Hydropower Investment Promotion Project (HIPP)

KHANI 2 HPP

PRE-FEASIBILITY STUDY

UPPER KHANISTSKALI RIVER BASIN

Wednesday, April 24, 2013

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USAID HYDROPOWER INVESTMENT PROMOTION PROJECT (HIPP)

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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

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

EXECUTIVE SUMMARY

Project Description

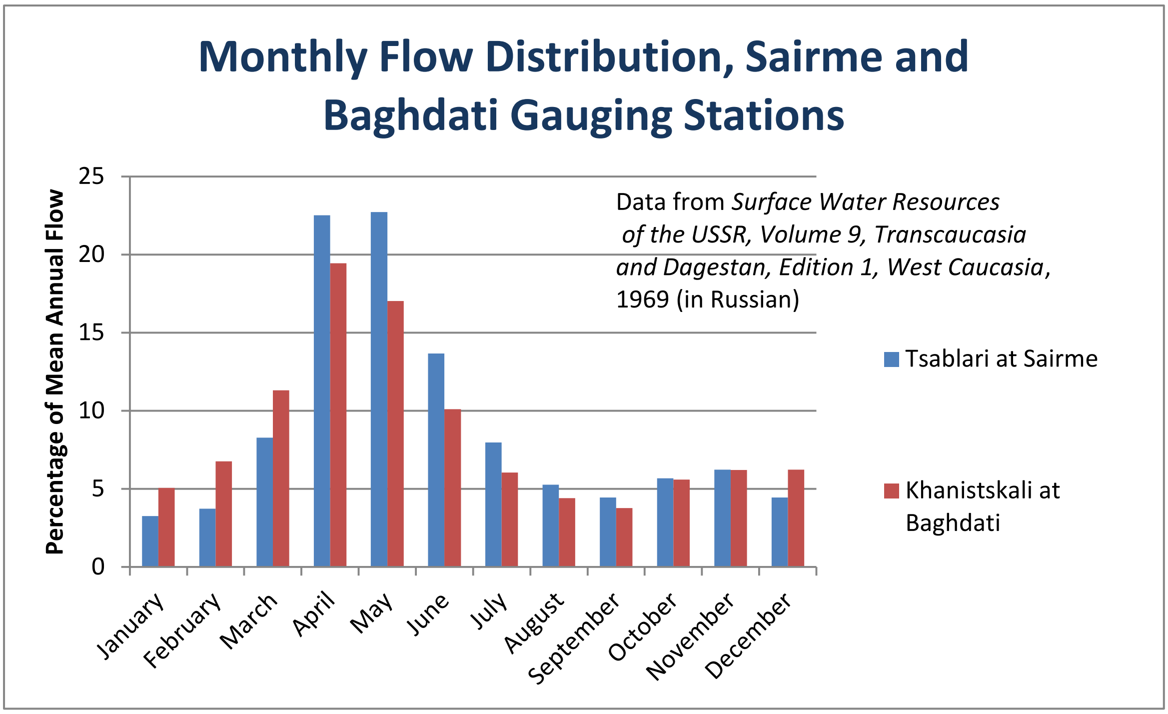
The site of the proposed Khani 2 Hydropower Plant Project (HPP) is located in the Baghdati district of western Georgia's Imereti Region. The potential hydropower project involves construction of an approximately 4.0 Megawatt (MW) run-of-river Hydropower Plant (HPP) on the Laishura River.

The Khani 2 HPP will be the upstream plant in a possible five-HPP cascade in the upper Khanistskali River Watershed Area. The Khanistskali River is 57 km long and drains an area of 914 km^2. It originates on the northern slopes of the Meskheti Mountain Range at an elevation of 2,280 m above sea level and flows into the Rioni River near Vartsikhe village. The river has four major tributaries, which are the heavily wooded with significant steep to very steep slopes that can create flash flood conditions. The upper reaches of the catchment are in the Alpine zone with alpine meadows with snowpack during the winter.

The Khani 2 Hydropower Plant site is located on the south bank of the Laishura River, located about 24 km upstream from the developed area of Baghdati district of Imereti Region. The nearest settlements are Khani and Kakaskhidi villages about 2.0-6.0 km away from the Khani 2 HPP powerhouse (See Appendices 1 and 2 for Location and Watershed maps).

The geologic conditions in the Khanistskali Basin are variable. The area enters the northern zone of the Adjara-Trialeti fold system of the Lesser Caucasus. No regional faults are observed within the watershed area, while earthquake probability is fairly high. Rock ranges from very strong deposits, through metamorphic rock zones to poorly cemented deposits. Layered tuffogenic rocks, tuff-breccias and alluvial formations are widely spread in the area. Alluvial sediments in the study area are predominately met along the river-valley having comparatively worked-out profile. 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 Khanistskali watershed area are very seasonal. Discharges are low during winter and summer months, and are high during spring. River is characterized by spring floods and autumn freshets. Icy edges are observed during January and February. Usually water is clear and potable during low-water periods and is not used for industrial purposes. The hydrological variability is demonstrated in the following chart, which shows the seasonality of flow at gauging stations in the upper Khanistskali River basin:



The diversion point for Khani 2 HPP is on the Laishura River, about 6.5 km upstream from Khani village. Moderate flows and high head are available at this location, making an HPP of about 4.0 MW appear attractive. The power plant will be located on the south bank of the Laishura River, about 2.0 km upstream from the village of Khani.

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

Project cost and construction schedule

The estimated cost of the Khani 2 HPP is US$ 11.9 million, or about US$ 2,980/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

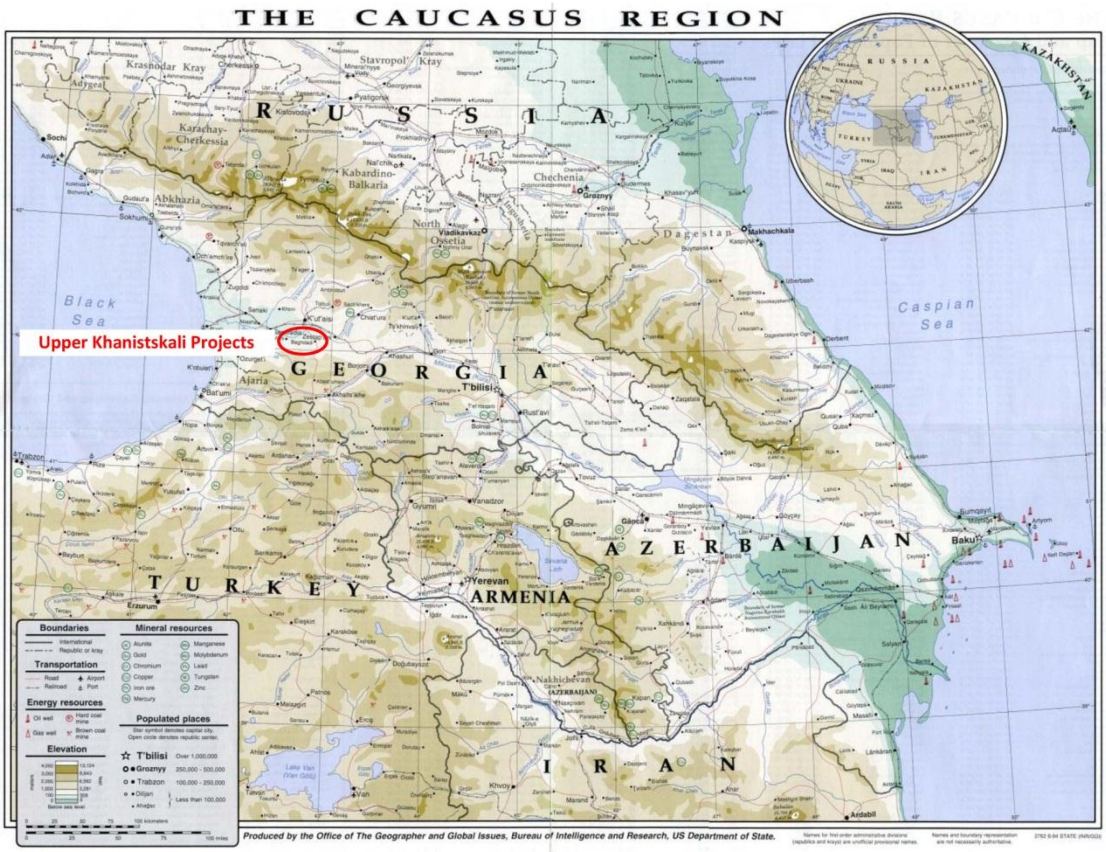
According to preliminary assessment, the plant offers a good potential opportunity to sell modest amounts of energy during three winter months inside Georgia, replacing (displacing) expensive thermal power; and to export energy during the remainder of the year to take advantage of the seasonal differentials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

Table 1: Project Significant Data

General	
Project name	Khani 2 Hydropower Project
Project location (political)	Baghdati District of western Georgia's Imereti Region
Nearest town or city	Baghdati
River name	Laishura River
Watershed name	Khanistskali River Watershed
Drainage area at diversion	89.0 km^2
Financial Estimates	
Estimated construction cost, including VAT	$ 11.9 Million
Estimated cost per kW capacity	$2,980/kW
Hydrological Data	
Stream gauge used	Sairme gauging station
Years of record	1965-86
Gauge drainage area	102 km^2
Mean river flow at intake	2.7 m^3/s
Facility design discharge	3.8 m^3/s
Preliminary design flood (100 yr. return period) (Adjusted to Intake Location)	24 m^3/s
Max. recorded flow (Sairme gauging station)	22 m^3/s
Mean annual flood (Sairme gauging station)	15.3 m^3/s
Diversion Facilities	
Normal operating level	757 masl
Approximate dam height	7 m
Approximate diversion pond area	1.1 ha
De-silting structure	Required
Sanitary or environmental bypass flow (assumed)	10% of mean annual flow
Power Tunnel	
Tunnel length	3,150 m
Tunnel section (horseshoe shape)	2.0 m wide, 2.5 m high
Penstock	
Penstock length	165 m
Outside diameter	1,420 mm
Powerhouse	
Type	Above-ground
Installed capacity	4.0 MW
Units, turbine output and turbine type	2 x 2.2 MW, horizontal Francis units
Units and rated generator capacity	2 x 2.75 MVA at 0.80 Power Factor
Preliminary generator voltage	10 kV or 6.3 kV
Rated speed	600 rpm
Units, type and net capacity at high-voltage transformer	2; 35/10-6.3 MVA or 35/6.3-6.3 MVA
Tailrace	
Length	30 m
Width	3.0 m
Type	Open channel
Normal tail water elevation	436 masl
Transmission line	
Interconnection location	Future Khani 3 SS connected to the existing 35 kV line Baghdati to Sairme
Distance to interconnection (km)	5.0 km
Voltage	35 kV
Power & Energy	
Gross head	130 m
Total head loss at rated discharge	7.4 m
Net head at rated discharge	122.6 m

Estimated average annual generation	Approximately 18.1 GWh
Nominal installed capacity	4.0 MW
Preliminary annual plant factor	52 %
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	Ajameti Protected Area

Project Location Map



1.0 GENERAL INTRODUCTION TO THE PROJECT

Table 2: Development Area Significant Data

Project Location (Political)	Western Georgia's Imereti Region
Political Subdivisions	Baghdati District (Municipality)
Area Population	28,800
Nearest Settlements	Khani and Kakaskhidi (Baghdati District)
River Name	Laishura
Economic Activity in the Area	Primarily agriculture, forestry, spring water production
Special Natural Resources	Timber, minerals, mineral waters
Special Cultural Resources	Churches, monasteries, ancient remnants of castles, etc.
Critical Environmental Receptors	Ajameti Protected Area

1.1 PROJECT AREA SOCIAL CHARACTERISTICS

The Khani 2 Project area is located in Baghdati Municipality, which is part of the Imereti Region Administrative Unit. The Bagdati municipality consists of one town and 23 villages. The city of Baghdati is the administrative center of the Baghdati district.The total area of Baghdati equals to 815 km^2, out of which 82.22 km^2 is used as an agriclutural land. The district is located between the elevations of 150 m and 2,200 m above sea level. The population for the whole municipality is about 28,800, giving a population density of 35.9 people/km^2 (National Statistics Office of Georgia, 2012). Of the residents, 99.5% are Georgians (*Source: National Population Sensus, 2002).*

Herdsmen from the Khani village. Image taken by HIPP team during the field visit

The village of Khani. Image taken by HIPP team during the field visit

Baghdati district is mainly covered by mountains and platueas drained by five major rivers with a total length of 136 km. The economy currently relies heavily on manufacturing wood products for construction in Baghdati and agriculture in the lowlands. However, the main agricultural activities of the region are tending vineyards and wine making, vegetable cultivation and animal husbandry.The district is rich in minerals (tuff, basalt, diabase, marble, granite) and mineral waters. In the Baghdati district there are two mineral hot spring resorts, Sairme and Zekari. Sairme mineral water spring resort is under renovation and expansion. In the Baghdati district, about 109,226 deciliters of spring water was commercially produced and bottled in 2005 (Source: Bagdadi Municipal Economic Development Plan, Baghdadi Municipality, 2007). The region is also culturally rich represented by many old churches, monasteries, towers and other cultural relics, such as Rhodopolis Castle dating back to the 4th -6th century A.D., Dimi Towers, etc. Ajameti Managed Reserve harboring endemic and the Red List species is one of the natural monuments of the district.

Khani 2 HPP lies in the upper reach of the Laishura River. The nearest settlments to the project area, Kakaskhidi and Khani villages (Nergeeti community), are at 18 km and 25 km respectively from Baghdati town. The villages are located at 750-850 m above sea level. According to the last census (2002) Kakaskhidi has up to 32 inhabitants, and 817 people reside in Khani village. The local community mainly depends on subsistance farming (animal husbandary, vineyeards and vegetables). Medievel historic monuments are found in the villages, such as churches of the twelve apostoles in Khani and “Berieti” in Kakaskhidi.

1.2 PROJECT AREA ENVIRONMENTAL CHARACTERISTICS

Floodplain at the Khanistskali River. Image taken by HIPP team during the field visit

Bridge across the Laishura River. Image taken by HIPP team during the field visit

Flora: The Khanistskali River watershed in Baghdati district of Imereti region is rich in biological resources. The district mainly extends over mountinious landscapes of the Meskheti range and Imereti lowlands. Forests occupy nearly 67% of the territory (See Appendix 7 - Land Cover) represented with native Colchic forest. Dominating trees are spruce (*Picea orientalis*), fir (*Abies nordmaniana*), pine (*Pinus kochiana*), ash (*Fraxinus excelsior*), beach (*Fagus orientalis*), birch (*Betuta pendula*), sycamore maple (*Acer pseudoplatanus*), hornbeam (*Carpinus betulus*), chestnut (*Castanea sativa*), lime-tree (*Tilia caucasica*), elm (*Ulmus glabra, Ulmus elliptica*), oak (*Quercus imeretina*), maple (*Acer laetum* & *Acer campestre*), and very occasionally yew (*Taxus baccata*).

The bushes that thrive within the forest include Pontic Rhododendron (*Rhododendron ponticum*), Holly (*Ilex aquifolium*), Laurel Cherry (*Laurocerasus officinalis*), Oriental Hornbeam (*Carpinus orientalis*), Bilberry (*Vaccinium myrtillus*), Cornel Cherry (*Cornus mas*), Medlar (*Mespilus germanica*), Hazelnut (*Corylus avellana*), Blackberry (*Rubus spp*.) and Raspberry (*Rubus idaeus*) (Encyclopedia of Georgia, 1984).

