptor is insensitive to disturbance
Value	**High (H)** – receptor is rare, important for social or economic reasons, legally protected, of international or national designation	**Low (L)** – receptor is common, of local or regional designation		

Column 2: Impact

This column is a description of the effect on the receptors during each of the project phases, construction followed by operations.

Column 3: Duration

Duration is the expectation for the length of time an impact will occur to a given receptor. The following table displays the rating values for duration:

Guidelines for determining the period of the project lifecycle

Duration of effect				
Classification	**Long Term (LG)**	**Medium Term (MD)**	**Short Term (SH)**	**Very Short Term (VSH)**
Guideline	10+ years	3-10 years	1-3 years	<12 months
Project phase	Operation	Operation	Construction (or part thereof)	Part of construction period

Column 4: Risk Level

Risk Level qualitatively addresses the exposure and vulnerability a receptor will have from the project or in some cases how specific risks could cause the project to increase exposure and vulnerability to the receptor. An example of this is Seismic Risk as it pertains to Soils, Geology, and Landscape during each project phase. Risk level also includes whether the impact is Irreversible or Reversible and temporary or Permanent. The following displays the rating values for Risk Level:

Risk Level Rankings Definitions and Description

Risk Level	Description
Very Low (VL)	Rarely occurs, and/or of very low magnitude, and/or rarely causes significant loss or life or property damage
Low (L)	Can occur during the life of the project, and/or can be of modest magnitude, and/or rarely causes loss of life but can cause property some damage
Medium (M)	Occurs several or more times during the life of a project, and/or of significant magnitude, and/or can cause some loss of life and significant property damage
High (H)	Occurs often or on a regular basis and/or of a very high magnitude, and/or causes large loss of life and major property damage
Irreversible	Impact causes irreversible change to the receptor
Reversible	Impact causes reversible changes to the receptor
Temporary	Impact is of a temporary nature and receptor will return to original conditions after activity concludes
Permanent	Impact from activity is permanent changing the original receptor conditions to a new state.

Column 5: Mitigation Practices

Mitigation practices are guidelines and recommendations for a type of prevention activity that will reduce impacts to a receptor, provide necessary data and information for decisions during a project phase, provide heath and safety guidelines, and environmental prevention practices to minimize impacts to the receptors.

Table - 1 Affected Environmental Impacts and Proposed Mitigation Measures Environmental Receptor Category: Water Resources

Water Resources				
Receptors Vulnerability (H, M, L, N) Value (H, L)	**IMPACT (Description of effect)**	**Duration (construction, operation or decommissioning LG/MD/SH/VSH term) and frequency**	**Risk Level (VL, L, M, H) Irrev./ rev.; Temp./ per**	**Mitigation Practices**
Surface Water Resources (quantity) M/L	**Construction Phase (HPP and Transmission Facility)**: • Altered surface runoff contribution to water courses and ditches, etc. as a result of land disturbance • Temporary Diversion of River away from Dam and intake structure • Large construction/tunnel volume debris disposal • Construction of the dam will create a small permanent reservoir changing natural river conditions.	SH SH SH LG	VL/R/T VL/R/T VL/R/T VL/IR/P	Very high sediment and bed load transport by upper river. Assume site preparation include in-water, bank side, and/or adjacent property. River flow and river channel may be temporarily redirected for site construction. Well understood process. Few if any uncertainties, assume runoff controls and spill prevention plans and monitoring are included in construction. Locate area for construction debris that can contribute to generation of usable land in the future.
M/L	**Operation Phase:** Effects on surface water resources during facility operations	LG	L/R/P	Run of river hydropower operations returns all diverted flow used for generation to the receptor river. Long penstock facilities must meet appropriate receptor guidelines for bypass flows as required.

Surface Water Quality M/L	**Construction Phase(HPP and Transmission Facility)**: • Altered surface runoff water quality to water courses and ditches, etc. as a result of land disturbance • Temporary Diversion of River away from Dam and intake structure	SH SH	VL/R/T VL/R/T	Very high sediment and bed load transport by upper river. Assume site preparation can include in-water, bank side, and/or adjacent property. River flow and river channel may be temporarily redirected for site construction. Well understood process. Few if any uncertainties, assume runoff controls and spill prevention plans and monitoring are included during construction.
M/L	**Operation Phase:** • effects on surface water resources during facility operations	LG	L/R/T	Run of river hydropower operations returns all diverted flow used for generation to the receptor river. Long penstock facilities must meet appropriate receptor guidelines for bypass flows as required.
Flooding Risk M/L	**Construction Phase (HPP and Transmission Facility):** • Increase to flood discharge from failure of dam during construction	VSH	L/R/T	• Construction to adhere to all design requirements. • Dispose of large volumes of construction debris in locations that will not increase flood levels, or impact floodplain negatively • Design to address appropriate levels of Flood Risk in planning construction phase. • Monitoring of river discharge upstream on main stem and significant tributaries (flash flood warning) • Emergency Evacuation Plan developed • Emergency site shut down plan to be developed.
M/L	**Operations Phase:** Prevent failure of dam and other project components in the event of a flood that would severely increase the impact from the flooding event	VSH	M/R/T	Insure all facilities are operating correctly including, spillway gates, trash racks, and shut off gates (tunnel and powerhouse), etc. Monitor Dam for seepage, leaks, and structural integrity. Monitor Tunnel for leaks and structural integrity Prepare Emergency operations plan that includes flooding events Prepare Emergency shut down and evacuation plan.

