Vardnili HPP Cascade Rehabilitation Project - Georgia

Environmental Due Diligence

August 2008

EXECUTIVE SUMMARY

STUCKY Ltd. in cooperation with Georgian Scientific research firm Gamma was commissioned by Engurhesi Ltd to look into the impact on environment related with rehabilitation/clean up of Vardnili canal. The report is developed for submission to the European Bank for Reconstruction and Development (EBRD) and the European Investment Bank (EIB). Objective of the report is to provide the Banks with information regarding the background environment and evaluate impact of the Vardnili cascade canal rehabilitation on environment.

Objectives of the survey include a review and analysis of existing environmental baseline information and other technical documentation to ensure that it complies with EU and national legislation and best practice. The survey covers identification of potential environmental/social impacts, including residual and cumulative ones (if any).

ES1 REGULATORY AND POLICY FRAMEWORK

The survey has been carried out in accordance with relevant Environmental legislation, standards and policies that are applicable to this Project at the national and EU levels.

Background

Location: Gali district south-east of autonomous republic of Abkhazia.

The system includes: Enguri, Vardnili cascade (Vardnili HPPs - №1, 2, 3 and 4, located downstream of Gali Reservoir) and 22 km tailrace canal.

The cascade was put in operation in 70-es of the last century (Vardnili 1 and 2 - 1971, Vardnili 3 and 4 in 1972).

Since the end of the war in Abkhazia in 1992, only one of four plants has functioned; the other three have been fully vandalized.

In 2000 Vardnili HPP 1 tailrace canal rehabilitation, earth and rock excavation, earth earning/removal to the canal borders, at conjunction of spillway canal and tailrace canal concrete lining works were performed.

In 2006-2007 the Ministry of Energy of Georgia financed partial rehabilitation of Unit #2. This included replacement of stator winding, stator core, etc. However some important components of the unit (e.g. the excitation system, control/protection system) were not replaced. The original 73 MW Unit #2 came back into operation by mid-2007.

Rehabilitation of two remaining units as well as replacement of the old common auxiliary (electrical) equipment was set as priority by the Ministry of Energy for 2008-2009. With this, instead of max 40 MW current capacity on each old unit, will reach its design capacity of 73 MW. Rehabilitation of Unit #1 is currently in progress under the state financing.

In parallel, full-scale rehabilitation of civil structures of Vardnili 1 (Dam and waterways) has been set as top priority urgent task for 2008-2011 as to allow full capacity operation of the largest 1300 MW Enguri HPP upstream of Gali reservoir.

The canal from the Gali reservoir through the Vardnili 1 plant and farther through the Vardnili 2, 3 and 4 plants is in a dangerous state. In the course of time, due to sedimentation, its capacity has reduced and is around 67%-70% of the design value. The tailrace canal has narrowed due to landslides and accumulation of sediments, in one location an artificial island has built up. The slopes of the canal and the island are heavily encroached by trees and bushes.

ES2 PROJECT DESCRIPTION: CANAL CLEANING AND DREDGING

Water discharge in the canal through the Vardnili cascade is composed of:

- the flow discharged from Enguri power plant (~90%)
- the flow from the natural watershed of the Gali reservoir,
- the flow from the inflowing rivers.

Rehabilitation of Vardnili 1 waterways and the canal of the cascade is of great importance for Enguri HPP because discaharged water from Enguri turbines has to be safely passed by Vardnili cascade canal.

In order to ensure that the full design capacity of Enguri HPP can pass, it is of critical importance to arrange for de-silting of the canal, removal of an island formed over the last 15 years downstream of Vardnili 3 plant and de-grubbing of the banks of the canal.

Description of the Canal and the Audit

Audit of the canal was carried out 28 June 2008, when Vardnili 1 was stopped to drain the canal, while water level in the Gali reservoir was lowered to the elevation of 100.95 m.s.l. as to accumulate water discharged from the Enguri HPP. Regulation of water in the reservoir enabled to cut off the flow in the canal for 10 hours. In the course of this time the measurements within the canal between Vardnili 1 and Vardnili 2 and visual audit of the rest of the canal were performed.

Detailed sectional description of the canal and sediments is given in Chapter 4 of the report.

The canal is open, total length 22 km. Cross section is vee-type, dimensions are different in different locations.

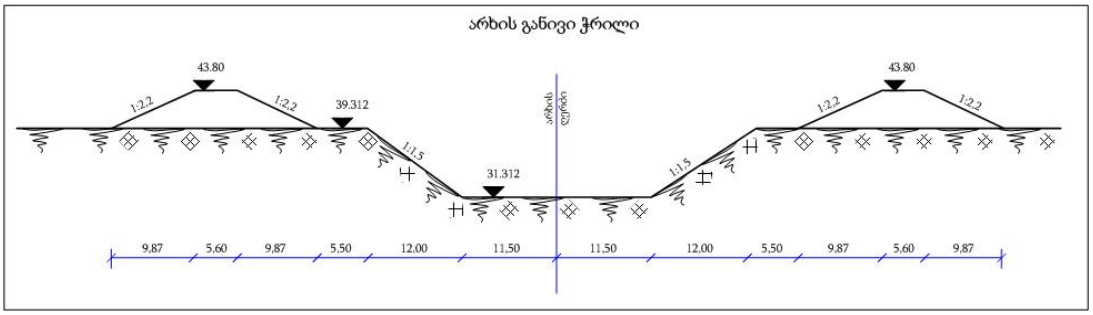

Figure ES2.1 Cross Section of Vardnili Canal

The canal area is built of proluvial, alluvial and alluvial-proluvial sediments. According to the original design the slops of the canal are not concrete lined, but these are concrete lined only on limited areas - 50-100 m upstream and downstream of each power house.