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

Fauna: The Khanistskali watershed area shelters various fauna species. The most common mammals in the area are: wolf (*Canis lupus*), jackal (*Canis aureus*), roe deer (*Capreolus capreolus*), chamois (*Rupicapra rupicapra*), wild boar (*Sus scrofa*), fox (*Vulpes vulpes*), marten (*Martes martes, M. foina*), badger (*Meles meles*) and hare (*Lepus europaeus*). The following bird species are relatively common throughout the watershed area: quail (*Coturnix coturnix*), woodcock (*Gallinago gallinago*), black grouse (*Tetrao mlokosiewiszi*), duck (*Anas plathyrhynchos*), corncrake (*Crex crex*), swan (*Cygnus olor*), wild pigeon (*Columba palumbus*), blackbird (*Turdus merula*), miscle thrush (*Turdus viscivorus*), chaffinch (*Fringilla coelebs*), woodpecker (*Dendrocopos spp*.), (Jordania R., Boeme B., Kuznetsov A., 1999).

Some of the resident species are among the “red-list” species of Georgia, including chamois with status of endangered (EN), black grouse being vulnarable (VU), and others.

The following fish species were reported to be found in the Khanistskali River: barbell (Barbus capito), mudfish (Cobitis taenia satunini) and trout (Salmo fario). The Red Book of Georgia classifies the trout as National Statute Vulnerable. (Elanidze, R. 1988).

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

Table 3: Khanistskali River Fish Spawning Periods

Fish	Spawning Period
Trout	September-October
Mudfish	May-June
Barbell	May-June

Literature on fish composition in the Khanistskali River dates back several decades. Since then no monitoring on fish species has been conducted. Therefore, it’s hard to know whether all of these species still inhabit the study area or not. The sampling of fish species should be included as part of the feasibility study and environmental assessment.

1.3 TRANSMISSION

The current transmission and high voltage (HV) 35 kV and 110 kV lines and distribution system in Baghdati District area are owned and operated by Energo-Pro, the licensed distribution utility serving most of Georgia outside Tbilisi. Energo-Pro also owns 110 kV Baghdati Substation (SS) which is connected to Kokhra SS in Zestaponi with 110 kV line. Energotrans/Georgian State Electrosystem (GSE) owns 500 kV Zekari line running from Kokhra SS to Akhaltsike newly built SS crossing the Khanistskali watershed area near village Khani.

Zekari 500 kV line near Zestaphoni. Image taken by HIPP team

10 kV line running to Khani village along the Khanistskali River. Image taken by HIPP team

The Khani 2 power plant will be located 2.0 km upstream from Khani village. About 5.0 km of new 35 kV line will be needed to evacuate the power from the Khani 2 SS to the planned Khani 3 SS, which in turn will be connected to the existing 35 kV line running parallel to the public road and serving the villages of the Tsablaristskali and Khanistskali Gorge and particularly the Sairme Resort.

1.4 ACCESS TO THE AREA

Infrastructure of the region is developed. The highway and road connections are good and it is possible to drive from Tbilisi to Baghdati in 3 hours. During recent period rehabilitation of roads has been implemented by the Government of Georgia within the region. The main road from Baghati to Sairme was recently repaved. The road to Baghdati and surrounding villages is kept open during wintertime.

The main roads beyond Baghdati are unpaved. 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 (Khani, and Sakraula) are sometimes closed during the winter and are subject to temporary closure due to heavy snowfall.

Head-structure location at the Laishura River. Image taken by HIPP team during the field visit

Power house location at the Laishura River. Image taken by HIPP team during the field visit

Some of the high-elevation intake areas (Khani 2 and Khani 3) 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. The proposed diversion structure and the power house location for the Khani 2 HPP can be passable on foot or horse only. To reach the Khani 2 HPP construction sites about 1.0 km of new road needs to be built and 4.0 km of existing road should be rehabilitated.

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	102 km^2
Total drainage area for Khani 2 HPP	86.0 km^2
Adjustment factor	0.873
Maximum plant discharge	4.1 m^3/s
Minimum plant discharge	As low as 0.4 m^3/s
Flood flows	Average Annual Flood 13.4 m^3/s*
Highest recorded flow	22 m^3/s
Calculated 100 year flood	24 m^3/s*, based on 21 year period of record
Records available	Mean monthly flows of the Tsablari River at Sairme gauging station for 22 years, from publications of the Hydromet.
Recommended additional data collection and study recommendations for feasibility and design	Install the new gauging station at Khani 2 HPP's headworks. It 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 Sairme 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	5.2	5.8	8.4	12.9	17.9	21.0	23.2	23.6	20.5	16.4	11.5	7.5	14.5	
Lowest Average monthly Air Temperature in °C	2.0	2.5	4.4	8.4	12.7	16.2	18.7	19.3	15.9	12.1	8.2	4.6		
Lowest Air Temperature in °C	-17	-13	-10	-5	2	9	11	11	5	-2	-10	-13		
Highest Average Monthly Air Temperature in °C	9.0	9.9	13.3	18.9	24.1	27.0	28.4	28.9	26.0	21.8	15.9	11.4		
Highest Monthly Air Temperature in °C	21	25	32	35	37	40	41	42	40	35	30	25		
Average Relative Humidity in %	68	68	69	66	69	72	76	75	74	71	65	64	70	
Average Monthly Precipitation in mm	136	131	113	99	84	97	110	91	116	131	131	141		1380
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	0.8	0.7	0.5	1.0	

Source: *Data on climate and meteorology for Kutaisi was provided by the Department of Hydrometeorology of Georgia.*

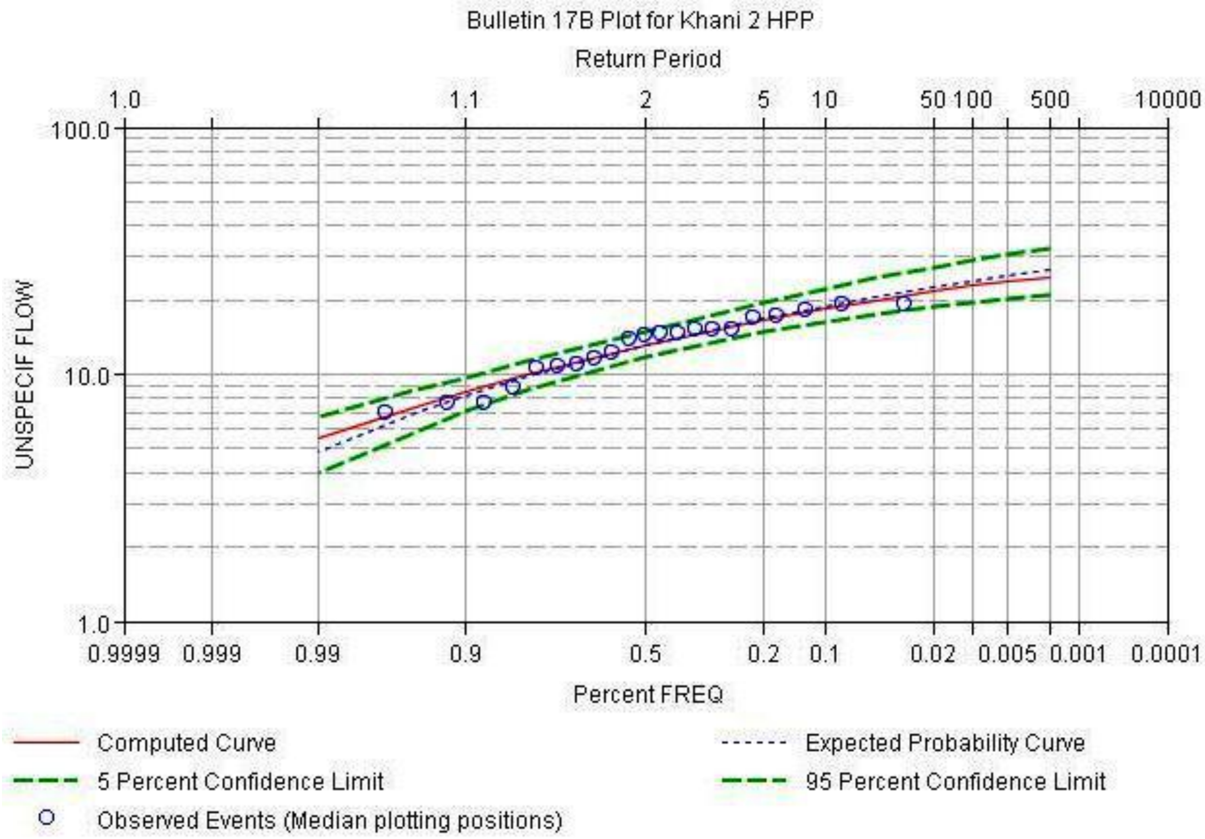
Also see Appendix 8 for the Map of the Mean Annual Precipitations.

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 21 years of peak flood flow data are available for the Sairme 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 for the Khani 2 HPP are shown on the following plot:



Flood flows of Sairme gauge 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.

2.4 SEDIMENT

There is no data on suspended and bed load sediments for the Khanistskali River within the project area. Solely, results of 8 years monitoring of sediment loads exist from the Didvela gauging station on the Khanistskali River which reflects contribution of the coarse materials from the main tributaries of Sakraula and Tsablaristskali Rivers.

New sediment data for the Khani 2 HPP should be made during feasibility study. Suspended solids, bed load, 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 Khanistskali River at the Didvela Gauge.

Table 6: Khanistskali River at Didvela 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	Assumed Daily Maximum kg/s
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**			
1950	0.12	1.2	11	15	1.7	1.1	0.73	0.097	0.12	2.5	0.038	0.046	2.80	88	82 (7/IV)
1951	0.076	1.2	4.6	0.54	1.5	1.4	11	0.48	1.0	7.6	20	1.4	4.23	130	320 (14/XI)
1952	3.3	2.6	2.3	6.4	11	18	0.24	0.003	0.004	0.31	0.39	6.3	4.24	130	260 (12/VI)
1953	6.0	2.0	6.8	22	3.5	3.0	1.3	6.1	0.47	1.6	2.0	1.3	4.67	150	150 (14/IV)
1954	3.8	2.2	9.5	14	9.0	3.9	1.3	0.75	0.14	0.41	0.047	0.008	3.75	120	140 (31/III)
1955	0.012	0.84	4.8	15	0.18	0.21	0.32	0.64	0.29	0.27	4.3	5.6	2.71	85	330 (1/IV)
1956	2.2	0.53	0.56	12	9.0	4.0	0.99	0.031	2.7	0.76	9.4	0.32	3.54	110	100 (20/V)
1957	2.4	0.99	11	7.1	2.3	1.5	3.8	0.35	0.19	4.4	1.7	11	3.89	120	240 (17/XII)
1958	0.45	3.3	17	14	3.4	1.0	0.33	0.086	0.20	4.1	2.1	1.3	3.94	120	420 (20/III)
Monthly Average	2.04	1.65	7.51	11.78	4.62	3.79	2.22	0.95	0.57	2.44	4.44	3.03	3.80	117	N/A
Monthly Maximum	6.00	3.30	17.00	22.00	11.00	18.00	11.00	6.10	2.70	7.60	20.00	11.00	N/A	N/A	N/A
Monthly Minimum	0.01	0.53	0.56	0.54	0.18	0.21	0.24	0.00	0.00	0.27	0.04	0.01	N/A	N/A	N/A

Note: This data is published by the Hydromet (The National Environmental Agency, Dept. of Hydrometeorology, Government of Georgia) and was collected and provided by a consultant to the project team.

3.0 GEOLOGY

3.1 GEOLOGICAL MAP

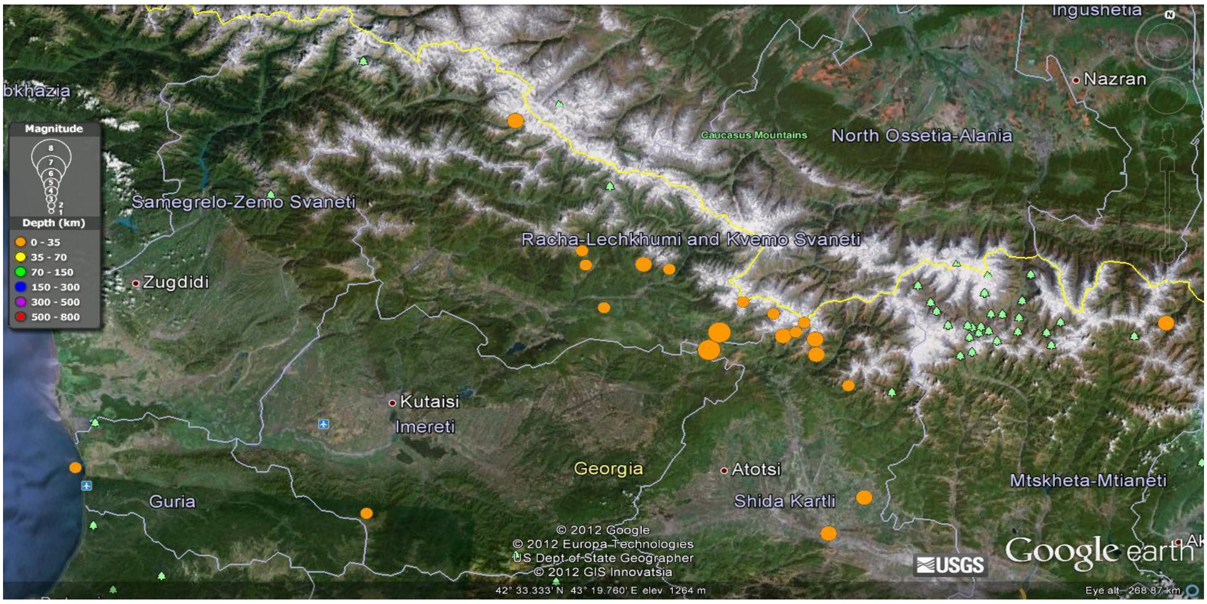
The geologic data available at the time of this study included geologic maps at the scales of 1:250,000, 1:50,000, and 1:25,000; and field reconnaissance notes by HIPP's consulting geologist. The Khani 2 HPP area has diverse geo-morphological structure, largely consisting of semi-rock and rock masses suitable for construction and operation of medium-sized HPPs. The Khanistskali river watershed belongs to northern branch of the Akhaltsikhe-Imereti ridge. The study area is built mainly of the Mid-Eocene lower suite consolidated rocks mixed with semi-consolidated masses. The rocks are formed from the packs of grained tuffs, tuff-sandstones and rarely tuff-argilites with layers and coverings of tuff-breccias and porphyrites. The penstock and canal go through the zone of deluvial deposits composed of sandstones. Part of the dam and power house will be located in the area of poorly cemented river deposits, mainly represented by the admixture of cobbles, pebbles and sand. No major faults or landslide zones are observed within the project area. 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 geology of the project area is characterized by crossing the boundary between two tectonic zones: the Fold system of the greater Caucasus (Gagra-Djava Zone) and Transcaucasia Intermountain Area (Central Zone of Uplift). As a result of being on the boundary of these tectonic plates, according to the current Georgian seismic zoning classification the project is in hazardous zone 8. 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 different regions of Georgia, 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 Khani 2 HPP development is expected to include a diversion weir across the Laishura River, intake structure, de-silting structure, canal, free-flow tunnel, pressure tank, penstock and surface powerhouse. A substation will be located near the plant. A 35 kV transmission line will connect Khani 2 SS to the planned Khani 3 SS, which in turn will be connected to the existing 35 kV line of Baghdati-Sairme. A short tailrace channel will convey water from the powerhouse to the Laishura 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 Khani 2 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 diversion for the run-of-river Khani 2 HPP will be located on the Laishura River. It will include sluice gates and a short concrete overflow spillway section. The intake structure will be located on the right side of the dam. It 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 intake will enter a transition section leading to a de-silting structure controlled by gates. The de-silting structure will direct the flow into the free-flow tunnel through the 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 1.4 m-diameter steel penstock, about 165 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 along the Khanistskali River.