Table - 2 Affected Environmental Impacts and Proposed Mitigation Measures Environmental Receptor Category: Soils, Geology, and Landscape

Soils, Geology and Land Use				
Receptors	**IMPACT (Description of effect)**	**Duration LG/MD/SH/VSH term)**	**Risk Level (VL, L, M, H, and Irreversible/ reversible; temporary/ permanent**	**Mitigation Practices**
Soils, Geology, Landscape **(Vulnerability (H, M, L, None) and Value (H, L)** M/H	**Seismic Risk** **Construction Phase (HPP and Transmission Facility)**: Impacts on infrastructure and public due to seismic activity	VSH	H/R and IR/T and P depending on seismic characteristics	Well understood process. The project structures to be built in the area have to have appropriate design specifications which are in line with the national and international standards. Severe activity can lead to failure, flooding, property damage and loss of human life. Emergency site shut down and Evacuation plans should be included in construction management planning.
M/H	**Operation Phase**: Impacts on infrastructure and public due to seismic activity that causes HPP to fail	VSH	H/R and IR/T and P depending on seismic characteristics	Well understood process but magnitude is unknown Severe seismic activity can lead to failure, flooding, property damage and loss of human life downstream of HPP. Emergency site shut down and Evacuation plans downstream should be included in HPP Operations Plan
Soils, Geology, and Landscape **(Vulnerability (H, M, L, None) and Value (H, L)** M/H	**Landslides and Mudslides** **Construction Phase (HPP and Transmission Facility)**: Improper stockpiling of materials, poor sitting, of storage and lay down areas, blasting activities and/or destruction of vegetation cover could increase receptor impacts if land slide or mud slide occurs at HPP site or upstream.	VSH	M/R/T	Erosion and sediment control plan (includes issues like: proper site sitting and engineering design based on best management practices, accumulated sediment disposal plan, grading and smoothing steep slopes, re-vegetation activities etc.) at national and international standards should be developed. Emergency shut down and Evacuation plans should be developed to protect receptors, property, and human life. Early Warning Monitoring to include Weather and watershed and upslope areas from HPP site and known land slide and mud slide locations Proper scheduling of construction activities Monitoring of vibration from construction equipment (and blasting activities)
M/H	**Operation Phase:** Minimize increasing the impacts from this natural occurrence from HPP operations	SH	L/R/T	Monitoring site conditions on a regular basis; implementation of pre-prepared emergency shut down and Evacuation plans ; Monitoring of Early Warning system

Soils, Geology, and landscape **(Vulnerability (H, M, L, None) and Value (H, L)** M/H	**Visual impact on landscape Construction Phase (HPP and Transmission Facility)**: Visual impact is important in this mountainous setting and impacts to this receptor are significant. Construction activities may cause visual disturbance of landscape (new project units (e.g. dam, powerhouse) will be constructed. Construction activities may cause removal of vegetation cover, changes in land use pattern. Waste generation due to construction activities may create visual impact on landscape as well as impact on land. Management and disposal of construction debris	SH	VL/R/T	Proper storage and utilization of topsoil and excavation materials. Restoration of soil cover, re-vegetation and reforestation activities to national and international standards Proper scheduling of construction activities. Develop construction management plan. Development appropriate waste management plan which includes management of solid, liquid, hazardous waste material and are in line with national and international environmental regulations. Construction debris should be disposed of according to current accepted practice, local and national laws. Where possible use construction in a sustainable manner that provides opportunities for agriculture, local industry, and does not impact local floodplain
M/H	**Operation Phase:** No more additional alterations of landscape are expected during the operation phase. Water body such as impoundment may be considered to create pleasant scenery.	SH	VL/IR/P	Monitoring the landscape restoration activities.

Table - 3 Affected Environmental Impacts and Proposed Mitigation Measures Environmental Receptor Category: Air Quality

Air Quality				
Receptor s	**IMPACT (Description of effect)**	**Duration LG/MD/SH/VSH term)**	**Risk Level (VL, L, M, H, and Irreversible/ reversible; temporary/ permanent**	**Mitigation Practices**
Air Quality **(Vulnerability (H, M, L, None) and Value (H, L)** **L/H**	**Construction Phase (HPP and Transmission Facility)**: Construction activities may increase the level of emission in the air and dust, especially under windy conditions.	SH	L/R/T	Well understood process. Air management plan should be developed, which includes activities like construction machinery maintenance scheduling, Exhaust gas quality, water spray on construction site to minimize dust, checking construction equipment and/or benzene quality etc.
L/H	**Operation Phase:** During operation there would not be any significant emission level.	VSH	VL/R/T	Ensuring compliance with air management plan, emergency generator exhaust controls.