On the upper berm of the canal service road is available. The road is damaged and needs rehabilitation. Damaged is majority of the berms along the canal and require rehabilitation.

Slopes of canal and berms are vegetated. The plants species within considered area do not belong to the category of protected species. Vegetation grown on slopes and berms of the canal hinder operation of the canal and reduce its flow capacity. Taking this into consideration the slopes and the berms must be de-grubbed. One of the reasons of reduction of flow capacity of the tailrace canal is accumulation of sediments. Taking into account that water from Enguri River flows through the Enguri reservoir of 1,1 billion m3 capacity and smaller Gali reservoirs, which, in this case represent tripping basins, getting of sediments from Enguri River into the canal is excluded. The sediments get into the canal from tributaries and through erosion.

According to the survey carried out in June 2008 the volume of sediments (sand and gravel) currently accumulated in the canal is estimated at 300,000 m3. In some areas – household waste is detected.

Sediment Removal – Methodology Options

Mechanical Dredging (Excavation):

There are two primary methods to dredge a canal, mechanical and hydraulic. Mechanical dredging uses normal excavation equipment located on the shoreline or on barges in the canal to dig the sediment out of the canal. The wet spoils are then placed on the barge or deposited on the adjacent upland shore areas. Mechanical dredging has numerous logistical problems and is not considered cost effective.

Hydraulic Dredging:

Hydraulic dredging equipment utilizes a cutter head that breaks through the sediment and suspends the soils into the water column where they are vacuumed through a large pumping system. The sediment laden water is then pumped through a network of pipes floating in the canal to the disposal area. Filter bags at the outlet pipe are the most common way to collect the sediment and release the water back into the canal. Earthen embankment or impoundment areas are another way to dewater the dredged slurry.

The dredging equipment will be installed on a barge. The unit will be electric power driven which is justified from economical and ecological point of view.

As indicated above, Vardnili canal sedimentation problem is related not with the Enguri HPP discharged water or the Gali reservoir sedimentation, but with the erosion at the tributary entries to the canal and erosion of the canal slopes, which produces an alluvial inert material and not slack.

Treatment of Dredged Material

As a widespread and approved method, the dredged inert material (from each section) may be temporarily moved to the spoil area on the specially allocated sites along the canal for de-

watering. The spoil areas are generally earthen impoundments constructed using dikes. For sedimentation, depending on location - pits and/or mobile type sheet metal construction can be used. After settling, the drained water will return to the canal.

Nevertheless, as the most efficient way of treating removed material both economically and technically, as well as the friendliest solution from the environmental perspective, it has been proposed to use the dredged alluvial material for strengthening the berms at both sides of the Vardnili canal.

The cross section of the canal illustrated below shows location and dimensions of the original berms (shoulders) which were created during excavation of the original canal that follow on both sides of the canal at its whole length.

With the purpose of dewatering the material back into the canal, small passages will be excavated along the berms. With the removed material of around 300 thousand m3, shoulders on one or the other side of the canal will be extended to max one meter in height and max one meter in width, or min 0.3 m in height and 1.4 m in width, depending on the condition of the existing shoulder intervals. Some sections of the canal banks (around 10% of total length) will not be used for sediment treatment due to natural hills and heights.

From the engineering viewpoint, such application of the removed alluvial material will increase slope reliability and stability against flooding and canal overflow. In total it is around 15-17 m3 material that needs to be placed at one lengthy meter of a shoulder, either at one bank or another. Upon full dewatering, a bulldozer will flatten the shoulder back.

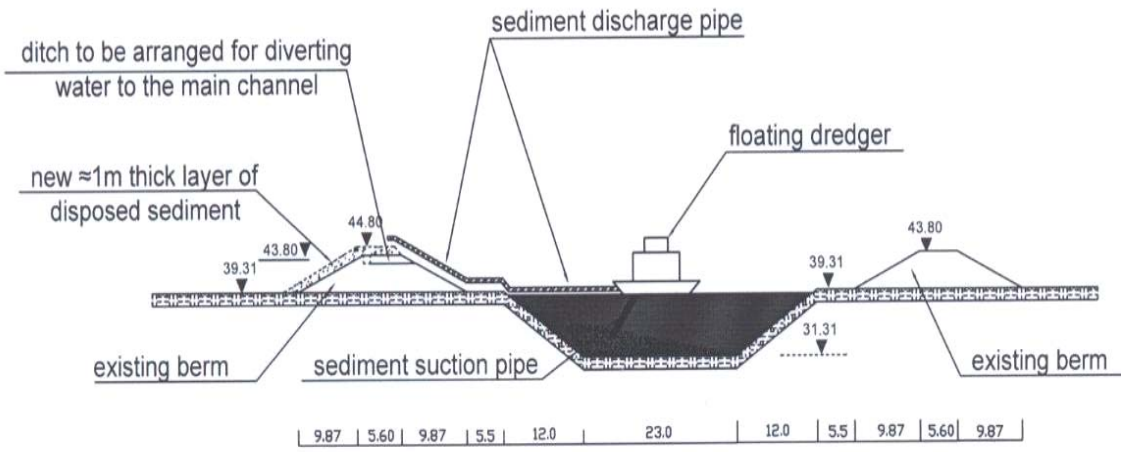

Figure ES2.1 Vardnili Canal. Dredging (Cross section)