This installation will result in a maximum electric power output, at the high-voltage transformer terminals, of about 4.0 MW, as shown in the following table:

Table 8: Khani 2 HPP Power and Energy Calculations

Calculations for Average Monthly Flows												
Tsablaristskali riv. Streamflow gauge Sairme						F= 102 km^2				1965-86		
I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Average**
1.12	1.28	2.84	7.73	7.80	4.69	2.74	1.81	1.53	1.95	2.14	1.53	3.10
Laishura riv. ▼750						F= 89.0 km^2				K=89.0/102=0.873		
0.98	1.12	2.48	6.75	6.81	4.09	2.39	1.58	1.34	1.70	1.87	1.34	2.70

Khani 2 HPP

Hydropower Calculations for Average Monthly Flows — Q_{HPP}= **3.8** 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 ∑h, 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	**0.98**	28	0.27	_	**0.71**	757	627	130	6.45	123.55	0.90	772	0.96	741	744	0.551
II	**1.12**	24	0.27	_	**0.85**	757	627	130	6.47	123.53	0.90	924	0.96	887	672	0.596
III	**2.48**	11	0.27	_	**2.21**	757	627	130	6.74	123.26	0.90	2,404	0.96	2,308	744	1.717
IV	**6.75**	44	0.27	2.68	**3.80**	757	627	130	7.37	122.63	0.90	4,114	0.96	3,950	720	2.844
V	**6.81**	44	0.27	2.74	**3.80**	757	627	130	7.37	122.63	0.90	4,114	0.96	3,950	744	2.939
VI	**4.09**	7	0.27	0.02	**3.80**	757	627	130	7.37	122.63	0.90	4,114	0.96	3,950	720	2.844
VII	**2.39**	11	0.27	_	**2.12**	757	627	130	6.72	123.28	0.90	2,310	0.96	2,217	744	1.650
VIII	**1.58**	17	0.27	_	**1.31**	757	627	130	6.53	123.47	0.90	1,428	0.96	1,371	744	1.020
IX	**1.34**	20	0.27	_	**1.07**	757	627	130	6.49	123.51	0.90	1,162	0.96	1,116	720	0.803
X	**1.70**	16	0.27	_	**1.43**	757	627	130	6.55	123.45	0.90	1,561	0.96	1,499	744	1.115
XI	**1.87**	14	0.27	_	**1.60**	757	627	130	6.59	123.41	0.90	1,741	0.96	1,672	720	1.204
XII	**1.34**	20	0.27	_	**1.07**	757	627	130	6.49	123.51	0.90	1,162	0.96	1,116	744	0.830

Gross average annual generation including losses	**18.113**	GWh
Estimated energy losses from outages, substation losses 5%	**0.906**	GWh
Average annual energy for sale	**17.207**	GWh
HPP operation duration per year	**4,586**	h
Capacity usage ratio/efficiency (plant factor)	**0.52**	

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 Khanistskali Watershed

River	Location	Drainage Area, km^2	Period of Record	Gauge Owner	Comments
Tsablaristskali	Sairme	102.0	1965-86	HydroMet	have monthly
Khanistskali	Baghdati	655.0	1937-90	HydroMet	have daily data

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 Khanistskali 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. Sanitary flow for this study is set as a 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 Khani 2 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 all phases of construction from initial land and water resource disturbance facility this is a short term impact period of approximately 3 years. It includes 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 Khani 2 HPP) are expected to be relatively low, based on information that is available at this time. The entirety of the Khani 2 HPP lies 17 km away from the boundaries of the Ajameti Protected Areas (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 Khanistskali 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 Baghdati District 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 Khani 2 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 Khani 2 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 March 2013. All costs were developed in US$ or were converted to US$ at exchange rates effective in March 2013.

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 thirty three 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: Khani 2 HPP Estimated Capital Expenditure

KHANI 2 HPP CAPEX				
	Units	Amt	Unit Cost US$	Total US$
Land purchase	ha	2.5	$12,000	$30,000
Preparatory & infrastructure works	LS			$150,000
New access road (8 m wide gravel)	m	1,000	$91	$90,600
Road rehabilitation	m	4,000	$23	$92,400
Stream diversion and cofferdams	LS			$130,000
Main Dam & Intake Structure	LS			$850,000
De-silting Structures	m	40		$350,000
Canal	m	20	$629	$12,580
Tunnel including rock bolts & shotcrete	m	3,150	$915	$2,882,250
Pressure Tank	LS			$61,000
Steel Penstock (D=1.42m)	m	165	$1,059	$174,735
Above ground power house	LS			$520,000
Tailrace canal	m	30	$780	$23,400
Turbines, Generators, Governors, Auxiliaries, etc. *	MW	4.0	$200,000	$800,000
Transformers and Switchyard equipment*	MW	4.0	$85,000	$340,000
Grid connection transmission line @ 35 kV	km	5.0	$75,000	$375,000
Subtotal of Schedule Items				**$6,881,970**
Geology (investigation field, lab and office) @ 1.5%	LS			$103,000
Feasibility study @ 1%	LS			$69,000
EIA @ 1%	LS			$69,000
EPCM @ 14%	LS			$963,000
Contingencies (Assumptions Variable) @ 25%	LS			$2,021,490
Subtotal				**$10,107,460**
VAT 18%				**$1,813,940**
Total				**$11,921,400**
MW Capacity	**4.0**		**CAPEX/kW**	**$2,980**

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

List of Figures

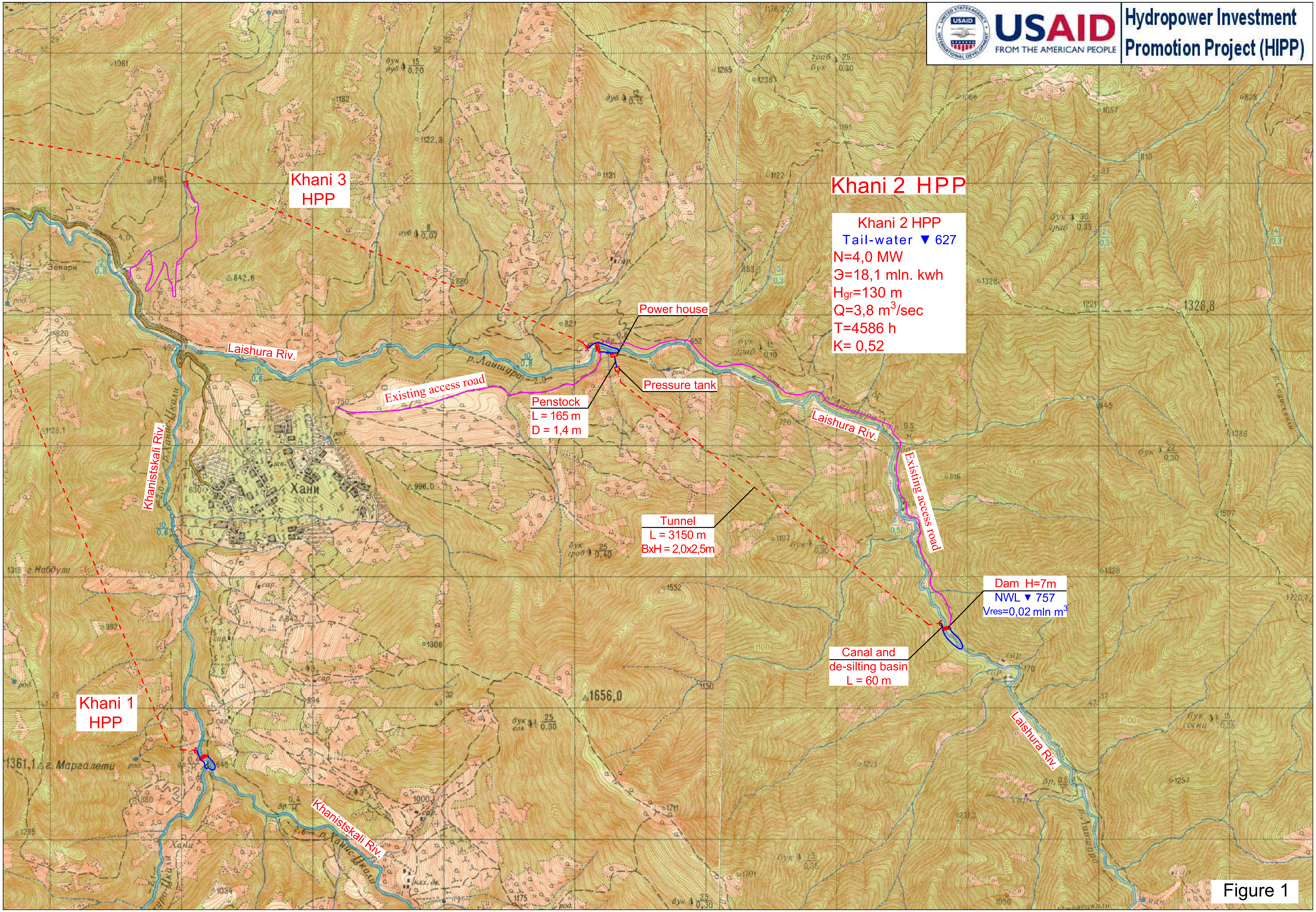

USAID
FROM THE AMERICAN PEOPLE
Hydropower Investment
Promotion Project (HIPP)
Khani 3 HPP
Khani 2 HPP
Khani 2 HPP
Tail-water ▼ 627
N=4,0 MW
Э=18,1 mln. kwh
Hgr=130 m
Q=3,8 m3/sec
T=4586 h
K= 0,52
Power house
Pressure tank
Laishura Riv.
Existing access road
Penstock
L = 165 m
D = 1,4 m
Laishura Riv.
Existing access road
Kanistskali Riv.
Tunnel
L = 3150 m
BxH = 2,0x2,5m
Dam H=7m
NWL ▼ 757
Vres=0,02 mln m3
Canal and
de-silting basin
L = 60 m
Laishura Riv.
Khani 1 HPP
Khanistskali Riv.
Figure 1

Figure 2

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

Khanistskali River Basin
Pre-Feasibility Study

Khanistskali River Profile

January 2013

Khani 2 HPP

Geological map

Scale 1:25 000

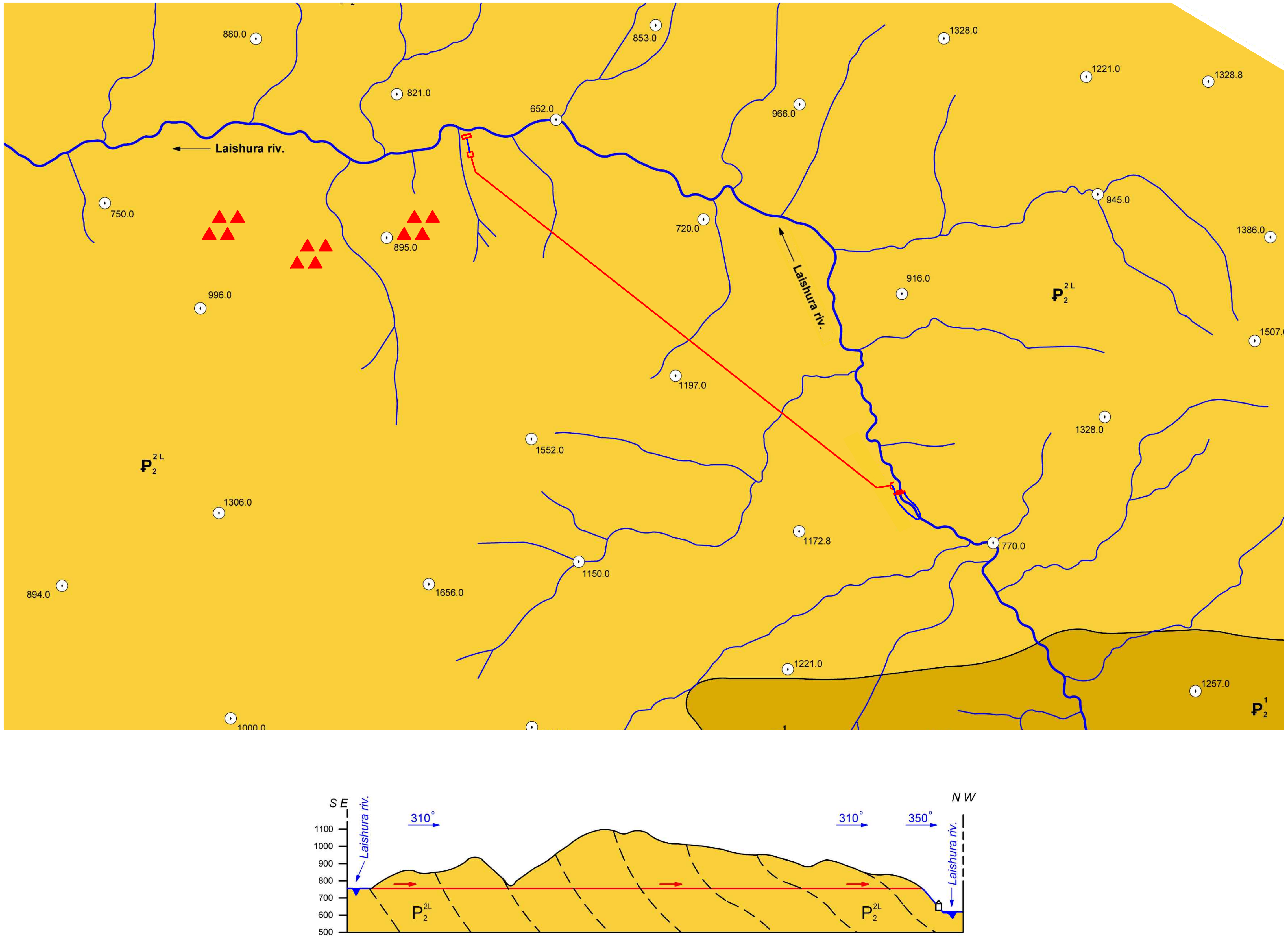
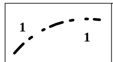
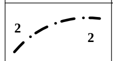
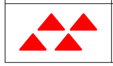


Figure 3

Figure 3A

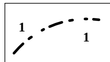
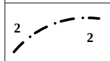
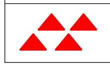
LEGEND

The Tertiary	The Paleogene	P_2^{2U}	Mid-Eocene. Upper Suite: massive Tuffs and tuff-breccias and with interlayers and coverings of porphyrites and aleurolites
		P_2^{2L}	Mid-Eocene. Lower Suite: Layered tuff-sandstones, tuff-Agillites, tuff-breccias with porphyrite coverings. Rarely, layers of massive lava-breccias and tuff-breccias.
		P_2^{1}	Lower-Eocene. Layered tuffs, tuff-sandstones with marl and sandstone layers