Table - 4 Affected Environmental Impacts and Proposed Mitigation Measures Environmental Receptor Category: Biodiversity

Biodiversity				
Receptor s	**IMPACT (Description of effect)**	**Duration LG/MD/SH/VSH term)**	**Risk Level (VL, L, M, H, and Irreversible/ reversible; temporary/ permanent**	**Mitigation Practices**
Terrestrial flora **(Vulnerability (H, M, L, None) and Value (H, L)** **L/H**	**Construction Phase (HPP and Transmission Facility)**: Project might have following primary and secondary impacts on the terrestrial flora: • Construction of HPP, new roads and/or Transmission lines may cause removal of vegetation (forests, topsoil); • Alien species invading the existing ecosystem;	SH	M/R/T	Well understood process. Restoration and reinstatement of soil cover; re-vegetation and/or reforestation activities.
L/H	**Operation Phase:** There would be minor or no impact on flora during the operation phase	MD	VL/R/P	Monitoring restoration activities.
Terrestrial fauna **(Vulnerability (H, M, L, None) and Value (H, L)** **L/H**	**Construction Phase (HPP and Transmission Facility)**: Project might have following primary and secondary impacts on the terrestrial fauna: • Disruption of sites of breeding and sheltering; • Animal mortality due to construction activities (e.g. accidents and/or mortality of birds due to Transmission lines) • Alien species invading the existing ecosystem; number of equipments and/or possible blasting activities may cause the increase the noise/vibration level during the construction process, which may disturb wildlife (affect species behaviour)	SH	M/R/T	Wildlife management plan should be developed. Noise management plan. Proper scheduling of construction activities; Monitoring of vibration and blasting activities from construction equipment

L/H	**Operation Phase:** Impacts affecting fauna elements during operation are: • Ecological barrier effect (movement is disabled or hindered • Mortality of animals on roads; • Mortality of birds on power lines	LG	VL/R/P	Implementing and monitoring the wildlife management plan.
Fishery **(Vulnerability (H, M, L, None) and Value (H, L)** **L/H**	**Construction Phase HPP**: Impact on fish species due to construction in the riverbed and altering the river flow through temporary diversion channel, and blasting activities.	MD	M/R/T	Installing fish protecting/screening facilities at the entrance of the HPP feeding tunnels/channels. Scheduling of construction activities. Avoiding the stock piling in the riverbed. Proper scheduling of construction activities; Monitoring of vibration and blasting activities from construction equipment
L/H	**Operation Phase:** Impacts on fish species due to diverting river flow to the powerhouse (mortality fish species in the turbines/generators). Exposure of bypass section of river to very low to no flow.	MD	M/R/T	Well understood process. Permanent monitoring of sanitary water flow; compliance with environmental and in-stream flow requirements with monitoring.

Table - 5 Affected Environmental Impacts and Proposed Mitigation Measures Environmental Receptor Category: Cultural Resources

Cultural Resources and Recreation				
Receptor s	**IMPACT (Description of effect)**	**Duration LG/MD/SH/VSH term)**	**Risk Level (VL, L, M, H, and Irreversible/ reversible; temporary/ permanent**	**Mitigation Practices**
Cultural and historic assets **(Vulnerability (H, M, L, None) and Value (H, L)** L/H	**Construction Phase HPP and Transmission Facility)**: There are no archaeological and/or cultural heritage sites in the vicinity of the projects. However, during construction works they might occur. Archaeological objects should be protected from damage.	VSH	VL/R/T	Identifying historical and cultural assets. Development of noise and construction management plan. Proper scheduling of construction activities Monitoring of vibration from construction equipment and blasting activities.
L/H	**Operation Phase:** No damage on archaeological/cultural resources is expected from operational phase. Small reservoir behind dam may provide new opportunities for recreational activities	VSH	VL/R/P	N/A

Table-6 Affected Environmental Impacts and Proposed Mitigation Measures Environmental Receptor Category: Community, Socio-Economic and Public Health