ES3 PROJECT IMPLEMENTATION SCHEDULE AND COSTS

Prior to development of the detailed plan/schedule of works, the canal has been dewatered in order to evaluate amount of sediments subject to removal. (Total estimated sediment quantity – 300,000 m3. Sediment treatment section – 14,000 l.m.) As silting is not uniform, the volume of planned works differs by location.

The works are scheduled for 2009. The total assignment is to take up 5 months. To reduce potential impact on ichtyofauna spawning season (from April-May to July) will be avoided.

The cost breakdown is as given below:

Table ES3.1 Vardnili canal rehabilitation – Cost Estimate

Stabilization of canal slopes with concrete structures: excavation & reinforced concrete works, 4400 l.m.	380,000 €
Supply of a dredger, excavator and a bulldozer	1,150,000 €
Removal of vegetation cover from the entire canal (2x22000m): auxiliary and handling equipment and cleaning works	150,000 €
Removal of island from downstream of HPP III; excavation works (2800 m2) to canal invert	120,000 €
Treatment of removed sediments: handling and disposal of about 300,000 m3 alluvial material	1,200,000 €
Labour and maintenance of equipment (5 months of works)	70,000 €
Implementation of environment protection measures - restoration of dewatering areas.	30,000 €
Physical Contingencies	300,000 €
Total Canal Works Budget	**3,400,000 €**

ES4 ASSESSMENT OF IMPACT ON ENVIRONMENT

The Consultants have carried out assessment of impact of the planned activity on environment. The Environmental Assessment works were carried out from June 3 to July 8, 2008. Methodology of the assessment is described below.

ES5 METHODOLOGY

In the course of the survey each of the potential impacts has been ranked by applying a set of formal criteria.

The assessment process consisted of the following main tasks:

- Scoping
- Baseline data gathering
- Assessment of impact (including cumulative impacts and risk assessment)
- Development of mitigation measures and residual impacts

Baseline conditions have been established by collecting information on the status of environment and receptors/resources which may be affected by the development. Once the baseline conditions have been established through a combination of desk studies, field surveys and consultation with key stakeholders, the impacts of the project were identified, their acceptability have been assessed in terms of environmental and social effects.

ES6 BASELINE STATUS & PROJECT RELATED IMPACT ON ENVIRONMENT

Terrestrial and Aquatic Ecology

Information on flora and fauna in the limits of the project area has been collected through desk study and site survey. The habitats and species identified during the initial field survey are considered to be of low nature conservation value. To avoid potential damage on ichtyofauna, the works will be scheduled so to avoid the spawning season.

As for the possible impact of the dredging on the water quality and aquatic life in the Black Sea, the following is to be considered:

1. The spatial extend of the project - the planned activity will cover the section from Vardnili 1 up to Vardnili 4 only;
2. The distance from the outermost project site to the outfall of the canal totals 12 km.
3. Level of the canal tail to the sea being 1.5 - 2 m below the sea level, and the fact that the sea has created a large bay at the end of Vardnili 4 tailrace canal;
4. Stepwise implementation schedule of the dredging works (section by section dredging);
5. The flow rate in the canal.

Considering the abovementioned, we shall assume that suspended particles will gradually settle within the canal downstream of Vardnili 4 and the sediment plums will not reach the sea. This, in turn, allows to suppose that the project-related increase of the sea water turbidity is not expected to be of concern in terms of deterioration of the Black Sea water quality and possible impact on the aquatic life. Nevertheless, the same precautionary measures as above viz, avoiding the spawning season, will help to avoid the impact.

The vegetation along the canal is secondary and do not have any significant value for nature conservation. This agricultural habitat type (where available) could easily be re-created in a short time. The fauna species recorded in the area are common in Georgia.

Certain number of plants will be cut during grubbing the banks, clearing the island, arrangement of fly camps (if any), arrangement of access to the sites. Both direct (felling) and indirect (impact of exhaust and dust emission, fuel spills) impact on flora will be reduced by strict keeping to the boundaries of the sites, prohibition of short cuts and proper maintenance of vehicles/machinery. The impact will be remediated by re-vegetation of the area.

Inevitable disturbance/impact of fauna (direct impact – injury, indirect impact – noise, vibration) will be short term taking into account limited area and duration of works.

Meteorological and Climate

A desk based study and assessment has been undertaken using the reference data. According to available information the climate in the region is marine humid subtropic. Mean air temperature ranges between 4-6°C in January and 24°C in July. Absolute minimum of temperature is 10-12°C, absolute maximum reaches 34-36°C. Relative humidity in the region surrounding the Site varies between 75% in March-April and 84% in August/September. In the region surrounding the Site, the annual average rainfall is between 1646 mm and 1760 mm. Maximum rainfall is in summer and autumn. Laying snow is generally possible between September and December and generally snow melts in March and April. North westerly

winds dominate the area with winds blowing from this direction nearly 50% of the time. Higher in the mountains is approximately 4°C lower, rainfall – between 1500-2000 mm.