	Syncline axis
	Anticline axis
	Rock slides

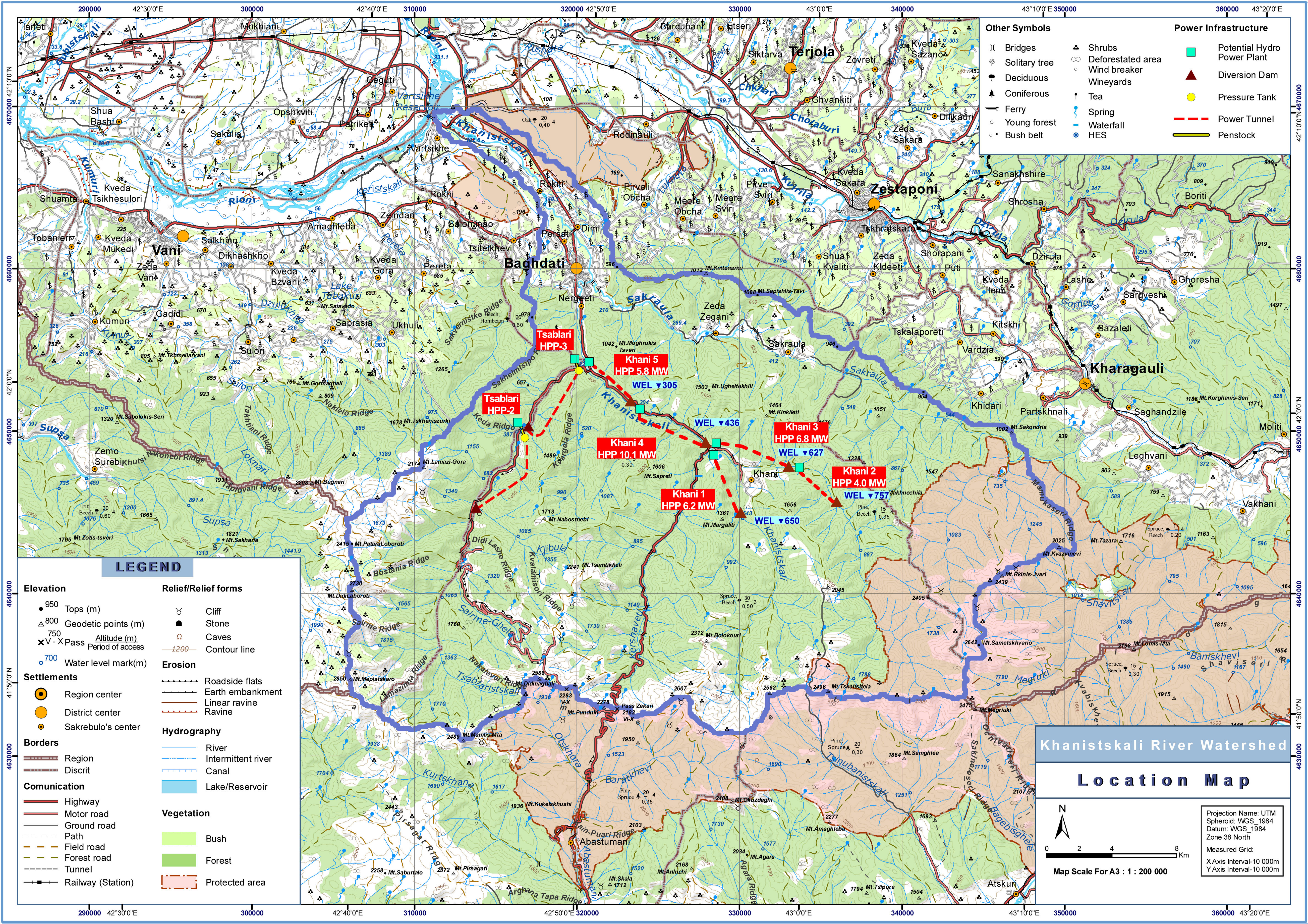
პირობითი ნიშნები

მესამეული სისტემა	პალეოგენი	P_2^{2U}	შუა ეოცენი (ზედა ქვეწყება) - მასიური ტუფები და ტუფობრექჩიები პორფირიტების დაიკებით და განფენებით, იშვიათად შრეებრივი ტუფებისა და ალევრიდების შუაშრეებით.
		P_2^{2L}	შუა ეოცენი (ქვედა ქვეწყება) - შრეებრივი ტუფები ტუფოქვიშაქვები, ტუფური არგილიტები, ტუფობრექჩიები პორფირიტების განფენებით. იშვიათად მასიური ტუფობრექჩიები და ლავური ბრექჩიების შუაშრეები.
		P_2^{1}	ქვედა ეოცენი - შრეებრივი ტუფები, ტუფოქვიშაქვები მერგელების და ქვიშაქვების შუაშრეებით.

	სინკლინის ღერძი
	ანტიკლინის ღერძი
	კლდეზვავი

APPENDIX 1

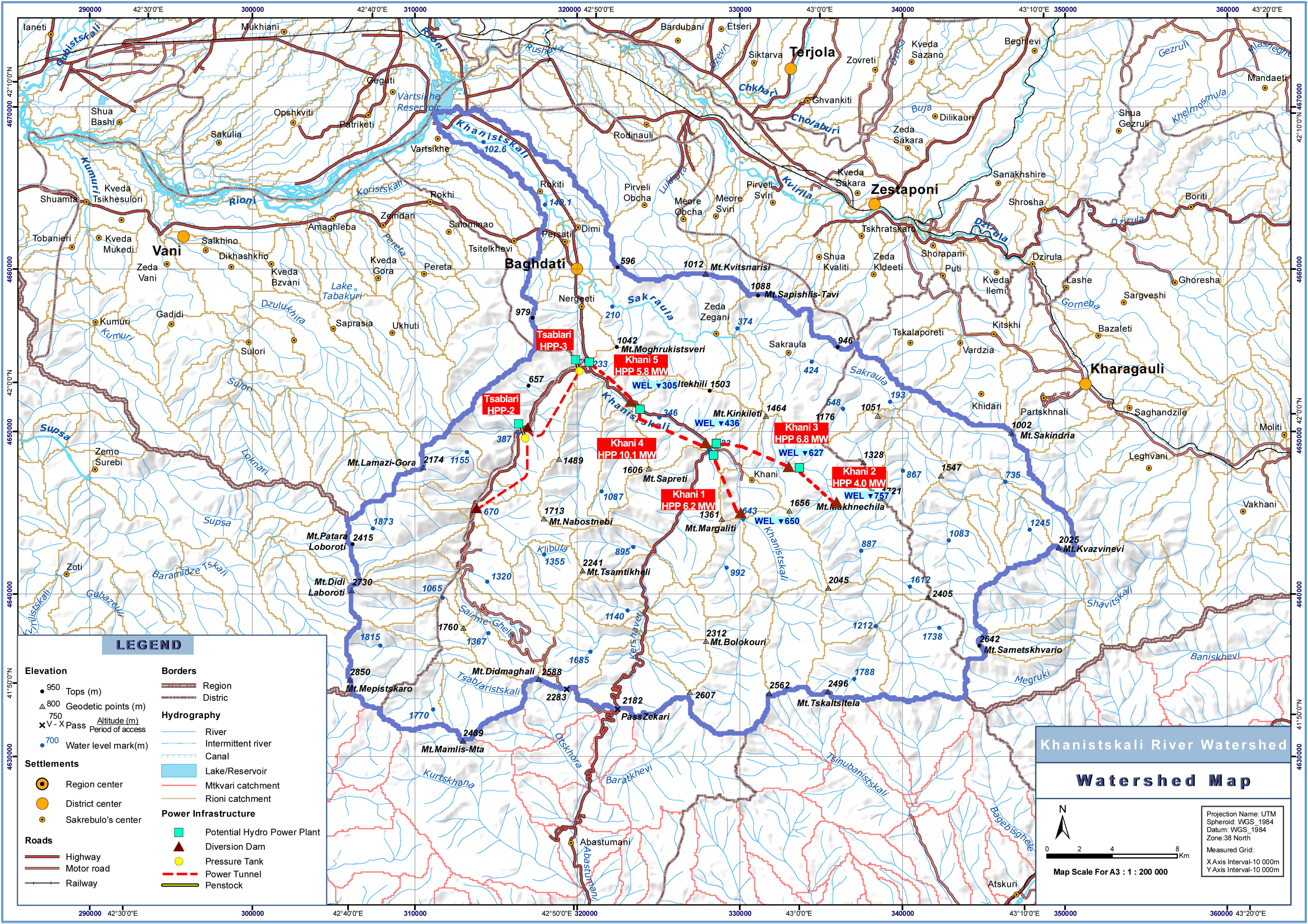
Location Map



Khanistskali River Watershed
Location Map
Other Symbols
Bridges
Solitary tree
Deciduous
Coniferous
Ferry
Young forest
Bush belt
Shrubs
Deforestated area
Wind breaker
Wineyards
Tea
Spring
Waterfall
HES
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Pressure Tank
Power Tunnel
Penstock
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
Region
Discrit
Comunication
Highway
Motor road
Ground road
Path
Field road
Forest road
Tunnel
Railway (Station)
Relief/Relief forms
Cliff
Stone
Caves
1200 Contour line
Erosion
Roadside flats
Earth embankment
Linear ravine
Ravine
Hydrography
River
Intermittent river
Canal
Lake/Reservoir
Vegetation
Bush
Forest
Protected area
Tsablari HPP-3
Tsablari HPP-2
Khani 5 HPP 5.8 MW
Khani 4 HPP 10.1 MW
Khani 3 HPP 6.8 MW
Khani 2 HPP 4.0 MW
Khani 1 HPP 6.2 MW
WEL ▼305
WEL ▼436
WEL ▼627
WEL ▼757
WEL ▼650
Terjola
Zestaponi
Baghdati
Vani
Kharagauli
Abastumani
Khanistskali
Rioni
Kvirila
Dzirula
Sakraula
Vartsikhe Reservoir
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m
Map Scale For A3 : 1 : 200 000
0 2 4 8 Km
N
290000 300000 310000 320000 330000 340000 350000 360000
42°30'0"E 42°40'0"E 42°50'0"E 43°0'0"E 43°10'0"E 43°20'0"E
4670000 4660000 4650000 4640000 4630000
42°10'0"N 42°0'0"N 41°50'0"N

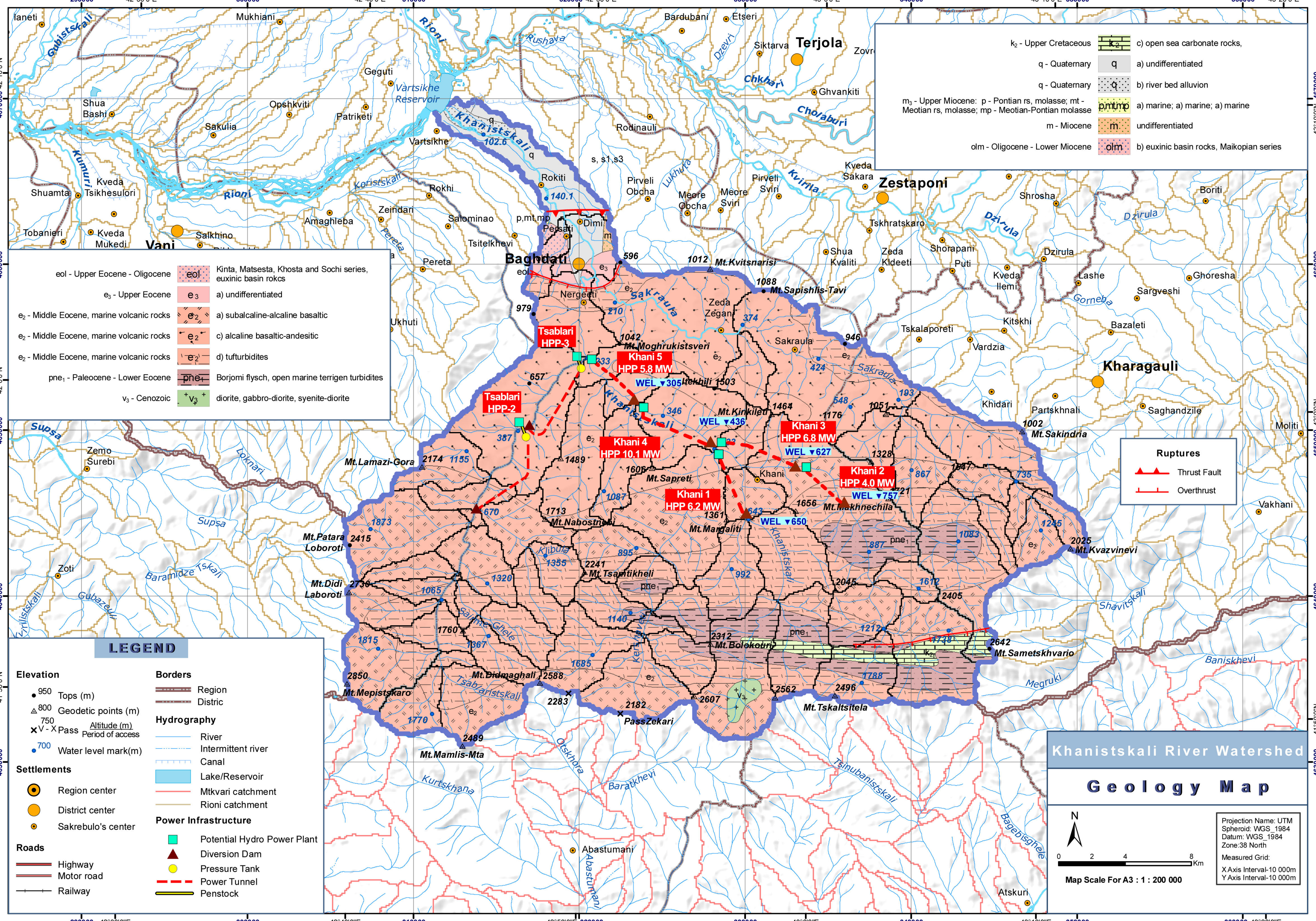
APPENDIX 2

Watershed Map


Khanistskali 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
Roads
Highway
Motor road
Railway
Borders
Region
Distric
Hydrography
River
Intermittent river
Canal
Lake/Reservoir
Mtkvari catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Pressure Tank
Power Tunnel
Penstock
Map Scale For A3 : 1 : 200 000
0 2 4 8 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
Tsablari HPP-3
Tsablari HPP-2
Khani 5 HPP 5.8 MW
Khani 4 HPP 10.1 MW
Khani 3 HPP 6.8 MW
Khani 2 HPP 4.0 MW
Khani 1 HPP 6.2 MW
WEL ▼305
WEL ▼436
WEL ▼627
WEL ▼757
WEL ▼650
Terjola
Zestaponi
Baghdati
Vani
Kharagauli
Abastumani
Khani
Khanistskali
Rioni
Kvirila
Sakraula
Vartsikhe Reservoir
Mt.Kvitsnarisi
Mt.Sapishlis-Tavi
Mt.Moghrukistsveri
Mt.Kinkileti
Mt.Sakindria
Mt.Makhnechila
Mt.Sapreti
Mt.Nabostnebi
Mt.Margaliti
Mt.Lamazi-Gora
Mt.Patara Loboroti
Mt.Didi Laboroti
Mt.Tsamtikheli
Mt.Kvazvinevi
Mt.Bolokouri
Mt.Sametskhvario
Mt.Didmaghali
Mt.Mepistskaro
Mt.Mamlis-Mta
Mt.Tskaltsitela
PassZekari
290000
300000
310000
320000
330000
340000
350000
360000
42°30'0"E
42°40'0"E
42°50'0"E
43°0'0"E
43°10'0"E
43°20'0"E
4670000
4660000
4650000
4640000
4630000
42°10'0"N
42°0'0"N
41°50'0"N