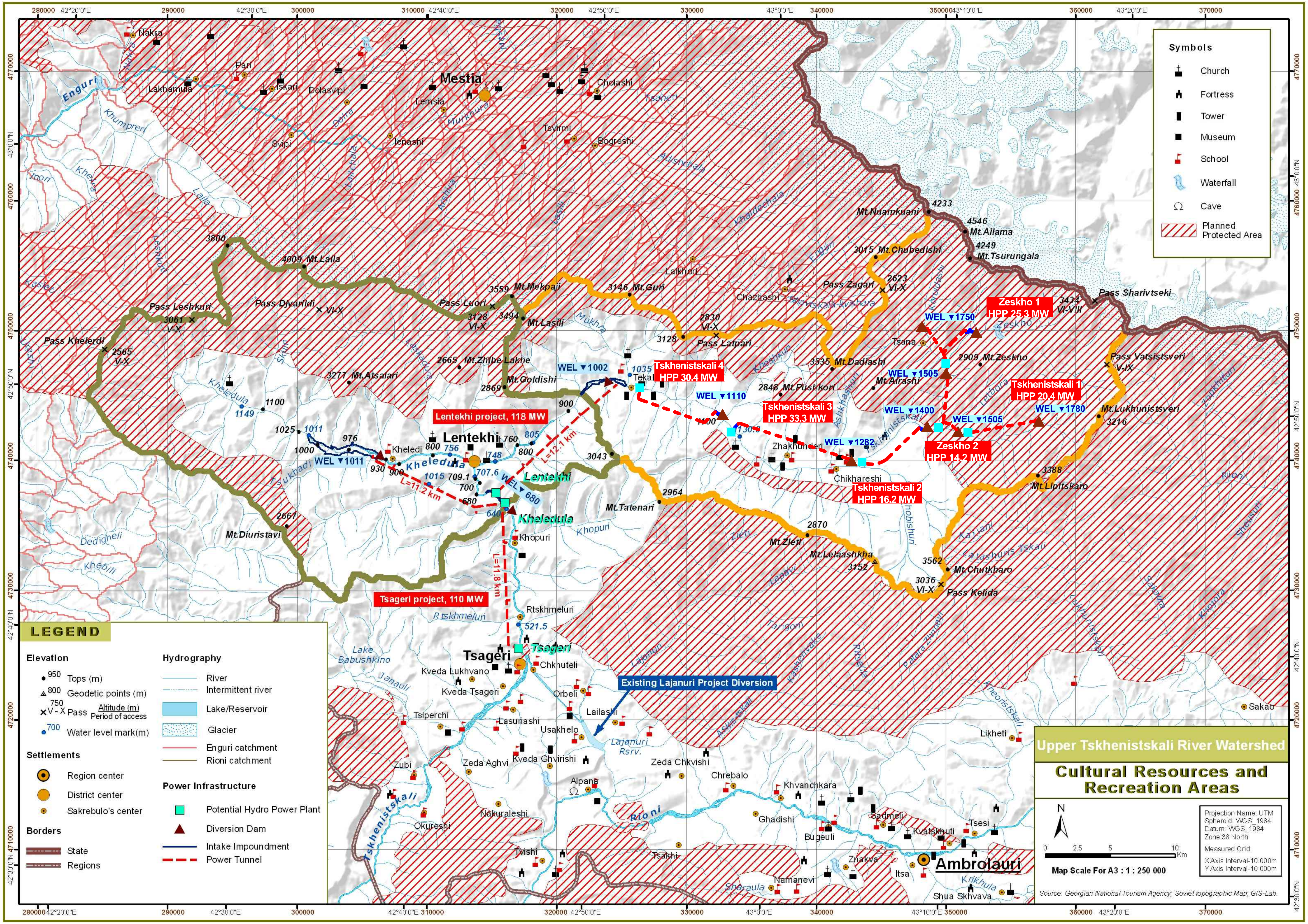
Community, Socio-Economic and Public Health				
Receptor s	**IMPACT (Description of effect)**	**Duration (LG/MD/SH/VSH term)**	**Risk Level (VL, L, M, H, and Irreversible/ reversible; temporary/ permanent**	**Mitigation Practices**
Agricultural Land **(Vulnerability (H, M, L, None) and Value (H, L)** L/H	**Construction Phase (HPP and Transmission Facility)**: Impact associated with land acquisition and thereby loss of agricultural land, which may cause loss of income earning means; disposal of debris; limit access to agricultural property	SH	L/R/T	Develop compensation mechanism for occupied agricultural land.; coordinate construction activities to minimize impacts to agricultural properties, appropriate selection of disposal areas, materials storage areas;, Monitoring the implementation of compensation scheme

L/H	**Operation Phase:** New infrastructure (e.g. access roads) may positively impact on local population, provide better access to markets for agricultural products	LG	VL/R/P	N/A
Population **(Vulnerability (H, M, L, None) and Value (H, L)** N/H	**Construction Phase (HPP and Transmission Facility)**: Machinery and/or possible blasting activities may cause the increase the noise/vibration level during the construction process, Construction activities cause traffic delays, which affect local population within the vicinity of project. New job opportunities and economic benefits to community	SH	L/R/T	Well understood process. Noise management plan Blast warning plan for construction crews and local residents. Proper scheduling of construction activities Monitoring of vibration from construction equipment (and blasting activities)
N/H	**Operation Phase**: The noise/vibration source during the operation will be generators and turbines located in the powerhouse. Since they are located in the closed building, it will have not any considerable nuisance.	N/A	N/A	N/A
Recreation (Vulnerability (H, M, L, None) and Value (H, L) L/H	**Construction Phase (HPP and Transmission Facility)**: Visual impact due to construction; activities may impact recreation in the region. Waste generation due to construction activities may create visual impact. Delay or prevent access to recreational locations	SH	VL/R/T	Proper scheduling of construction activities. Develop construction management plan. Development appropriate waste management plan which includes management of solid, liquid, hazardous waste management and are in line with national and international environmental regulations. Provide construction schedules and coordinate with recreational locations to minimize access issues for visitors.
L/H	**Operation Phase:** New reservoir and new infrastructure (e.g. better roads) may positively impact on recreational activities	LG	L/IR/P	Operations practice should coordinate with recreational activities so as to assure safe access (fishing), adequate water in bypass channels to support in-stream activities, and provide access to river for such activities if project limits access.