No impact on climate is related at any stage of the project.

Air Quality

There is no information regarding historic air quality in the area. However, as no worth to mention industrial activities are currently performed in the area, the quality of the air can be assumed as acceptable.

As for the greenhouse gas effect emission, which in case of hydropower production is mainly related to decay of vegetation in reservoirs resulting in production of carbon dioxide and CH4, keeping in mind that Vardnili and Enguri HPPs history dates back to 70-es of the last century, generation of GHG's as a result of deterioration of vegetation is marginal.

Currently measured gaseous and particulate concentrations are found to comply with EU ambient air quality standards at the sampling locations.

In the course of the project the air quality will be temporarily deteriorated (dust related to earthworks and traffic, exhaust emission from vehicles and machinery), however, taking into account the type and duration of the works, the background air quality and travel distance of emitted pollutants expected impact will not be of concern and can be mitigated through proper maintenance of vehicles/machinery and sound operation practices. With consideration of distance from the residential area – no impact on community is expected. Traffic will be limited to the project area and therefore no impact on the local community will be observed. As for the indirect impact of the project related emission on plants – it will be of low scale, short term and reversible.

Noise and vibration

Because of political instability in the area, economic activities in the project zone are practically non-existent. Since there are no industrial developments and the traffic flows are negligible, background noise and vibration levels are low.

Project generated noise will not be high. With consideration of the quantity of machinery/vehicles and distance to the residential area, noise related impact on community is very marginal. Nevertheless, as a precaution, potential noise impact will be mitigated by keeping to the daytime work hours. Noise related impact on fauna will be short term and reversible.

Soil and Geology

The geology and soils of the proposed development were evaluated following a desk study review of existing data. According to geotechnical zoning the study area belongs to Gagra-Java zone (located in the limits of folded system of the south slope of Caucasus) and partly to Kolkheti zone (part of the Georgian block). Gagra-Java zone is built of sandy-clay sediments, Baiosian volcanogenic series (porphyrite series) and upper Jurassic and Cretaceous terrigeneous and carbonate deposits. The linear folds in the area are less compressed compared with those of the rest of the folded zone.

In the limits of the study area yellow soil dominates. This soil develops under the broadleaf forest cover and overtops Palaeogene-Neogene clay-slates and clay. The soil alkaline with medium humus content.

Impact on soil stability and quality may be the case. To reduce the risk of soil erosion the slopes will be designed and constructed using appropriate factors of safety, the stockpiles/bunds seeded and re-vegetated, potentially hazardous (from the view of erosion or landslide development) location must be identified and monitored.

Other potential impacts such as pollution with spilled fuel/oil can be minimized by proper maintenance of vehicles/machinery. Pollution from waste avoided/mitigated by proper waste management practice.

Natural Resources

The natural resources of the Gali area include limestone, brick clay, sand-gravels, gypsum and water. Based on information of the Ministry of Environment Protection and Natural Resources of Georgia by category are as follows:

Type of mineral and	Location of the deposit	Resource (as of 01.01.2001)
Chalk limestone	Okumi	3,962 x1000m3
	Gali	3,800x1000m3
Brick clays	Achigvari	4,063x1000m3
	Gali	119x1000m3
Building sand-gravel	Enguri II	61,500x1000m3
Gypsum	Okumi	810x1000 t
Artesian fresh waters	Rechkhi-Tskiriri	107x1000 m^3/d

Source: Ministry of Environment Protection and Natural Resources

The project will not have any negative impact on any of these resources.

Hazardous geological processes

The main hazardous geological processes in the area include landslide risks, in particular in the limits of the villages (Lukukhona, Dakhazurga, Saberio, Mziuri, Chuburkhinji, and environs of Gali) of the foothills. River bank erosion is an issue for the Eristskali River especially in the section near vil. Etseri, while soil settlement is rather often observed in vil. Dakhazurga, Saberio and Gali.

By seismic conditions the study area belongs to the zone with 9-strong seismic intensity (according to the MSK-64 scale).

As the project is associated with certain amount of earthworks and dredging, impact on soil stability/erosion may be of concern. To avoid/reduce this impact all slopes will be designed and constructed using appropriate factors of safety; bunds seeded and re-vegetated, banks/slope-strengthened, potentially hazardous (from the view of erosion or landslide development) location must be identified and monitored.

Hydrology

The river system in Gali region is dense. The most water abundant is Okumi River which originates from the south slope of Akibi ridge. Its main tributaries are Eristskali River (left tributary) and Oboja and Chkhortali (right tributary). The rivers are fed by atmospheric water, Eristskali – partly with cavern waters. Another big river in the limits of the study area is Enguri. The letter originates from Enguri glassier and flows into the sea near Anaklia. The tributaries are Adishistskali, Khaldechala, Mulkhra, Dolrachala, Nakra and Nenskra from the right; and Tseishi, Khumpresi, Lasili, Magana, Jumi and others from the left. Enguri is fed by glassier (66%) water as well as by ground 22% and atmospheric waters.

As Vardnili cascade "transmits" the flow discharged from Enguri power plant, flow from the natural watershed of the Gali reservoir and the flow from feeder canal diverting water from the Enguri River directly into the reservoir, with proper state of its maintenance, will ensure preservation of proper water regime in the system.