APPENDIX 3

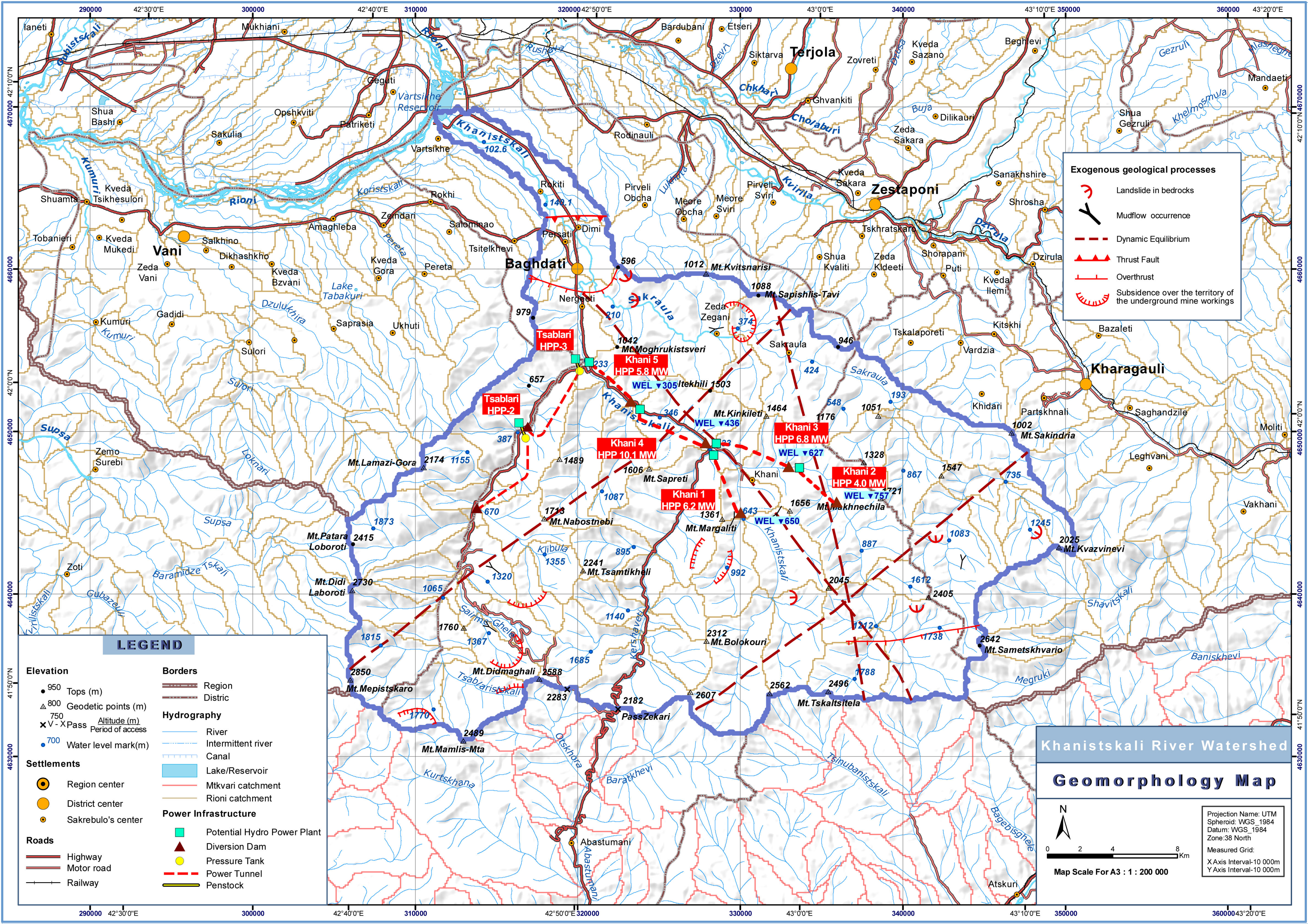
Geology Map



Khanistskali 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
Roads
Highway
Motor road
Railway
Borders
Region
Distric
Hydrography
River
Intermittent river
Canal
Lake/Reservoir
Mtkvari catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Pressure Tank
Power Tunnel
Penstock
eol - Upper Eocene - Oligocene | eol | Kinta, Matsesta, Khosta and Sochi series, euxinic basin rokcs
e3 - Upper Eocene | e3 | a) undifferentiated
e2 - Middle Eocene, marine volcanic rocks | e2 | a) subalcaline-alcaline basaltic
e2 - Middle Eocene, marine volcanic rocks | e2 | c) alcaline basaltic-andesitic
e2 - Middle Eocene, marine volcanic rocks | e2 | d) tufturbidites
pne1 - Paleocene - Lower Eocene | pne1 | Borjomi flysch, open marine terrigen turbidites
v3 - Cenozoic | v3 | diorite, gabbro-diorite, syenite-diorite
k2 - Upper Cretaceous | k2 | c) open sea carbonate rocks,
q - Quaternary | q | a) undifferentiated
q - Quaternary | q | b) river bed alluvion
m3 - Upper Miocene: p - Pontian rs, molasse; mt - Meotian rs, molasse; mp - Meotian-Pontian molasse | p,mt,mp | a) marine; a) marine; a) marine
m - Miocene | m | undifferentiated
olm - Oligocene - Lower Miocene | olm | b) euxinic basin rocks, Maikopian series
Ruptures
Thrust Fault
Overthrust
Tsablari HPP-3
Tsablari HPP-2
Khani 5 HPP 5.8 MW
Khani 4 HPP 10.1 MW
Khani 3 HPP 6.8 MW
Khani 2 HPP 4.0 MW
Khani 1 HPP 6.2 MW
WEL ▼305
WEL ▼436
WEL ▼627
WEL ▼757
WEL ▼650
Terjola
Zestaponi
Kharagauli
Baghdati
Vani
Vartsikhe Reservoir
Rioni
Khanistskali
Sakraula
Kvirila
Dzirula
Chkhari
Cholaburi
Supsa
Abastumani
Mt.Kvitsnarisi
Mt.Sapishlis-Tavi
Mt.Moghrukistsveri
Mt.Kinkileti
Mt.Sapreti
Mt.Nabostrebi
Mt.Margaliti
Mt.Makhnechila
Mt.Sakindria
Mt.Kvazvinevi
Mt.Lamazi-Gora
Mt.Patara Loboroti
Mt.Didi Laboroti
Mt.Tsamtikheli
Mt.Bolokouri
Mt.Sametskhvario
Mt.Mepistskaro
Mt.Didmaghali
Mt.Tskaltsitela
Mt.Mamlis-Mta
PassZekari
N
0 2 4 8 Km
Map Scale For A3 : 1 : 200 000
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m

APPENDIX 4

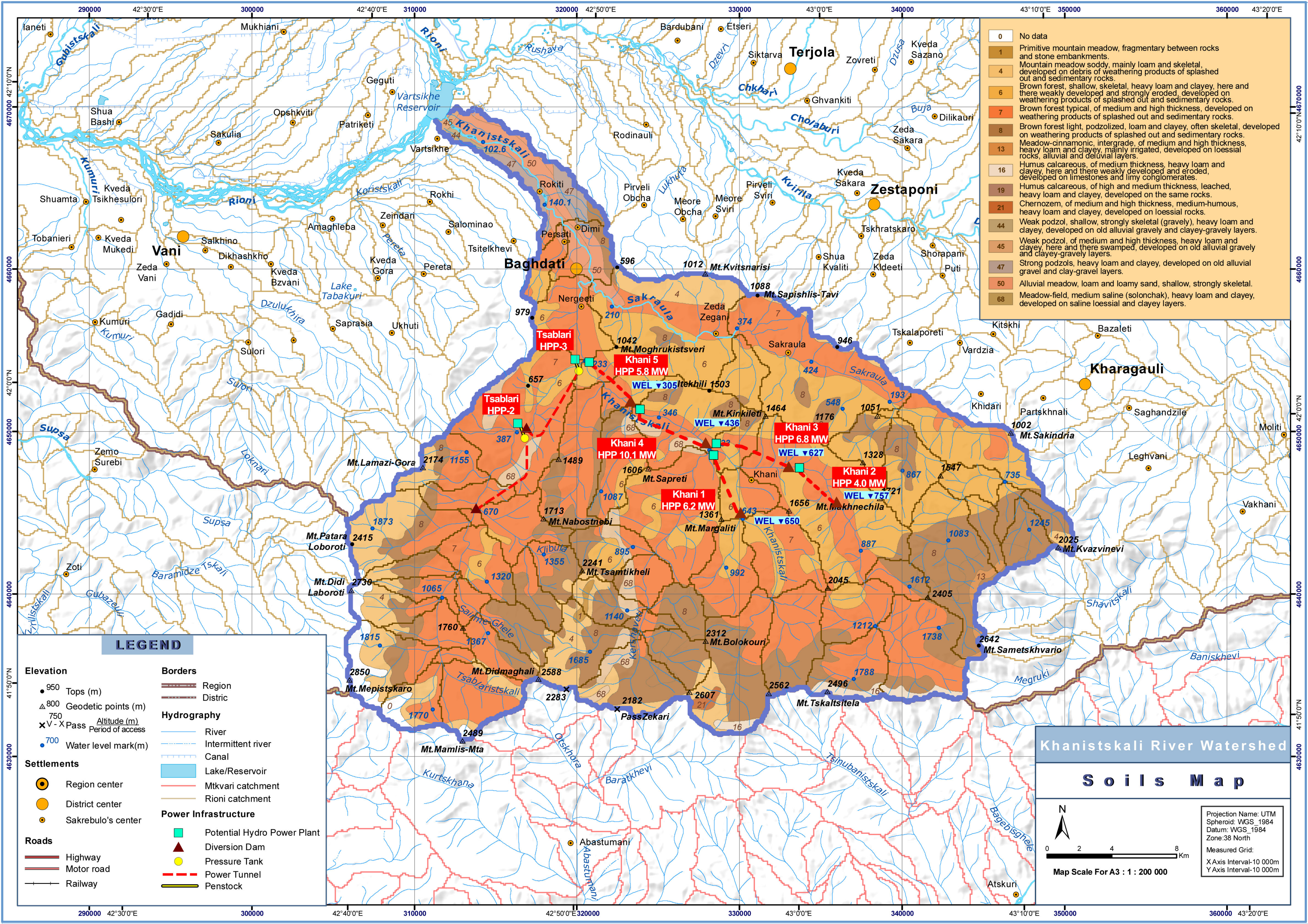
Geomorphology Map



Khanistskali River Watershed
Geomorphology Map
Exogenous geological processes
Landslide in bedrocks
Mudflow occurrence
Dynamic Equilibrium
Thrust Fault
Overthrust
Subsidence over the territory of the underground mine workings
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
Roads
Highway
Motor road
Railway
Borders
Region
Distric
Hydrography
River
Intermittent river
Canal
Lake/Reservoir
Mtkvari catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Pressure Tank
Power Tunnel
Penstock
Map Scale For A3 : 1 : 200 000
0 2 4 8 Km
N
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m
Tsablari HPP-3
Tsablari HPP-2
Khani 5 HPP 5.8 MW
Khani 4 HPP 10.1 MW
Khani 3 HPP 6.8 MW
Khani 2 HPP 4.0 MW
Khani 1 HPP 6.2 MW
WEL ▼305
WEL ▼436
WEL ▼627
WEL ▼757
WEL ▼650
Terjola
Zestaponi
Vani
Baghdati
Kharagauli
Khanistskali
Rioni
Sakraula
Kvirila
Dzirula
Supsa
Vartsikhe Reservoir
Lake Tabakuri
Mt.Kvitsnarisi
Mt.Sapishlis-Tavi
Mt.Moghrukistsveri
Mt.Kinkileti
Mt.Sapreti
Mt.Nabostnebi
Mt.Margaliti
Mt.Makhnechila
Mt.Sakindria
Mt.Kvazvinevi
Mt.Lamazi-Gora
Mt.Patara Loboroti
Mt.Didi Laboroti
Mt.Tsamtikheli
Mt.Bolokouri
Mt.Didmaghali
Mt.Mepistskaro
Mt.Mamlis-Mta
Mt.Tskaltsitela
Mt.Sametskhvario
PassZekari
Abastumani
Atskuri
290000 300000 310000 320000 330000 340000 350000 360000
4630000 4640000 4650000 4660000 4670000
42°30'0"E 42°40'0"E 42°50'0"E 43°0'0"E 43°10'0"E 43°20'0"E
42°10'0"N 42°0'0"N 41°50'0"N

APPENDIX 5

Soils Map



Khanistskali 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.
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.
13 Meadow-cinnamonic, intergrade, of medium and high thickness, heavy loam and clayey, mainly irrigated, developed on loessial rocks, alluvial and deluvial layers.
16 Humus calcareous, of medium thickness, heavy loam and clayey, here and there weakly developed and eroded, developed on limestones and limy conglomerates.
19 Humus calcareous, of high and medium thickness, leached, heavy loam and clayey, developed on the same rocks.
21 Chernozem, of medium and high thickness, medium-humous, heavy loam and clayey, developed on loessial rocks.
44 Weak podzol, shallow, strongly skeletal (gravely), heavy loam and clayey, developed on old alluvial gravely and clayey-gravely layers.
45 Weak podzol, of medium and high thickness, heavy loam and clayey, here and there swamped, developed on old alluvial gravely and clayey-gravely layers.
47 Strong podzols, heavy loam and clayey, developed on old alluvial gravel and clay-gravel layers.
50 Alluvial meadow, loam and loamy sand, shallow, strongly skeletal.
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
Roads
Highway
Motor road
Railway
Borders
Region
Distric
Hydrography
River
Intermittent river
Canal
Lake/Reservoir
Mtkvari catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Pressure Tank
Power Tunnel
Penstock
Tsablari HPP-3
Tsablari HPP-2
Khani 5 HPP 5.8 MW
Khani 4 HPP 10.1 MW
Khani 3 HPP 6.8 MW
Khani 2 HPP 4.0 MW
Khani 1 HPP 6.2 MW
WEL ▼305
WEL ▼436
WEL ▼627
WEL ▼757
WEL ▼650
Baghdati
Vani
Terjola
Zestaponi
Kharagauli
Khanistskali
Sakraula
Rioni
Kvirila
Vartsikhe Reservoir
Mt.Kvitsnarisi
Mt.Sapishlis-Tavi
Mt.Moghrukistsveri
Mt.Kinkileti
Mt.Sakindria
Mt.Lamazi-Gora
Mt.Sapreti
Mt.Nabostnebi
Mt.Margaliti
Mt.Makhnechila
Mt.Patara Loboroti
Mt.Didi Loboroti
Mt.Tsamtikheli
Mt.Kvazvinevi
Mt.Bolokouri
Mt.Sametskhvario
Mt.Didmaghali
Mt.Mepistskaro
Mt.Mamlis-Mta
Mt.Tskaltsitela
PassZekari
Abastumani
N
0 2 4 8 Km
Map Scale For A3 : 1 : 200 000
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m

APPENDIX 6

Preliminary Turbine – Generator Characteristics

TURBNPRO Version 3 - FRANCIS TURBINE SOLUTION SUMMARY

Solution File Name: d:₩projects₩database₩turbin~1₩khani2

TURBINE SIZING CRITERIA

Rated Discharge:	67.1	cfs	/	1.9	m3/s
Net Head at Rated Discharge:	402.2	feet	/	122.6	meters
Gross Head:	426.5	feet	/	130.0	meters
Site Elevation:	2057	feet	/	627	meters
Water Temperature:	41	Degrees F	/	5	Degrees C
Setting to Tailwater:	6.6	feet	/	2.0	meters
Efficiency Priority:			5		
System Frequency:			50 Hz		
Minimum Net Head:	402.2	feet	/	122.6	meters
Maximum Net Head:	405.2	feet	/	123.5	meters

FRANCIS TURBINE SOLUTION DATA

Arrangement: HORIZONTAL WITH RUNNER ON TURBINE SHAFT
Intake Type: SPIRAL CASE WITH INLET BELOW UNIT AXIS
Draft Tube Type: ELBOW
Runner Diameter: 25.4 inches / 645 mm
Unit Speed: 600.0 rpm
Multiplier Efficiency Modifier: 1.000
Flow Squared Efficiency Modifier: 0.0000

Specific Speed at Rated Net Head -	(US Cust.)	(SI Units)
At 100% Turbine Output:	17.5	66.7
At Peak Efficiency Condition:	16.7	63.8

SOLUTION PERFORMANCE DATA

At Rated Net Head of: 402.2 feet / 122.6 meters

% of Rated Discharge	Output (KW)	Efficiency (%)	cfs	m3/s
** 109.0	2210	88.7	73.1	2.1
100	2058	90.1	67.1	1.9
* 90.9	1881	90.5	61.0	1.7
75	1537	89.7	50.3	1.4
50	960	84.0	33.5	1.0
25	384	67.2	16.8	0.5
+ 44.3	826	81.5	29.7	0.8

** - Overcapacity
* - Peak Efficiency Condition
+ - Peak Draft Tube Surging Condition

At Maximum Net Head of: 405.2 feet / 123.5 meters

Sigma Allowable	Max. Output (KW)	Efficiency (%)	cfs	m3/s
0.040	2227	88.7	73.1	2.1