Roads, Infrastructure, and Communities **(Vulnerability (H, M, L, None) and Value (H, L)** L/H	**Construction Phase (HPP and Transmission Facility)**: It is expected that during construction new access roads will be built. Loads on the existing roads will increase due to construction machinery. Traffic increase will affect Noise, Air Quality, community safety, and Public Health Receptors. Construction provides jobs and economic benefits to community	SH	L/R/T	Develop construction management plan that addresses materials delivery, storage, noise, and air quality issues that are sensitive to local communities and meet all Georgian environmental and legal requirements. Include job training for local population where appropriate.
L/H	**Operation Phase:** It is expected that during operational phase vehicular movement will be increased for maintenance, etc purposes. Consider community health, safety and security issues, as well as Noise and Air Quality Receptors.	LG	VL/R/P	Develop traffic management plan with limited vehicular movement during operational phase. Ensure compliance with local and regional laws that effect the community
Public Health **(Vulnerability (H, M, L, None) and Value (H, L)** L/H	**Construction Phase (HPP and Transmission Facility)**: Construction activities might cause health impact to the workers (e.g. construction related accidents). Also see Air Quality, Population Receptors	SH	VL/R/T	Health and safety plan should be in line with national and international standards. Occupational health and safety measures should be identified and implemented. Necessary precautionary measures should be implemented in order to avoid and minimize risk of accidents (e.g. fire, flooding etc)
L/H	**Operation Phase:** Operational activities might cause health impact to the workers and/or local population.	LG	VL/R/P	Ensure compliance with health and safety plan

APPENDIX 10

Cultural Resource & Recreation Areas


Upper Tskhenistskali River Watershed
Cultural Resources and Recreation Areas
Symbols
Church
Fortress
Tower
Museum
School
Waterfall
Cave
Planned Protected Area
LEGEND
Elevation
950 Tops (m)
800 Geodetic points (m)
750 V - X Pass Altitude (m) Period of access
700 Water level mark(m)
Settlements
Region center
District center
Sakrebulo's center
Borders
State
Regions
Hydrography
River
Intermittent river
Lake/Reservoir
Glacier
Enguri catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Intake Impoundment
Power Tunnel
Lentekhi project, 118 MW
Tsageri project, 110 MW
Tskhenistskali 4 HPP 30.4 MW
Tskhenistskali 3 HPP 33.3 MW
Tskhenistskali 2 HPP 16.2 MW
Tskhenistskali 1 HPP 20.4 MW
Zeskho 1 HPP 25.3 MW
Zeskho 2 HPP 14.2 MW
Existing Lajanuri Project Diversion
L=11.2 km
L=12.1 km
L=11.8 km
Mestia
Lentekhi
Tsageri
Ambrolauri
Map Scale For A3 : 1 : 250 000
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m
Source: Georgian National Tourism Agency, Soviet topographic Map, GIS-Lab.

APPENDIX 11

Listed Cultural Properties in Lower Svaneti

Historical, Cultural and Archeological Resources in Lentekhi and Tsageri Districts

#	Name	Location	Dated
Lentekhi District			
1	Church “Macxvar”	Village Bavari	Medieval
2	Tower	Buleshi Village	Medieval
3	Gardaphkhadze Residential Complex 1. Tower 2. Residential house	Village Tekali	N/A
4	Church “Zagaloti”	Tekali Village surroundings	XI-XII A.D.
5	Tower	Lentekhi	Medieval
6	The Charkvianis’ Tower	Village Leusheri	Medieval
7	Larashi – Dadiani’s Residential Complex 1. Tower 2. Castle 3. Other buildings	Village Leksura	Medieval
8	St. George’s Church “Jgrag”	Village Luji, cemetery	Medieval
9	Tower	Village Mami	Medieval
10	Church “Matskhovari” (Church of the Redeemer)	Village Mami, cemetery	X-XI A.D.
11	St. George’s Church “Jgrag”	Village Margvishi, cemetery	Medieval
12	Residential Complex “Machubi”	Village Makhashi	Medieval
13	Tower “Moroldirad”	Village Makhashi	Medieval
14	Onianis’ Tower	Village Mebetsi	Medieval
15	Church	Village Mele, cemetery	Medieval
16	Onianis’ Tower	Village Mele	Medieval
17	Church Tarigzeli (Church of Archangel)	Village Mutsdi, cemetery	Medieval
18	Church Tarigzeli (Church of Archangel)	Village Natsuli, cemetery	Medieval
19	Church Tarigzeli (Church of Archangel)	Village Sasashi, surroundings of “Sands”	Medieval
20	St. George’s Church “Jgrag”	Village Sakdari	Medieval
21	Tower	Village Tvibi	Medieval
22	Church Tarigzeli (Church of Archangel)	Village Tvibi surroundings	X-XI A.D.
23	Church Tarigzeli (Church of Archangel)	Village Phaki	Medieval
24	Church Tarigzeli (Church of Archangel)	Village Ghobi, at the Tskheniskali River embankment	Medieval
25	St. Mary Church	Village Ghobi, cemetery	Medieval
26	Church Tarigzeli (Church of Archangel)	Village Shtvili	Medieval
27	St. Mary Church “Lamaria”	Village Chikhareshe, cemetery	XIX A.D.
28	St. Mary Church “Lamaria”	Village Chikhareshe, Dabishi District	Medieval
29	Church Tarigzeli (Church of Archangel)	Village Chukuli, cemetery	Medieval
30	Siani Tower	Village Chukuli, “Nakisheri”	Medieval.
31	Church	Village Chukuli	Medieval
32	Church “Muchpa	Village Chukuli	XII-XIII A.D.
33	Church Tarigzeli (Church of Archangel)	Village Chukuli	X-XII A.D.
34	Church	Village Kheria, Lamzagora	IX-X A.D.
35	St. George’s Church “Jgrag”	Village Zhakhunderi	XI-XII A.D.
Tsageri District			
36	Church	Town Tsageri	Medieval
37	Remnant of the “Shkhudala” Monastry	Village Alpana, near the Lajanuri and Rioni Rivers confluence	Medieval