Clean up/de-silting of the canal will have beneficial effect on capacity of the canal. At the same time the dredging will enable to avoid the flooding of the banks, bank erosion and damage of vegetation/infrastructure along the banks in case the flow increases. Pollution of surface water will be avoided by proper maintenance of vehicles/machinery, prohibition of re-fuelling/servicing at not less than 50m distance from the surface water body and sound management of waste. Emergency response measures must be developed and put in place.

Hydrogeology

The area belongs to Kolkheti artesian basin of porous, fissure and fissure-cavern water. Structurally the region represents a deep syncline depression complicated with sharp folds and faults formed in Cretaceous layer. The basin includes three main artesian aquifers comprising multiple water bearing strata:

- aquifer of fissured and fissure-cavern waters of lower Cretaceous limestone.
- aquifer of fissure and fissure-cavern waters of Upper Cretaceous
- aquifer of the Quaternary formations.

Underground waters aquifers of modern alluvial sediments are unconfined, sloping toward the river flow. The depth of the ground water varies from 0.5 to 1.5m. Water abundance varies by location and depends on the grain size. Filtration coefficients are:

- boulder-pebbles - from 100 to 300 m/day and above
- sands from 30 to 50m/day,
- clayey and clay formations – less than 1 m/day.

Total mineralization is from 0.5 to 1 g/l. The groundwater is recharged by surface flows, atmospheric water and partly ground water. Water regime strongly depends on variation of surface water level and atmospheric water regime.

Total resources of the region can be estimated as 10 m3/sec.

The works will be carried out with care to avoid contamination of ground water with drained (turbid) water.

To avoid pollution of ground water with spilled re-fuelling/servicing (if any) of the vehicles and machinery will be allowed only on hardstanding, spill kits made available, sound waste management practices put in place.

Traffic and Infrastructure

Access to the sites of Vardnili cascade is either via the road on the right bank of the Gali reservoir from the Saberio settlement or through Zugdidi bridge. The main settlements along the canal are Gali, Mziuri and Etseri located downstream the Gali reservoir, south to the canal. The main road runs practically parallel to the canal along the left bank of the latter.

Access roads along the right bank of the dredged canal are in good condition. An access track is also built on the right bank of the canal but not passable in wet weather conditions or with heavy trucks.

Gali railway station is in total disrepair. Traffic along the main roads, since the conflict in the region is not high.

Project related traffic will be limited to the canal and its alienation zone. No impact on the background flow, because of the limited additional traffic is expected. “Contribution” of the project traffic on the status of the infrastructure is negligible.

Landscape

The subtropic area of Kolkheti lowland to which the region belongs represents lowland and foothills with humid forests and mountain-flatland landscape.

Based on a field survey undertaken to evaluate the landscape and visual amenity of the area at and surrounding the proposed development the landscape was classified as being not sensitive. Works will be limited in space and time, the area re-vegetated as appropriate, which means that impact on visual amenity and the landscape will be minimum.

Protected areas

There are no protected areas in the project impact zone.

Cultural Heritage

The cultural heritage baseline data has been collected based on the reference data and literature review. No information on any archaeological heritage in the area is available. The only known site of importance is that in the village Tagiloni, the right bank of the Enguri River where remains/artefacts dated by XI-X and I-II BC were unearthed.

No impact on archaeological/cultural monuments is expected as not available/known. However, as generally done in case of the earthworks of any scale, adequate care is to be taken, in case any artefacts unearthed the fact will be immediately reported to relevant authorities.

Socio-Economics

Population of Gali region is mainly Georgian. There is no official statistics available on demographic situation in Gali District and in Abkhazia in general. It is known, however, that in 1996-1997 around 40,000 IDPs returned to Gali district. In 1998 many were displaced again as a result of briefly renewed fighting between Georgian partisans and the Abkhaz Militia in Gali. Many of the IDPs residing in Samegrelo are "permanent" migrants, crossing the Enguri River separating Abkhazia from Samegrelo, in order to cultivate land or harvest hazelnuts in the Gali area.

Impact on health and safety (if any) of community/staff during construction/rehabilitation will be mitigated through utilisation of the best practice grievance mechanism for any health, safety or other issues raised by the community surrounding the proposed project.

ES7 IMPACTS AND MITIGATIONS

A summary of impacts requiring mitigation identified during this project for

- air quality (A),
- soil, geology and hydrogeology (GEO),
- hydrology and flood risk (H),
- terrestrial and aquatic ecology (EC),
- traffic and infrastructure (T),
- noise and vibration (NV),
- waste and wastewater management (W),
- landscape and visual (LV),
- archaeology and cultural heritage (ARC) and
- socio-economics (SE)

are shown below, along with proposed mitigation and an assessment of residual impacts:

Table ES7.1 Summary of environmental and social impact assessment

Item No.	Impact	Phase			Unforeseen Events	Potential Significance	Mitigation Measure	Residual Impact	Significance of Residual Impact
		Mobilisation	Rehabilitation/ construction	Demobilisation					
Air									
A1	Dust	Yes	Yes	Yes	N/A	Medium/ Low	In case of necessity cover truck to reduce dust emission during transportation. If appropriate - reduce the speed of the traffic. Minimise drop heights	No	N/A
A2	Combustion emission	Yes	Yes	Yes	N/A	Medium/ Low	Ensure proper status of maintenance of the vehicles, machinery	No	N/A
A3	Odour	No	Yes	Yes	N/A	Medium/Low	Sniff testing (olfactometry) and monitoring of complaints can be suggested as the simplest ways of the nuisance control. In case of necessity the odour can be controlled/mitigated, by spreading lime over the sediment load, which neutralizes natural uncontaminated dredged material odours.	NO	N/A
Soil, Geology and Hydrogeology (GEO)									
GEO1	Soil stability	No	Yes	No	N/A – if appropriate factors of safety are used	Medium	All slopes to be designed and constructed using appropriate factors of safety Stockpiles/bunds seeded and re-vegetated Landslide affected area (the right bank of the canal downstream Vardnili 1 near the spillway), sediments accumulated in the bed of the canal near the confluences, island downstream Vardnili 3 affecting the flow through the canal and leading to development of hazardous geodynamic processes must be removed. The rate of sediment accumulation monitoring is recommended to be introduced to identify the schedule of subsequent de-silting, de-grubbing operations.	No	N/A

Item No.	Impact	Phase			Unforeseen Events	Potential Significance	Mitigation Measure	Residual Impact	Significance of Residual Impact
		Mobilisation	Rehabilitation/ construction	Demobilisation					
GEO2	Soil productivity	Yes	Yes	Yes	No	Low	In case the fly camps are arranged or earthworks required remove the top soil layer, temporarily store and reintroduce, re-vegetate	No	N/A
GEO3	Soil contamination resulting from hydrocarbon spills from vehicles or site facilities equipment, or other potentially contaminating liquids	Yes	Yes	Yes	Yes -accidental hydrocarbon or other liquid spills	Medium	Re-fuelling in designated areas on hardstanding with available spill kits; proper maintenance of vehicles and equipment; proper waste management	No	N/A
GEO4	Groundwater contamination from contaminants in stockpiled soil, hydrocarbon spills from vehicles or Site facilities equipment, or other potentially contaminating liquids	Yes	Yes	Yes	Yes -accidental hydrocarbon or other liquid spills	Medium	Re-fuelling in designated areas on hardstanding with available spill kits, Proper waste management	No	N/A
Hydrology and Food Risk (H)									
H1	Surface water contamination	Yes	Yes	Yes	Yes -accidental hydrocarbon or other liquid spills	Medium/ Low	Re-fuelling in designated areas on hardstanding with available spill kits; proper waste management Adequate bank protection in the catchment area to prevent erosion (replanting and maintenance of vegetation), extraction of coarse material from the river bed, use of sediment trapping devices, establishment and maintenance of optimum levels of water flow to minimize erosion		
H2	Flood risk[1]	No	No	No	N/A	N/A	N/A	N/A	N/A
Terrestrial and Aquatic Ecology (EC),									

[1] risk of flood may be observed in case the dredging is not implemented

Item No.	Impact	Phase			Unforeseen Events	Potential Significance	Mitigation Measure	Residual Impact	Significance of Residual Impact
		Mobilisation	Rehabilitation/ construction	Demobilisation					
EC1	Impact on vegetation	Yes- in case the temporary camp and earthworks is required	Yes	Yes	N/A	Medium	Keep the boundaries of the camp (if any), and operation area to reduce extend of the damage Estimate exact qty of trees to be cleared to avoid excess felling/damage. Do not allow shortcuts to avoid direct impact (damage of plants) Maintain proper level of maintenance of vehicles and machinery to avoid/reduce indirect impact by emission Re-vegetation	Yes	Medium
EC2	Impact on fauna (including ichtyofauna)	Yes	Yes	Yes	Direct impact (injury), disturbance	Medium/Low	Reduce traffic speed to optimum Works to avoid the spawning season (April-May to July)	N/A	N/A
Traffic and Infrastructure (T)									
T1	Impact on traffic flows	Yes	Yes	Yes	N/A	N/A	N/A		
T2	Impact on infrastructure	Yes	Yes	Yes	Deterioration of road pavement quality	Low	N/A		
Noise and Vibration (NV)									
NV1	Increased noise levels at residential receptors due to operational and decommissioning activities.	Yes	Yes	Yes	N/A	Medium	Plant will be maintained in efficient working order; Plant will be shut down or throttled to a minimum when not in use Works will be carried out during the day time	No	N/A
Waste and Wastewater Management (W)									
W1	Household solid and liquid waste from temporary camps (if available)	Yes	Yes	Yes	N/A	Medium	Maintain adequate waste bins for disposal to landfill and ensure proper waste management/disposal	No	N/A