At Minimum Net Head of: 402.2 feet / 122.6 meters

Sigma Allowable	Max. Output (KW)	Efficiency (%)	cfs	m3/s
0.040	2210	88.7	73.1	2.1

Solution File Name: d:₩projects₩database₩turbin~1₩khani2

MISCELLANEOUS DATA

Maximum Runaway Speed (at Max. Net Head):	947 rpm	
Turbine Discharge at:		
Runaway Speed (at Rated Net Head & 100% gate):	27 cfs	0.8 m3/s
Synchronous Speed-No-Load (at Rated Net Head):	5 cfs	0.1 m3/s
Site's Atmospheric Pressure minus Vapor Pressure:	31.2 feet	9.5 meters
Sigma Allowable (at 100% Output & Rated Net Head):	0.030	
Sigma Plant (at 100% Output & Rated Net Head):	0.061	
Maximum Hydraulic Thrust (at Max. Net Head):	11629 lbs	5286 kg
Approximate Runner and Shaft Weight:	1830 lbs	832 kg
Vel. at Draft Tube Exit (at Rated Head & Discharge):	5.3 fps	1.6 m/s

DIMENSIONAL DATA

Intake Type: SPIRAL CASE WITH INLET BELOW UNIT AXIS

	inches	mm
Inlet Diameter:	30.0	762
Inlet Offset:	48.9	1241
Centerline to Inlet:	74.8	1899
Outside Radius A:	63.9	1622
Outside Radius B:	61.1	1552
Outside Radius C:	58.0	1472
Outside Radius D:	53.7	1365

Draft Tube Type: ELBOW

	inches	mm
Centerline to Invert:	50.8	1290
Shaft Axis to Exit Length:	137.1	3483
Exit Diameter:	48.2	1226
Exit to Bottom Floor:	25.0	635

Shafting Arrangement: HORIZONTAL WITH RUNNER ON TURBINE SHAFT

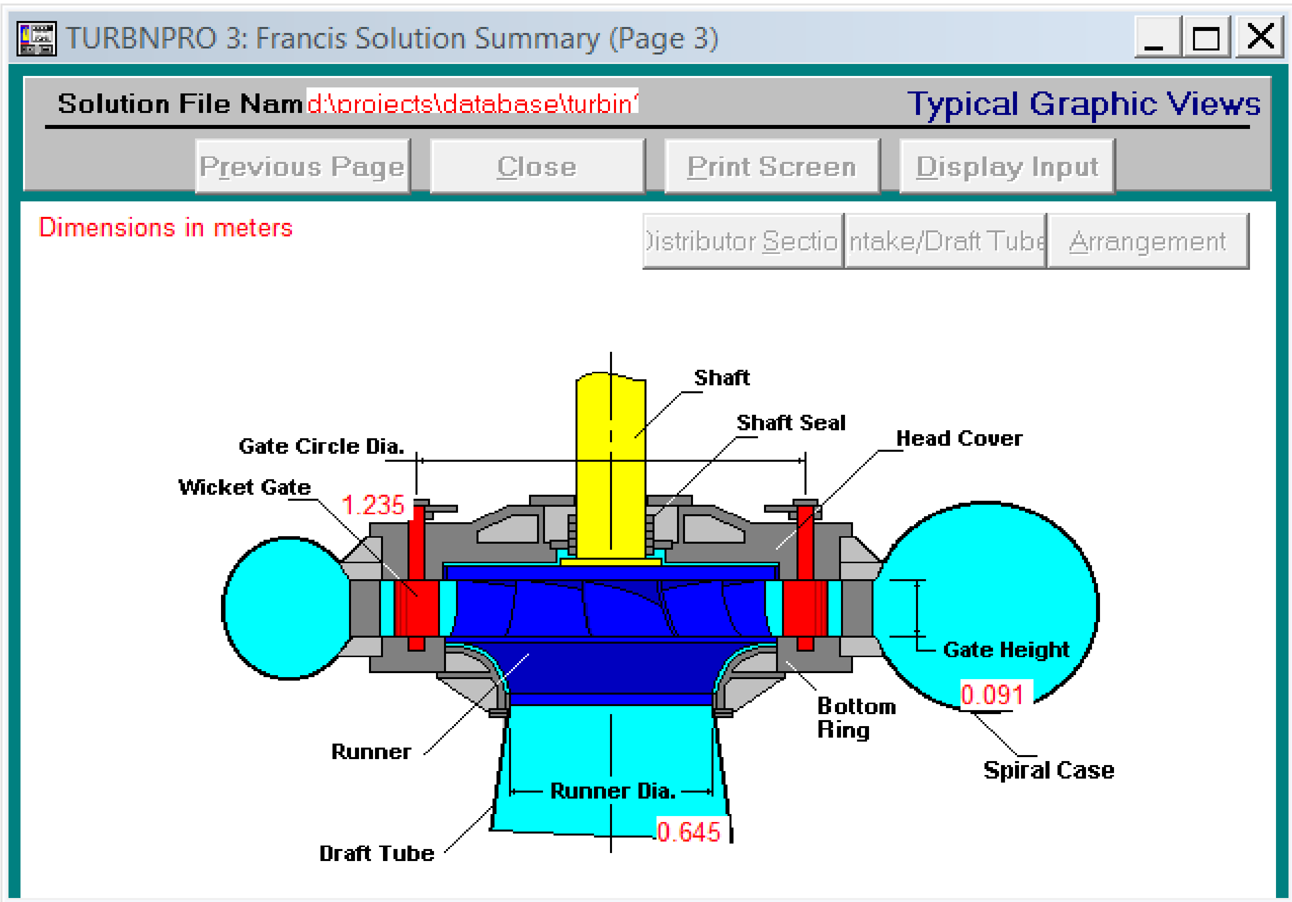
	inches	mm
Centerline to Shaft Coupling:	58.0	1472
Turbine Shaft Diameter:	7.1	181

Miscellaneous:

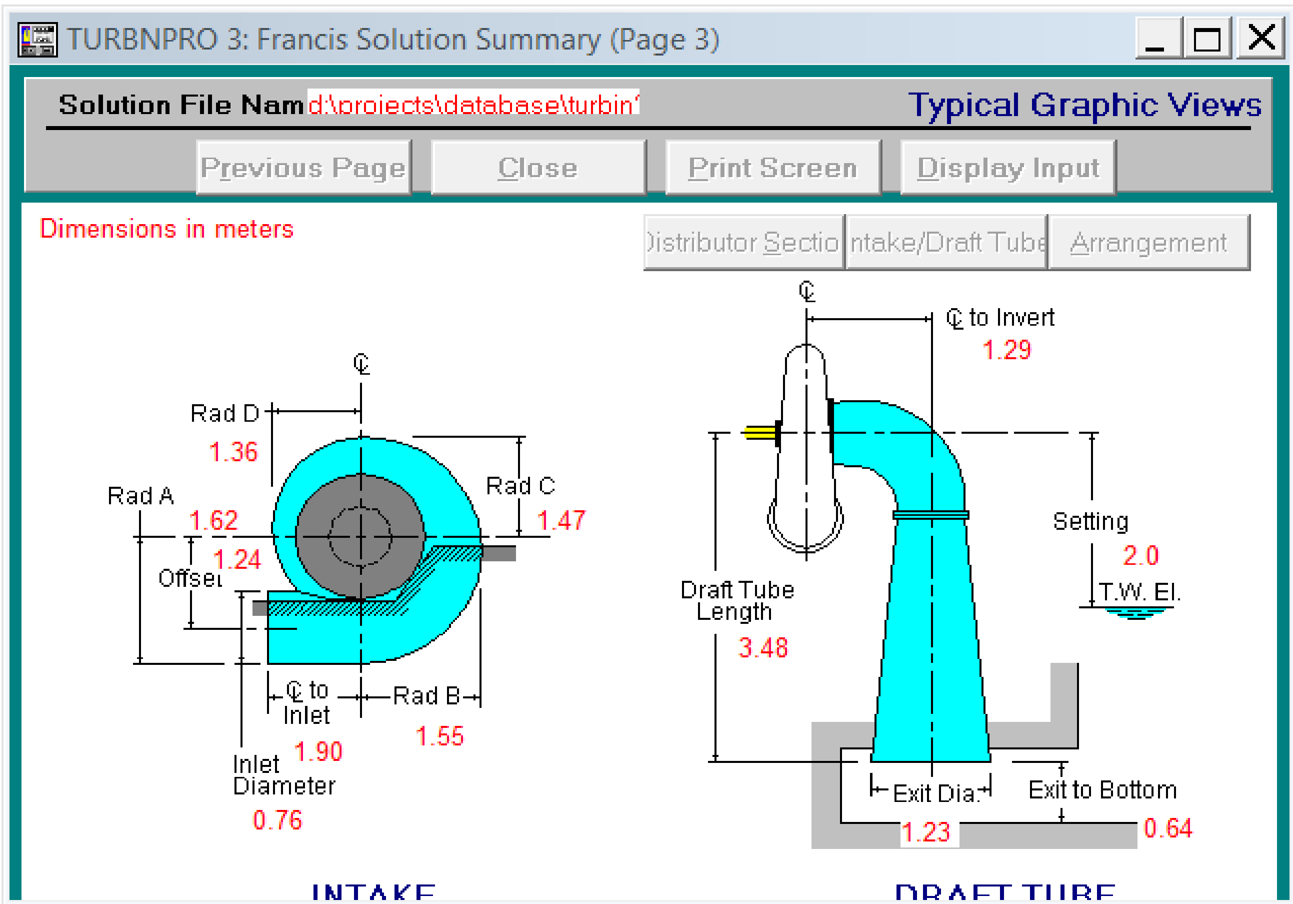
	inches	mm
Wicket Gate Height:	3.6	91
Wicket Gate Circle Diameter:	48.6	1235

**** 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₩khani2
Runner Diameter: 645 mm
Net Head at Rated Discharge: 122.60 meters
Unit Speed: 600.0 rpm

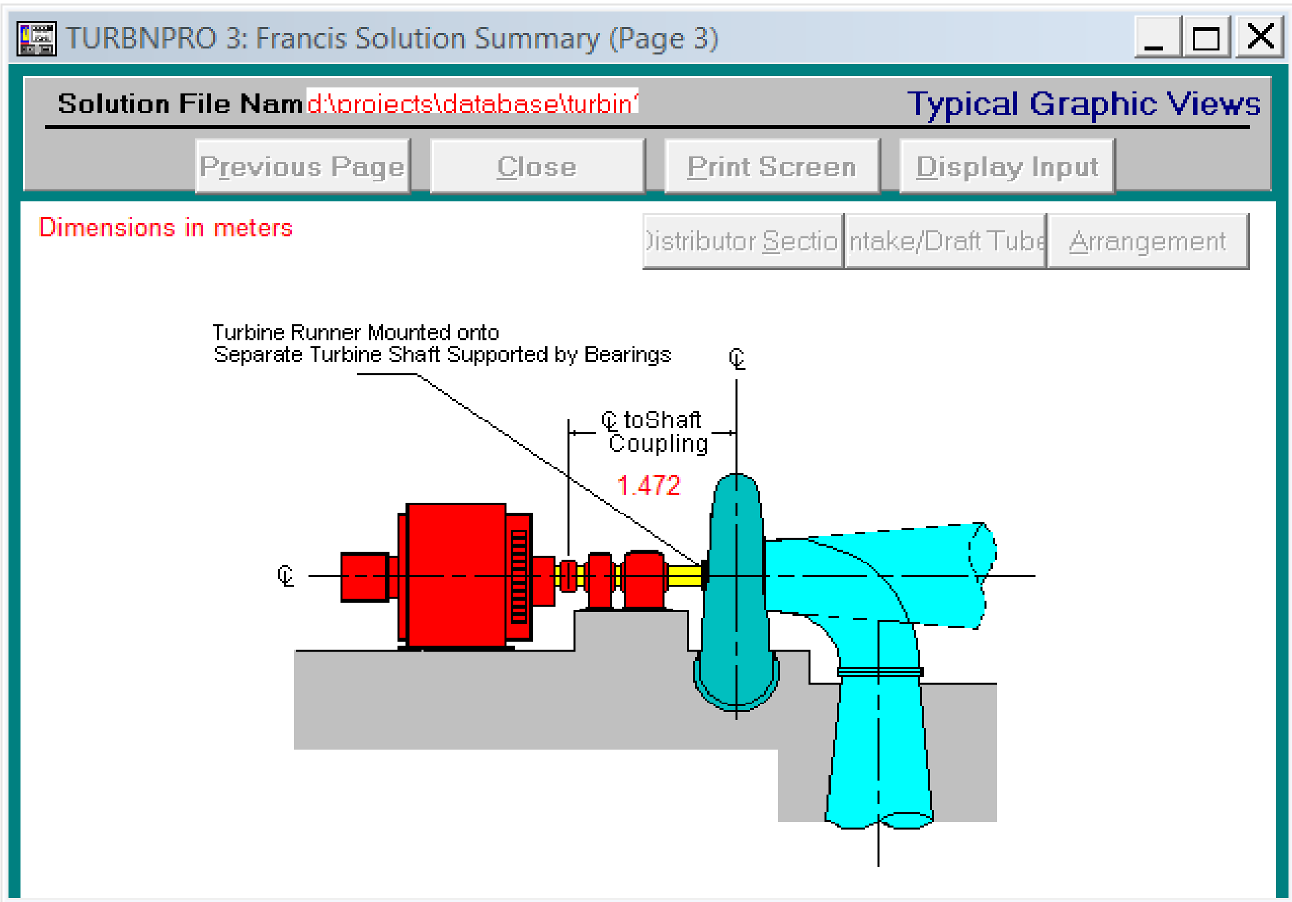


```
Solution File Name: d:\projects\database\turbin~1\khani2
Runner Diameter:                645   mm
Net Head at Rated Discharge:   122.60  meters
Unit Speed:                    600.0  rpm
```



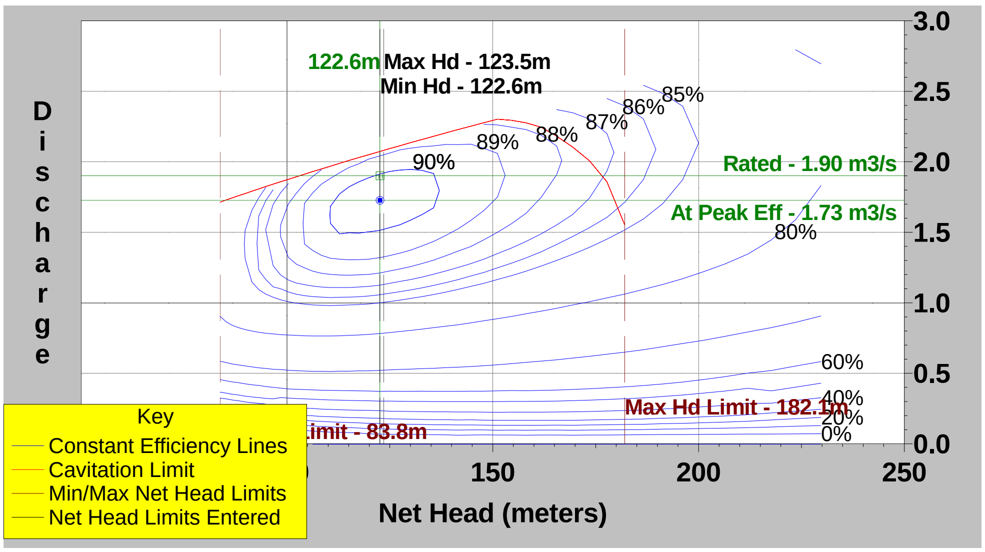
TURBNPRO Version 3.0 - FRANCIS TURBINE SOLUTION GRAPHICS

Solution File Name: d:₩projects₩database₩turbin~1₩khani2
Runner Diameter: 645 mm
Net Head at Rated Discharge: 122.60 meters
Unit Speed: 600.0 rpm