38	Gveso Complex	Village Gveso	IX-X A.D.
39	Sosilei Tower, Charkviani Tower	Village Gveso surroundings	Medieval
40	Remnants of the Tower	Village Gveso, R. Tsvarianis' premises	Medieval
41	Wooden House "Oda"	Village Gveso, M. Chikovanis' premises	XX A. D.
42	Church "Mtavarangelozi" (Church of Archangel)	Village Upper Aghvi, cemetery	Medieval
43	St. George's Church	Village Upper Sairme, cemetery	XIX A. D.
44	St. Mary Church	Village Zogishi	Medieval
45	"Zubi" Church	Village Zubi, surroundings	Medieval
46	Tower-Church "Dedaghvtisa"	Village Tabori, mountain	Medieval
47	Church	Village Tabori	VI A.D.
48	Isunderi Tower	Village Isunderi	Medieval
49	St. Mary Church	Village Isunderi, cemetery	XIX A. D.
50	Synagogue	Village Lailashi	XIX-XX A.D.
51	Church	Village Lailashi	Medieval
52	St. George's Church	Village Lailashi, cemetery	XIX A.D.
53	Church "Amaghleba" (Church of the Ascension)	Village Lailashi	1859
54	Church of the Holy Trinity "Sameba"	Village Makhura, cemetery	XIX A. D.
55	St. George's Church	Village Nakuraleshi, cemetery	XVII A. D.
56	Church	Village Nakuraleshi	Medieval
57	St. Mary Church	Village Nasperi, cemetery	XIX A. D.
58	Tower	Village Nasperi, G. Murtseladze's premises	Medieval
59	Goni Church of St. George	Village Orkhvi, surroundings	X A. D.
60	St. George's Church	Village Orkhvi	XIX A. D.
61	Tower –Fortress "Qvatsikhe", "Qvarianis' Tower"	Village Orkhvi	Medieval
62	Remnant of the St. George's Church	Village Okureshi, surroundings	Medieval
63	Wooden House	Village Okureshi, K. Arjevanidze's premises	XIX A. D.
64	Church	Village Okureshi	Medieval
65	St. George's Church	Village Usakhelo, cemetery	XIX A. D.
66	Remnant of the Dadeshqelianis' Fortress	Village Usakhelo, surroundings	Medieval
67	St. George's Church	Village Utskheri, "Gudula" location	Medieval
68	Remnant of St. Mary Church	Village Utskheri	Medieval
69	"Utskheri" Tower-Fortress	Village Utskheri	Medieval
70	St. Mary Church	Village Lower Aghvi, cemetery	XIX
71	Remnant of St. Mary Church	Village Qorenashi, cemetery	Medieval
72	Qorenishi Tower	Village Qorenishi, J. Asatiani premises	Medieval
73	"Dedaghvtisa" Church	Village Ghu, Cemetery	1880
74	Muri Church	Village Chkhuteli, surroundings	Medieval

Source: *Ministry of Culture of Georgia: Ministerial Orders #3/133 and #3/110(2006 and 2011)*

APPENDIX 12

Report on Public Awareness Workshop

Background

The United States Agency for International Development (USAID) through the Hydropower Investment Promotion Project (HIPP) supports development of a minimum 400 MW in new, run-of-the-river hydropower stations in Georgia. This project is managed by Deloitte Consulting. As part of this program, HIPP has identified a cluster of six project sites in the Tskhenistskali River Basin. HIPP is now conducting pre-feasibility studiesf for 6 projects with a total capacity of 139.8 MW. These HPP sites are on the River Tskhenistskali and its tributary Zeskho River in lower Svaneti (Lentekhi) region. The HIPP team is preparing basic technical studies to evaluate the technical and economical feasibility of the projects.

As part of this process and with the aim of ensuring public participation at the early planning stage, identify areas of community concern, and gather feedback from local residents public awareness workshop was held in the Building of Jakhunderi village (Lentekhi region) Secondary School with the communities of Jakhunderi, Chikhareshi, Mele, Tsana, Zeskho, Luji, Sasashi, Mummie, Leusheri, Panaga, Cholouri and Mazashi.

Aim of the Workshop

- Increase awareness of local communities on small and medium run-of-the-river hydro power plans and promote their support to such activities;
- Inform local community the goal of the project and ensure their involvement at the early planning stage.
- Identify community concerns regarding the possible development of the project and gain their feedback; ensure positive attitude towards the project and increase cooperation perspectives between public and project developers.

Workshop Process

The purpose of the meetings was to provide information and get the opinions of the locals related to the project. The date, place and the scope of these meeting was preliminary informed and agreed with Lentekhi Local Government during HIPP team field visits. Meeting date and venue were agreed with Local Municipalities; Public workshop was announced to all communities in Lentekhi district by local municipality, written advertisements were made at Municipality Building. Advertisement was sent to CENN electronic distribution network. HIPP team facilitated attendance of the Attorneys of all communities together with other active members at the Workshops. Lentekhi (in village Jakunderi) PAW attended by community members from: Jakhunderi, Chikhareshi, Mele, Tsana, Zeskho, Luji, Sasashi, Mummie, Leusheri, Panaga, Cholouri and Mazashi communities. Totally more than 50 community members attended the workshop.