Item No.	Impact	Phase			Unforeseen Events	Potential Significance	Mitigation Measure	Residual Impact	Significance of Residual Impact
		Mobilisation	Rehabilitation/ construction	Demobilisation					
W2	Used oils and greases from vehicles and machinery	Yes	Yes	Yes	N/A	Medium	Provide equipment servicing off site when possible. Adequate secondary containment, spillage protection and emergency clean up equipment to be maintained on site.	No	N/A
W3	Vegetation waste from site clearance	Yes	Yes	No	N/A	Low	Dispose on site or remove waste vegetation off site Felled wood may be used by locals as firewood		
Landscape and Visual (LV)									
LV1	Impact on landscape and visual amenity	Yes	Yes	Yes	N/A	Medium	Appropriate mitigation measures include: preservation of existing vegetation and keeping to the boundaries of the project area and access road should be undertaken; reclamation/ planting of greenery along /on the bunds to merge them into the background.	Yes	Low
Archaeology and Cultural Heritage (ARC)									
ARC 1	Impact on archaeological excavations and cultural monuments	No	No	No	Adequate care is to be taken during .earthworks – it is not likely to be the case but any findings if unearthed are to be reported to relevant authorities	Low	N/A	N/A	N/A
Socio-economics (SE)									
SE1	Community health and safety during rehabilitation/construction						Utilise existing best practice grievance mechanism for any health, safety or other issues raised by the community surrounding the proposed project		

ES8 MANAGEMENT AND MONITORING

An environmental and social monitoring plan of the project is shown in Table ES.8.1 below:

Table ES8.1 Summary of potential monitoring measures

Item No.	Impact	Monitoring Measure
Air, Odour and Emissions (A)		
A1	Dust emission	Good management practice at the Site would aim to minimise dust impacts by, for example: • Adequate sheeting of vehicle loads up until tipping point when moving around the Site; • Securely cover skips and minimise drop heights, regularly dampen down surfaces with water; • Provision of upturned exhausts for vehicles/mobile plant on-Site; • Use of dust filters on fixed plant and machinery.
A2	Combustion/exhaust emission	Monitoring of the proper status pf maintenance of the vehicles/machinery
A3	Odour	Sniff testing (olfactometry) and monitoring of complaints can be suggested as the simplest ways of the nuisance control. In case of necessity the odour can be controlled/mitigated, by spreading lime over the sediment load, which neutralizes natural uncontaminated dredged material odours.
Soil, Geology and Hydrogeology (GEO)		
GEO1	Soil stability	Note any visual impacts to surrounding areas .
GEO2	Soil productivity	N/A
GEO3	Soil contamination resulting from hydrocarbon spills from vehicles or site facilities equipment, or other potentially contaminating liquids	During rehabilitation
GEO4	Groundwater contamination from contaminants in stockpiled soil, hydrocarbon spills from vehicles or Site facilities equipment, or other potentially contaminating liquids	May be introduced in case any doubt regarding possible impact/complains occurs
GEO4	Sediment Transport to Water Courses	• Monitor sediment (total dissolved solids) within irrigation canal. • If total dissolve solids are above baseline conditions identify source and implement appropriate mitigation, which might include re-seeding or providing other protection to stockpiles of earth, reseeding closed section of the banks, etc
Hydrology and Flood Risk (H)		
H1	Surface water contamination - Change in physical, chemical, and biological quality	Visual control Monitor sediment (total dissolved solids) within canal – is deemed advisable

		Check water quality – if deemed required
H2	Flood risk[2]	Visual control
Terrestrial and Aquatic Ecology (EC)		
EC1	Impact on vegetation	Visual control
EC2	Impact on fauna (including ichtyofauna)	Visual control
Traffic and Infrastructure (T)		
T1	Impact on traffic flows	N/A
T2	Impact on infrastructure	End of the project – visual control
Noise and Vibration (NV)		
NV1	Increased noise levels at residential receptors due to operational and decommissioning activities.	Occasionally, during the project
Waste and Wastewater Management (W)		
W1	Household solid and liquid waste from temporary camps (if available)	According to the waste management plan/procedure
W2	Used oils and greases from vehicles and machinery	According to the waste management plan/procedure
W3	Vegetation waste from site clearance	Control throughout rehabilitation to avoid excess damage of vegetation
Landscape and Visual (LV)		
LV1	Impact on landscape and visual amenity	N/A
Archaeological and Cultural Heritage (ARC)		
ARC 1	Discovery of, and possible damage to, unforeseen buried cultural heritage resources revealed during construction.	Provide a monitoring archaeologist undertaking a watching brief during construction activities to record any discovered heritage resources.
Socio-economics (SE)		
SE1	Community health and safety during construction and operation	Compliance with international, local, and national health and safety regulations Training of personnel Emergency plans in place

ES9 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

- The right bank of the canal downstream Vardnili 1 near the spillway is damaged by landslide. This affects flow capacity of the canal, the bed is instable, the risk of development of hazardous geodynamic processes is existent;
- In the tail water of Vardnili 3, in about 100m from the concrete lined section of the canal island built of sediments carried in as a result of erosion affects flow capacity of the canal and favours development of bank erosion;
- Along the canal (in particular in the confluences and next to eroded slopes of the canal) vast amount of sediments is accumulated. As a result flow capacity of the section is reduced and favour development of hazardous geodynamic processes;