Solution File Name: d:\projects\database\turbin~1\khani2

Runner Diameter:	645	mm
Net Head at Rated Discharge:	122.60	meters
Unit Speed:	600.0	rpm
Peak Efficiency:	90.5	%
Multiplier Efficiency Modifier:	1.000	
Flow Squared Efficiency Modifier:	0.0000	



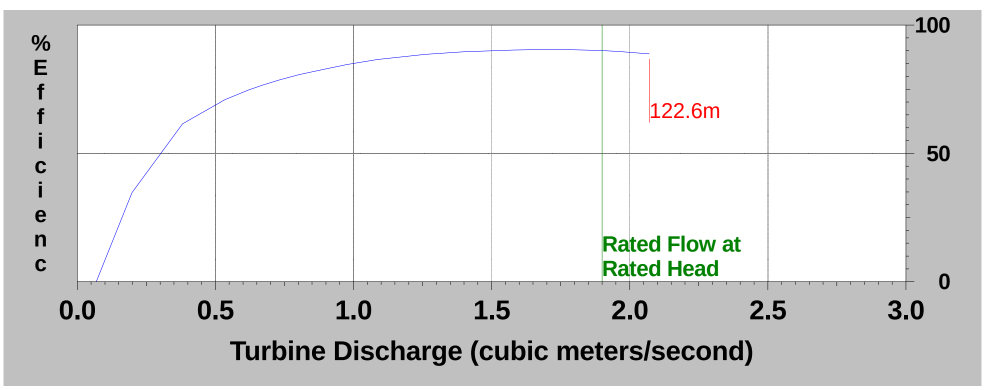
NOTE: Discharge is in cubic meters per second

TURBNPRO Version 3 - FRANCIS TURBINE CROSS PLOT

Solution File Name: d:₩projects₩database₩turbin~1₩khani2
Runner Diameter: 645 mm
Net Head at Rated Discharge: 122.60 meters
Unit Speed: 600.0 rpm
Multiplier Efficiency Modifier: 1.000
Flow Squared Efficiency Modifier: 0.0000

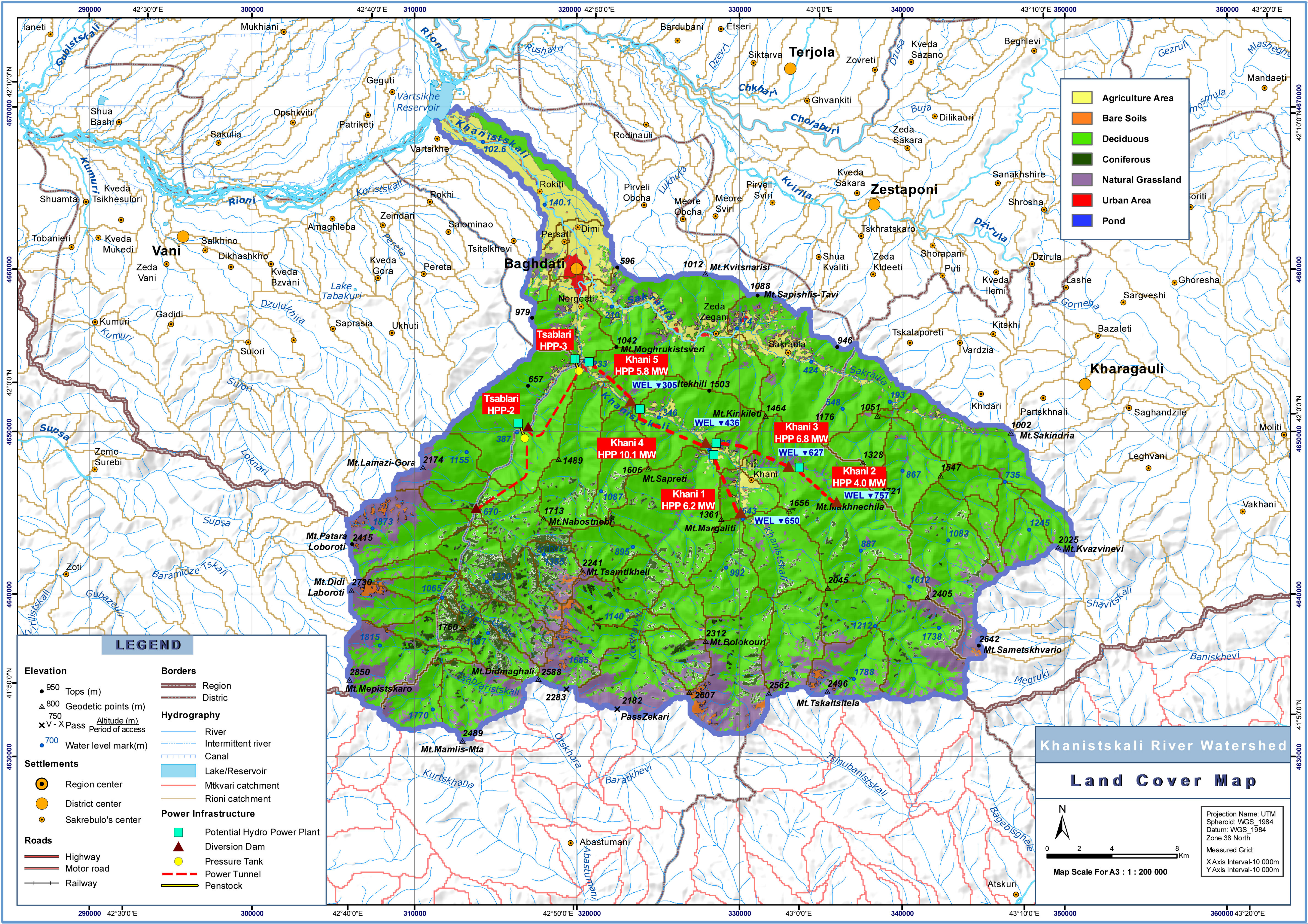
Performance Data Shown is for a Net Head of: 122.6000

Power (KW)	Efficiency (%)	Discharge (m3/s)	Notes
2210	88.7	2.07	Additional Output Capability
2121	89.6	1.97	Additional Output Capability
2058	90.1	1.90	Rated Flow/Head Condition
2022	90.2	1.86	-
1915	90.4	1.76	-
1880	90.5	1.73	Best Efficiency Condition
1802	90.4	1.66	-
1685	90.2	1.55	-
1565	89.8	1.45	-
1444	89.2	1.35	-
1321	88.4	1.24	-
1194	87.2	1.14	-
1067	85.7	1.04	-
937	83.6	0.93	-
809	81.2	0.83	-
683	78.4	0.72	-
559	74.7	0.62	-
435	69.8	0.52	-
316	63.5	0.41	-
191	51.1	0.31	Low efficiency; not used in energy calculation
90	36.0	0.21	Low efficiency; not used in energy calculation
12	9.3	0.10	Low efficiency; not used in energy calculation



APPENDIX 7

Land Cover Map


Khanistskali River Watershed
Land Cover Map
Agriculture Area
Bare Soils
Deciduous
Coniferous
Natural Grassland
Urban Area
Pond
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
Roads
Highway
Motor road
Railway
Borders
Region
Distric
Hydrography
River
Intermittent river
Canal
Lake/Reservoir
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Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Pressure Tank
Power Tunnel
Penstock
Tsablari HPP-3
Tsablari HPP-2
Khani 5 HPP 5.8 MW
Khani 4 HPP 10.1 MW
Khani 3 HPP 6.8 MW
Khani 2 HPP 4.0 MW
Khani 1 HPP 6.2 MW
WEL ▼305
WEL ▼436
WEL ▼627
WEL ▼757
WEL ▼650
Baghdati
Vani
Terjola
Zestaponi
Kharagauli
Vartsikhe Reservoir
Khanistskali
Rioni
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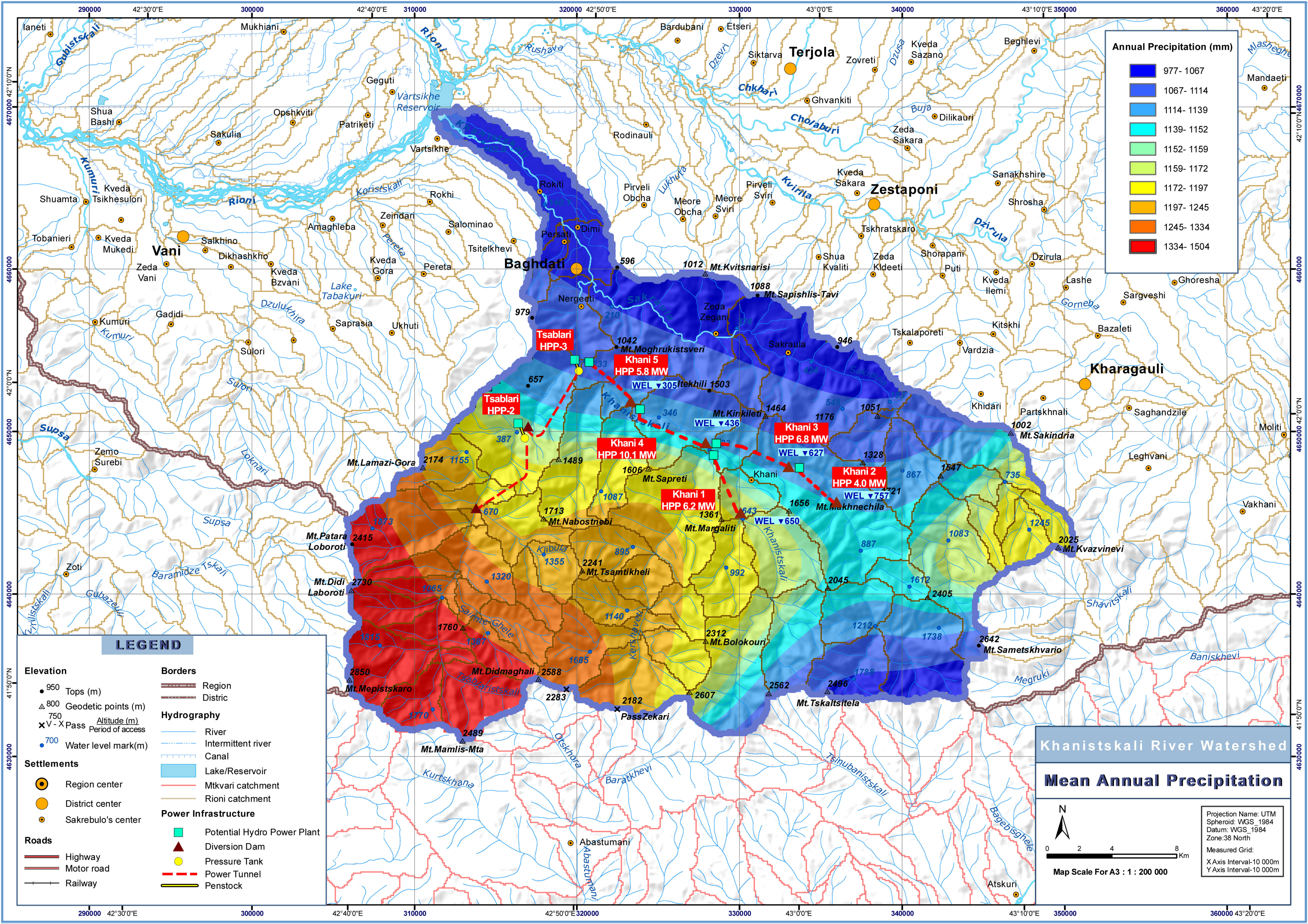
Mt.Kvitsnarisi
Mt.Moghrukistsveri
Mt.Kinkileti
Mt.Sapreti
Mt.Margaliti
Mt.Nabostnebi
Mt.Tsamtikheli
Mt.Bolokouri
Mt.Didmaghali
Mt.Mepistskaro
Mt.Mamlis-Mta
Mt.Tskaltsitela
Mt.Sametskhvario
Mt.Kvazvinevi
Mt.Sakindria
Mt.Lamazi-Gora
PassZekari
Abastumani
N
0 2 4 8 Km
Map Scale For A3 : 1 : 200 000
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m

APPENDIX 8

Mean Annual Precipitation



Khanistskali River Watershed
Mean Annual Precipitation
Annual Precipitation (mm)
977- 1067
1067- 1114
1114- 1139
1139- 1152
1152- 1159
1159- 1172
1172- 1197
1197- 1245
1245- 1334
1334- 1504
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
Roads
Highway
Motor road
Railway
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Region
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Hydrography
River
Intermittent river
Canal
Lake/Reservoir
Mtkvari catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Pressure Tank
Power Tunnel
Penstock
Tsablari HPP-3
Tsablari HPP-2
Khani 5 HPP 5.8 MW
Khani 4 HPP 10.1 MW
Khani 3 HPP 6.8 MW
Khani 2 HPP 4.0 MW
Khani 1 HPP 6.2 MW
WEL ▼305
WEL ▼436
WEL ▼627
WEL ▼757
WEL ▼650
Baghdati
Vani
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Rioni
Kvirila
Dzirula
Supsa
Khanistskali
Sakraula
Vartsikhe Reservoir
Mt.Kvitsnarisi
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Mt.Moghrukistsveri
Mt.Kinkileti
Mt.Sakindria
Mt.Lamazi-Gora
Mt.Sapreti
Mt.Nabostnebi
Mt.Margaliti
Mt.Makhnechila
Mt.Kvazvinevi
Mt.Patara Loboroti
Mt.Didi Laboroti
Mt.Tsamtikheli
Mt.Bolokouri
Mt.Sametskhvario
Mt.Didmaghali
Mt.Mepistskaro
Mt.Mamlis-Mta
Mt.Tskaltsitela
PassZekari
Abastumani
N
0 2 4 8 Km
Map Scale For A3 : 1 : 200 000
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m

APPENDIX 9

Environmental and Social Impacts, Affected Environment

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
  - Terrestrial Flora
  - Terrestrial 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 health 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 L/R/T L/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	VL/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	VL/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	L/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	L/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	L/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	L/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	VL/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/R/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