During the workshop HIPP team members provided information about the project in general, made presentations on technical characteristics of the proposed HPP projects and on possible environmental and social impact. Issue that project will not create significant impoundment causing displacement of adjacent population was stressed during the workshop.

The HIPP team stressed the importance of public participation at early project design phase. Participants have been asked to express their opinion/attitude towards the project in general as well as impact on environment and socio-economic conditions of their household.

THEMES:

- Community members asked to consider a cumulative impact that may take place in case of implementation of all 6 projects identified by HIPP. In this regard, health issues were underlined that may occur by increased humidity. HIPP representatives underlined that the impact would be minimal and mainly during the construction phase, though the investors would be obligated to meet international environmental and social protection requirements;
- Local benefits of the projects; Community members were interested whether they could benefit from the low electricity tariffs;
- Will the local community be able to influence on decision-making process of the project implementation? For instance, change certain component of the project. HIPP representatives explained that the main goal of the Workshop was achieving community influence on the project planning and asked them to note all their concerns and comments in the questioners distributed at the meeting so that HIPP could include the community concerns in the information offered to potential investors.

CONCLUSIONS:

- The outcome of Tskhenistskali Community public awareness workshops is as follows:
- Community's attitude towards the project development is positive; Community members think they could benefit from development of project in case the project developers properly consider their concerns/suggestions and watershed characteristics. On the other hand, community members are willing to cooperate with HPP project developers. From operation of the HPP local population expects to receive new job opportunities;
- Tskhanistskali community expressed interest in implementation of the projects, as they have the problems in electricity supply and think that if a new HPP is constructed nearby their problems will be resolved. Though main reason of their poor power supply is depreciated distribution networks, power supply lines and poles, which need replacing.
- Tskhenistskali Workshop also revealed no need of making a change in the design of the HIPP's sites. None of the residents declared their rights of ownership on any of the places, where constructions of the power house or intake structures are were planned, or concerning their pastures.
- The only concern was expressed that it would negatively impact on fish (Salmon) population and possible timber logging. Also questions were asked about the possible influence on cultural heritage. HIPP team assured that one of the HPP projects were projected near any churches or cemeteries.
- In summary, 30 community members filled in the questioner forms distributed by HIPP, out of which only two are negative; five had a neutral attitude and the rest, twenty three members marked positive.

The presentation on the project profiles, informational brochure on Tskhenistskali River Basin HPP Cascades, also, USAID energy map were used as supportive documentation. Meeting agenda, photos, and electronic version of the brochure distributed among them are attached to this report as illustrative materials.

Attachment A: Public Awareness Workshop Agenda

Public Awareness Meeting for Tskhenistskali River Basin HPP Cascades

Agenda

15:00–15:10	Registration		10 min
	Introductions	**Moderator :**	Duration
15:10–15.15	Opening remarks	USAID / HIPP, I. Iremashvili	5 min
15:15–15:25	HIPP Project description	HIPP / I. Iremashvili	10 min
15:25–16:10	HPP Project outline	HIPP / G. Sikharulidze	45 min
16:10–16:30	Presentation of identified social and environmental issues	HIPP / Iremashvili / G. Sikharulidze	20 min
	Questions and Discussion		
16:30–13.45	Filling out of the meeting questionnaire Discussion • Socioeconomic Issues • Environmental Issues • Public Health & Safety Issues • Construction Issues	Facilitated by: HIPP / I. Iremashvili HIPP / G. Pochkhua	1 hour

Attachment B: Photos of Public Awareness Workshops in Village Jakhunderi, Lentekhi Region

Attachment C: Informational Brochure on HIPP and Tskhenistskali HPP Projects

Hydropower Investment Promotion Project (HIPP)

HIPP - Main Goals and Activity

By the request of Georgian Government, the United States Agency for International Development (USAID) has been supporting a three year Hydropower Investment Promotion Project (HIPP) since March, 2010. HIPP is implemented by the international consulting company Deloitte Consulting.

Georgia's hydropower potential is largely undeveloped. Currently only 25% of the country's total generation potential has been realized. The country has many rivers that can provide environmentally friendly, power generation run-of-river hydropower projects with high annual plant factors, making them highly attractive to investors.

The goal of the HIPP initiative is to identify investment opportunities and incentivize investors resulting in private sector commitments to construct run-of-river hydropower plants – leading to increased generating capacity, locally produced energy, enhanced energy security, and the elimination of winter imports, greatly reducing the use of natural gas and other fuel sources for electricity production.

To stimulate and secure investment in Georgia's small and medium-sized hydropower market, Deloitte/HIPP is working with local and international partners in all areas to promote awareness and investment in Georgia's hydropower resources. Key areas of activity include:

- Developing Quality Engineering and Technical Information;
- Providing Targeted and Effective Investor Outreach and Promotion;
- Supporting Institutional Strengthening and Capacity Building; and
- Partnering Programs and Opportunities to Stimulate Investment.

Tskhenistskali HPP Cascade

As part of this program, HIPP has identified a cluster of project sites along the Tskhenistskali River (4 HPPs) and Zeskho River (2 HPPs) in Lentekhi region with total capacity of 121.3 MW.