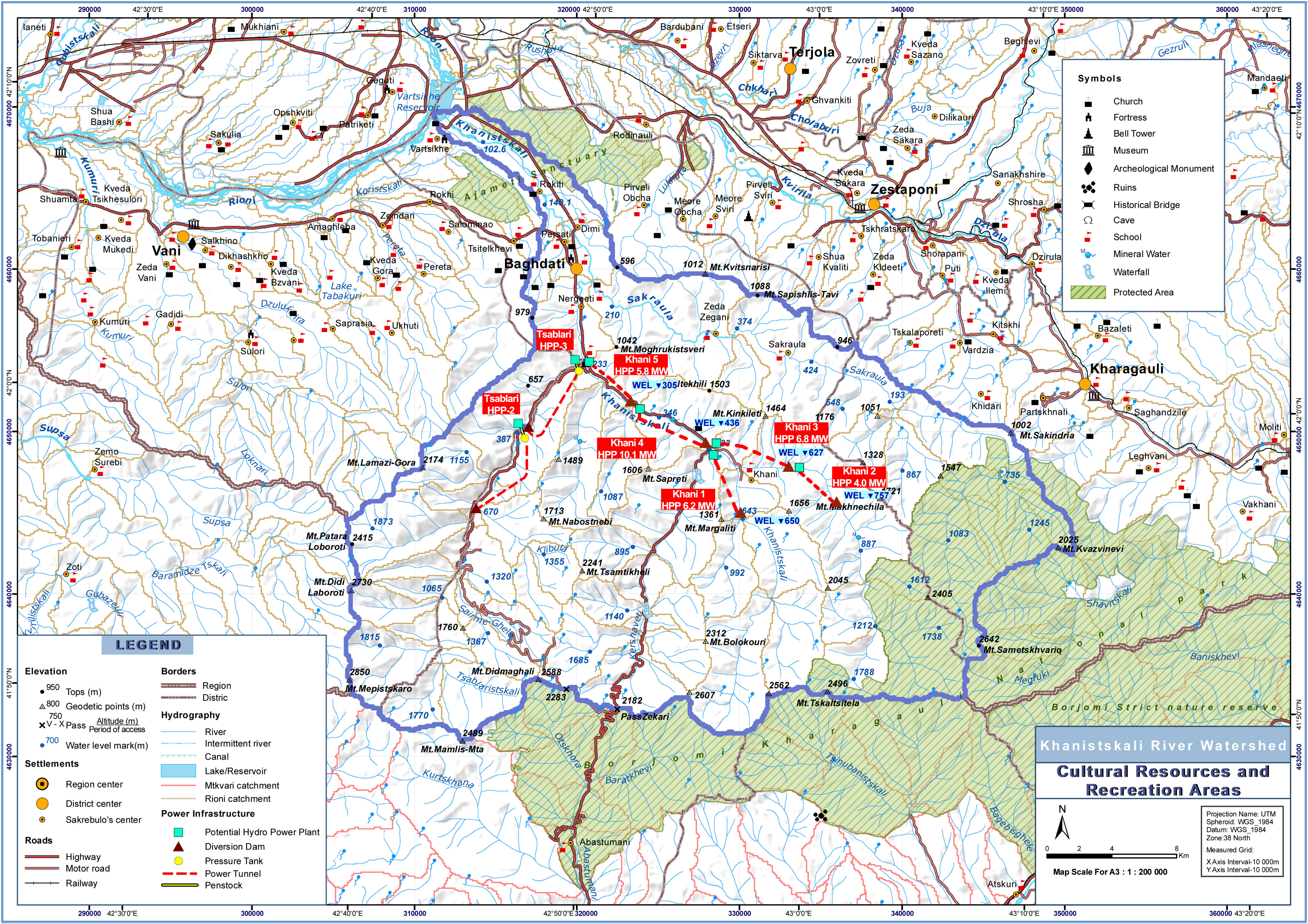
Community, Socio-Economic and Public Health				
Receptor s	**IMPACT (Description of effect)**	**Duration (LG/MD/SH/VSH term)**	**Risk Level (VL, L, M, H, and Irreversible/ reversible; temporary/ permanent**	**Mitigation Practices**
Agricultural Land **(Vulnerability (H, M, L, None) and Value (H, L)** 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	L/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.	LG	VL/R/P	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



Khanistskali River Watershed
Cultural Resources and Recreation Areas
Symbols
Church
Fortress
Bell Tower
Museum
Archeological Monument
Ruins
Historical Bridge
Cave
School
Mineral Water
Waterfall
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
Roads
Highway
Motor road
Railway
Borders
Region
Distric
Hydrography
River
Intermittent river
Canal
Lake/Reservoir
Mtkvari catchment
Rioni catchment
Power Infrastructure
Potential Hydro Power Plant
Diversion Dam
Pressure Tank
Power Tunnel
Penstock
Projection Name: UTM
Spheroid: WGS_1984
Datum: WGS_1984
Zone:38 North
Measured Grid:
X Axis Interval-10 000m
Y Axis Interval-10 000m
Map Scale For A3 : 1 : 200 000
N
0 2 4 8 Km
Tsablari HPP-3
Tsablari HPP-2
Khani 5 HPP 5.8 MW
Khani 4 HPP 10.1 MW
Khani 3 HPP 6.8 MW
Khani 2 HPP 4.0 MW
Khani 1 HPP 6.2 MW
WEL ▼305
WEL ▼436
WEL ▼627
WEL ▼757
WEL ▼650
Terjola
Zestaponi
Baghdati
Vani
Kharagauli
Abastumani
Khani
Vartsikhe Reservoir
Ajameti Sanctuary
Borjomi Kharagauli National park
Borjomi Strict nature reserve
Rioni
Kvirila
Khanistskali
Sakraula
Dzirula
Supsa
Mt.Kvitsnarisi
Mt.Sapishlis-Tavi
Mt.Moghrukistsveri
Mt.Kinkileti
Mt.Sapreti
Mt.Margaliti
Mt.Makhnechila
Mt.Sakindria
Mt.Kvazvinevi
Mt.Sametskhvariq
Mt.Tskaltsitela
Mt.Bolokouri
Mt.Tsamtikheli
Mt.Nabostnebi
Mt.Lamazi-Gora
Mt.Patara Loboroti
Mt.Didi Laboroti
Mt.Mepistskaro
Mt.Mamlis-Mta
Mt.Didmaghali
Pass Zekari
290000 300000 310000 320000 330000 340000 350000 360000
42°30'0"E 42°40'0"E 42°50'0"E 43°0'0"E 43°10'0"E 43°20'0"E
4670000 4660000 4650000 4640000 4630000
42°10'0"N 42°0'0"N 41°50'0"N

APPENDIX 11

Listed Cultural Properties in Baghdati District

Historical, Cultural and Archeological Resources in Baghdati Districts

#	Name	Location	Dated
1	Sigunava's Wooden House "Oda"	Baghdati	Beginning of XX A.D.
2	Tkhmeli Fortress	Baghdati	Late Medieval
3	Agricultural building	Baghdati	End of XIX A.D.
4	Church remnants	Baghdati, "Kopadzeebi"	Medieval
5	Remnants of Castle	Baghdati, Javakhishvili str.	Late Medieval
6	Church Remnants "Dziroti"	Baghdati, Javakhishvili turn	Medieval
7	Church remnants	Baghdati, cemetery	Late Medieval
8	Gognadze's Praying Sacred Place	Baghdati, "Kapani" surroundings	Medieval
9	Church remnants	Village Alismereti	Medieval
10	Remnants of St. George's Church	Village Alismereti	Medieval
11	Kvenetadze Residential Complex and Remnants of the Tower	Village Dimi	Late Medieval
12	Church of Archangel	Village Dimi	XIX A.D.
13	Vartsikhe Governmental Residence	Village Vartsikhe	-
14	Vartsikhe Fortress	Village Vartsikhe, surroundings	IV-VI/IX-XI A.D.
15	Remnants of Castle	Village Vartsikhe, Ajameti Protected Area	Late Medieval
16	Church Remnants	Village Vartsikhe, fortress area	Late Medieval
17	Remnant of the Monastery Cell	Village Vartsikhe, fortress area	Medieval
18	Church	Village Vartsikhe, fortress area	Late Medieval
19	St. George's Church	Village Upper Dimi	1812
20	Remnants of the Tower	Village Upper Dimi, mountain surroundings	XVII-XVIII A.D.
21	Church Remnants	Village Upper Zegani, cemetery	VII-X A.D.
22	"Berieti" Church	Village Kakaskhidi	Medieval
23	Church	Village Kakaskhidi, surroundings	XIX A.D.
24	St. George's Church	Village Meore Obcha	XIX A.D.
25	Charkviani's Wooden House "Oda"	Village Meore Obcha	Mid-Medieval
26	St. George's Church	Village Nergeti	Mid-Medieval
27	St. George's Church	Village Pirveli Obcha	1661
28	Church of Matskhovari (Church of the Redeemer)	Village Rokiti	Medieval
29	Chamber	Village Rokiti, cemetery	Medieval
30	Fortress	Village Sakraula, Sakraula gorge	Mid-Medieval.
31	Church	Village Sakraula, cemetery	VIII-IX A.D.
32	Church "Salkhino"	Village Persati, cemetery	XIX A.D.
33	Church	Village Persati, cemetery	Late Medieval
34	St. George's Church	Village Zegani, cemetery	Late Medieval
35	St. George's Church	Village Tsablaraskhevi	Medieval
36	Devadzes' Church	Village Tsitelkhevi	XIX A.D.
37	"Tetri" Monastry (White Monastry)	Village Tsitelkhevi	Medieval
38	"Kakhori" Church	Village Tsitelkhevi, surroundings	VII-X A.D.
39	Church "Amaghleba" (Church of the Ascension)	Village Tsitelkhevi, surroundings	Medieval
40	Abashidze's Wooden House "Oda"	Village Tsitelkhevi	XX A. D.
41	Zirakadze's Residential Complex	Village Tsipa	XX A. D.
42	St. Mary Church	Village Tskaltashua, cemetery	Medieval
43	St. George's Church	Village Tskaltashua, surroundings	Late Medieval
44	Tower	Village Khani, mountainous surroundings	Late Medieval
45	Church	Village Khani, cemetery	Early Medieval
46	Giorgadze's Wooden House "Oda"	Village Khani	XIX A.D.
47	Vardosanidze's Wooden House "Oda"	Village Khani	XX A. D.

<u>Source:</u> *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 studies for 6 projects with a total capacity of more than 32 MW. These HPP sites are on the River Khanistskali and its tributary Laishura River in Baghdati, Imereti Region. The HIPP team is preparing basic technical studies to evaluate the technical and economic 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 Khani village (Bagdati region) Secondary School with the communities of Khani, Kakaskhidi and Alismereti.

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 Baghdati local government during HIPP team field visits. Meeting date and venue were agreed with Local Municipality; Public workshop was announced to all communities in Baghdati district by local Khani 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. Khanistskali (in village Khani) PAW attended by community members from: Khani, Kakaskhidi, and communities. Totally up to 70 community members attended the workshop. Together with HIPP team the PAW was conducted by USAID's Senior Energy Infrastructure Advisor, Sukru Bogut.

During the workshop USAID and 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.

USAID and 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 the local infrastructure problems, mainly bad roads, which were particularly worsened after the construction of the high voltage line through the region, and asked USAID HIPP to consider the road construction works as the main requirement for potential investors;
- Another main requirement expressed by the local community of Khanistskali was ensuring employment of the local community members in HPP construction and operation works;
- In addition, the villages in Bagdati region including Khani, Kakaskhidi and Alismereti, i.e. the communities which participated in the PAW, have severe electricity supply problems, frequent electricity cuts (electricity was gone in the middle of the HIPP PAW too). Therefore community members expressed great hope that in case of realization of the HPP projects their power supply problems would be solved.
- Community members agreed with USAID HIPP representatives that environmental impact of the run-of-river HPP projects would be minimal and mainly during the construction phase, and expressed hope that the investors would meet international environmental and social protection requirements;

CONCLUSIONS:

- The outcome of Khanistskali 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;
- Khanistskali 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.
- Khanistskali 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.
- In summary, more than 40 community members filled in the questioner forms distributed by HIPP, and all of them marked positive attitude about possible implementation of the project in case the above-mentioned requirements are observed by investors.

The presentation on the project profiles, informational brochure on Khanistskali River Basin HPP Cascades, also, the local 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 Khanistskali River Basin HPP Cascades

Agenda

12 July 2013, Secondary School Building, Village Khani, Baghdadi Municipal District

12:00–12:10	Registration		10 min
	Introductions	**Moderator :**	Duration
12:10–12:20	Opening remarks	USAID, S. Bogut	10 min
12:20–12:50	HIPP Project description, social and environmental issues	HIPP / I. Iremashvili	30 min
12:50–13:20	HPP Project outline	HIPP / G. Sikharulidze	30 min
	Questions and Discussion		
13:20–13.50	Filling Out of Meeting Questionnaire Discussion • Socioeconomic Issues • Environmental Issues • Public Health & Safety Issues • Construction Issues	Facilitated by: HIPP / I. Iremashvili HIPP / G. Pochkhua	30 min
13:50–14:00	**Concluding Remarks**	HIPP/Local Municipality	10 min

Attachment B: Photos of Public Awareness Workshops in Khani

Attachment C: Informational Brochure on HIPP and Khanistskali HPP Projects

Local Community Benefits by Project Implementation

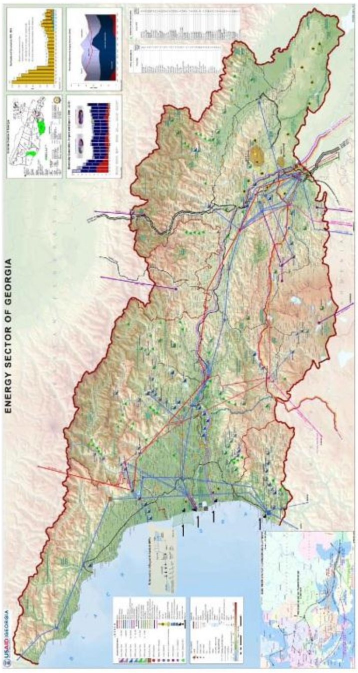
Local labor forces will be employed during the construction period, as well as after commissioning of the Plant to carry out operations and maintenance works.

- 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 7 km will be constructed and existing 11 km will be rehabilitated 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. Khani 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 Khani HPP Cascade will amount to more than 32.9 MW. 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 Investment Promotion Project (HIPP)

KHANI HPP Cascade

Tbilisi, June, 2013
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Promoting Renewable Energy
Promoting the Renewal of Georgia

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.

Khani HPP Cascade

As part of this program, HIPP has identified a cluster of project sites along the Khanistskali River (3 HPPs) and Laishura River (2 HPPs) in Baghdati district with total capacity of 32.9 MW.

The cascade of 5 HPPs (**Khani 1, 2, 3, 4, and 5 HPPs**) will be positioned near the villages: Khani, Kakashidi, Alismereti, Tskaltashua and Nergeeti on the Khanistskali and Laishura Rivers, which are characterized by moderate flows and high head. The Khanistskali River originates on the northern slopes of the Meskheti Mountain Range and flows into the Rioni River. The river has four major tributaries including Laishura river. The catchment area is heavily wooded with significant steep slopes. The river flows in Khanistskali watershed area are very seasonal. Discharges are low during winter and summer, and are high during spring. Spring floods and autumn freshets are common to the river. Ice edges are observed during January and February. Usually water is clear and potable during low-water periods and is not used for industrial purposes.

- **Khani 1 HPP** will be positioned on the left-bank of the Khanistskali river near Khani, Kakaskhidi and Alismereti villages: its power house is in 4 km upstream from Alismereti, while intake structure is planned to be in 2.5 km upstream from Khani. The HPP will be the first stage in a cascade of five HPPs. According to the preliminary assessments, the 6.2 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 28.70 GWh, at a plant factor of about 52.8 percent.
- **Khani 2 HPP** will be positioned on the Laishura river very near Khani and Kakaskhidi villages: its power house - in 2-6 km from Khani and Kakaskhidi, as for the intake structure of the plant it should be built in 6.5 km upstream of Khani. The HPP will be the second stage in a cascade of five HPPs. According to the preliminary

General Technical Data

assessments, the 4.0 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 18.10 GWh, at a plant factor of about 51.7 percent.

- **Khani 3 HPP's** its power house will be in 4 km upstream of the village Alismereti on the north bank of Khanistskali river. While the intake structure of the plant will be located in 2.5 km upstream of Khani on the Laishura. The HPP will be the third stage in a cascade of five HPPs. According to the preliminary assessments, the 6.8 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 31.20 GWh, at a plant factor of about 52.4 percent.
- **Khani 4 HPP** intake will be positioned in 1 km upstream of Kakaskhidi village and about 3.5 km downstream of Khani village, as for its power house, it should be built in 4.0 km upstream of Tskaltashua village. The HPP will be the fourth stage in a cascade of five HPPs. According to the preliminary assessments, the 10.1 MW run-of-river, tunnel derivation type hydro power plant can be built here. The site offers seasonally variable average annual generation of about 55.30 GWh, at a plant factor of 62.5 percent.
- **Khani 5 HPP' s** power house will be positioned in 2.0 km upstream of the village of Nergeeti, and its intake structure will be in 2.0 km downstream of Alismereti and 4.0 km upstream of Tskhaltashua villages. The HPP will be the fifth stage in a cascade of the five HPPs. According to the preliminary assessments, the 5.8 MW run-of-river, tunnel derivation type hydro power plant can be built here. The site offers seasonally variable average annual generation of about 31.90 GWh, at a plant factor of 62.8 percent.

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

USAID Hydropower Investment Promotion Project (USAID-HIPP)

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