The cascade of 6 HPPs (**Tskhenistskali 1, 2, 3, 4, and Zeskho 1, and 2 HPPs**) will be positioned near the villages: Makhashi, Tsana, Mele, Luji, Zeskho, Mami, Leusheri, Sasashi on the Tskhenistskali and Zeskho Rivers, which are characterized by high flows. The upper Tskhenistskali River basin with its tributaries Zeskho and Koruldashi lies between the north slopes of the Lechkhumi and the south slopes of the Svaneti Mountain Ranges. Its source is in the main range of the Caucasus Mountains, in the easternmost part of the Lentekhi District, Lower Svaneti. The river flows in Lower Svaneti are very seasonal. Discharges are low during winter months when most precipitation falls as snow, and are high during spring and summer when melt-water and rain runoff are combined.

- **Tskhenistskali 1 HPP** will be positioned near Makhvashi and Tsana villages: its power house - in 9 km from Makhvashi and 10 km downstream from Tsana, as for the intake structure of the plant it is planned in 16.5 km downstream of Tsana and 15 km upstream of Makhashi. he HPP will be the first stage in a cascade of six HPPs. According to the preliminary assessments, the 20.4 Megawatt (MW) run-of-river, tunnel derivation type hydro power plant can be built on the river. The site offers seasonally variable average annual generation of about 95.30 GWh, at a plant factor of about 53 percent.

General Technical Data

- **Tskhenistskali 2 HPP** will be positioned very near Makhvashi and Tsana villages: its power house - in 2 km from Makhvashi and 1.5 km downstream Mele, as for the intake structure of the plant it should be built in 5.5 km upstream of Makhashi. The HPP will be the second stage in a cascade of six HPPs. According to the preliminary assessments, the 16.2 Megawatt (MW) run-of-river, tunnel derivation type hydro power plant can be built on the river. The site offers seasonally variable average annual generation of about 73.60 GWh, at a plant factor of about 52 percent.
- **Tskhenistskali 3 HPP's** its power house will be in 1 km downstream of the village Luji and in 3 km from Sasashi. The intake structure of the plant will be located in 4.5 km downstream of Makhashi and 0.7 km upstream of Mele. The HPP will be the third stage in a cascade of six HPPs. According to the preliminary assessments, the 33.3 MW run-of-river, tunnel derivation type hydro power plant can be built on the river. The site offers seasonally variable average annual generation of about 153.60 GWh, at a plant factor of about 53 percent.
- **Tskhenistskali 4 HPP** will be positioned in 1 km downstream of Mami Village and in 2 km of Leusheri, as for the its power house, it should be built in 1 km downstream of Luji and 2 km upstream of Panaga Villages. The HPP will be the fourth stage in a cascade of six HPPs. According to the preliminary assessments, the 30.4 MW run-of-river, tunnel derivation type hydro power plant can be built here. The site offers seasonally variable average annual generation of about 139.40 GWh, at a plant factor of 52 percent.

This Brochure was prepared by Deloitte Consulting, the implementer of USAID funded Hydropower Investment Promotion Program

General Technical Data

- **Zeskho 1 HPP' s** power house will be positioned in 5.3 km of Zeskho Village and in 2.7 km of Tsana Village, and its intake structure will be in 1 km downstream of Tsana and 0.5 km from Zeskho. The HPP will be the fifth stage in a cascade of the six HPPs. According to the preliminary assessments, the 25.3 MW run-of-river, tunnel derivation type hydro power plant can be built here. The site offers seasonally variable average annual generation of about 119 GWh, at a plant factor of 54 percent.
- **Zeskho 2 HPP**'s power house will be positioned in 7 km downstream of Makhashi Village and in 2 km of Leusheri, and the intake structure should be built in 10 km upstream of Makhashi and 3 km - of Tsana Villages. The HPP will be the final, sixth stage in a cascade of the six HPPs. According to the preliminary assessments, the 14.2 MW run-of-river, tunnel derivation type hydro power plant can be built here. The site offers seasonally variable average annual generation of about 65.30 GWh, at a plant factor of 53 percent.

Local Community Benefits by Project Implementation

Local labor forces will be employed during the construction period, as well as after commissioning of the Plant to carry out operations and maintenance works.

- Local labor forces will be employed during the construction period, as well as after commissioning of the Plant to carry out operations and maintenance works. Job creation will also help the community as most of the people will get training in their proficiencies.
- New high quality access roads with total length of (km?) will be constructed that will significantly improve the village infrastructure.
- Small gabions will result in more regular water flows in river bed and help minimize flooding.
- Increased reliability of electricity supply and improved energy supply.

Expected results

Implementation of the project will support the realization of Georgia's hydropower potential. Tskhenistskali HPPs Cascade will substantially increase power generation and help to raise the Country's energy security for a future with sustainable energy resources. Total hydroelectric generation of Tskhenistskali HPP Cascade will amount to more than 120MW. Realization of the project will create good opportunities for:

- selling electricity inside Georgia supplementing expensive thermal power during winter;
- exporting electricity during non-winter months to take advantage of the seasonal differentials in power prices between Georgia and its neighboring countries;
- Utilization of additional renewable energy source that will help to reduce local as well as global carbon oxide emissions to the atmosphere.

USAID FROM THE AMERICAN PEOPLE Hydropower Investme Promotion Project (HI

Tskhenistskali HPP Casca

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Promoting Renewable Energy
Promoting the Renewal of Georgia

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