[2] risk of flood may be observed in case the dredging is not implemented

- Flow capacity of the canal is affected by overgrowth (unmanaged growth of vegetation along the canal bed);
- In order to restore design flow capacity of the canal the sediment (accumulated sediments) and vegetation are to be removed;
- No worth to mention negative impact on soil is expected. Higher will be impact on surface water quality, dredging and liquidation of the island downstream the Vardnili 3 will result in increase of water turbidity;
- Taking into account: 1). the spatial extend of the project - the planned activity will cover the section from Vardnili 1 up to Vardnili 4 only; 2) the distance from the outermost project site to the outfall of the canal – 12 km.; 3) the fact that the level of the canal tail to the sea is 1.5 - 2 m below the sea level, and that the sea has created large bay at the end of Vardnili 4 tailrace canal; 4) stepwise implementation schedule of dredging works (section by section dredging); 5) the flow rate in the canal it is assumed that suspended particles will gradually settle within the canal downstream of Vardnili 4 without having impact on sea water quality in the area next to the confluence. The project related impact on the Black Sea aquatic ecology will not be an observed;
- Certain impact on ichtyofauna and damage of hydrocole is likely to occur due to increase in water turbidity;
- During the project approximately 59,000 trees and bushes will be cut along the canal and the island. This impact will be significant, however as the vegetation is secondary no endangered or relict species will be lost. As mitigation/compensation of this loss after completion of the project the outer slopes of the canal can be planted with greenery;
- As the works will be limited to the alienation strip of the canal no impact on fauna will be the case. Disturbance (noise, vibration) of animal species will be temporary;
- The planned development will not have any negative impact on air quality. Modelling reveals that concentration of all hazardous matter emitted in the course of development at the nearest recipient (the residential area) is in allowable limits;
- Noise level at the nearest residential area will be below 51 dBA, which is less than allowable limit for the daytime (55 dBA). No works will be performed at night time;
- Taking into account vicinity of the project site to the residential area (for the sections between Vardnili 1 and Vardnili 3) obnoxious impact on the residents may be an issue.
- Social impact of the project will be positive – temporary workplaces will be provided. Dredging of the canal and restoration of the canal capacity will enable to avoid the risk of floods and damage of land/infrastructure in case of high water.

Recommendations:

- Grubbed vegetation to be rehabilitated by planting of greenery in the outer reaches of the alienation zone;
- With consideration of results of the analysis (grain size, friability) extracted inert material can be used in construction and/or for road rehabilitation purposes.

- Floating household waste and household waste found in dredged material to be disposed to the Gali landfill.
- To reduce impact of works on ichtyofauna the spawning season (April-July) depending on the species will be avoided.
- Sniff testing (olfactometry) and monitoring of complaints can be suggested as the simplest ways of the nuisance control. In case of necessity the odour can be controlled/mitigated, by spreading lime over the sediment load, which neutralizes natural uncontaminated dredged material odours.

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GENERAL DESCRIPTION

INTRODUCTION

Scope of the present report is to determine impact on environment related with rehabilitation/clean up of Vardnili tailrace canal. The report is developed for submission to the European Bank for Reconstruction and Development (EBRD) and the European Investment Bank. Objective of the report is to provide the Banks with information regarding the background environment and evaluate impact of the Vardnili cascade canal rehabilitation on environment.

1. GENERAL DESCRIPTION OF THE PROJECT

1.1 General information

Location and physical description

Enguri HPP complex is located in Gali Region of Abkhazia, in the Enguri River Valley near to the north-east coast of the Black Sea. The Gali district borders with Ochamchire district from the north, Tsalenjikha – from the east, Zugdidi district – from the south and the Black Sea from the west. The region is relatively rural and economically disadvantaged, in particular because of the conflict in the area.

Enguri complex includes Enguri HPP (installed capacity 1300 MW: 5 Units each 260 MW capacity), Vardnili cascade (Vardnili 1 – 220 MW; Vardnili 2, 3, 4 - 40 MW each). To date only Enguri and Vardnili 1 HPP are in operation.

Figure 1.1.1. General map

Enguri HPP includes:

- 271,5m high arch dam which forms reservoir near Jvari.
- Enguri reservoir – design capacity of the reservoir 1.1 bil m^3, width – 30 km);
- pressure tunnel – diameter 9m, length 16km
- equalizing tower – diameter 16m, height 167 m.

- 5 penstocks - length 451m
- underground HPP with 5 units
- free flow tunnel- length 3.2km, cross section 10.8x13.2m
- Gali reservoir – capacity 1.45 mil m3 with 58m high stone dam.

Vardnili 1 is located downstream the Gali reservoir and connects to the Black Sea with 23.3km long canal. The width of the canal at the bottom line is 23m, width at the surface – 47m. The scheme and the map showing location of facilities is given in Figure 1.1.2. and 1.1.3. respectively

Vardnili I HPP - is a hydroelectric power plant with seasonal regulation; its water reservoir is located nearby river Eristskali north to the city of Gali, with 146 million m3 of water reservoir. Its installed capacity is 220 (3x73.3) MW and rated average annual production capacity - 663 million kW/h. Water reservoir of Vardnili HPP is located on the river Eristskali, at the end of Enguri HPP water diversion canal.

Vardnili HPP - 2, 3 and 4 - are uniform run-of-river type hydro electric power plants of identical capacity and output, located on Vardnili water tailrace canal. They are located in 5.5 km, 10.1 km and 14.9 km respectively from Vardnili HPP 1. Each plant has its own waste canal and water dissipater, as well as 110/35 kV outdoor switchgear substation. Installed capacity of each plant is 40 (2x20) MW, annual production capacity - 120 million kW/h. Vardnili 2 HPP was put into operation in 1971, Vardnili 3 and 4 HPPs - in 1972.

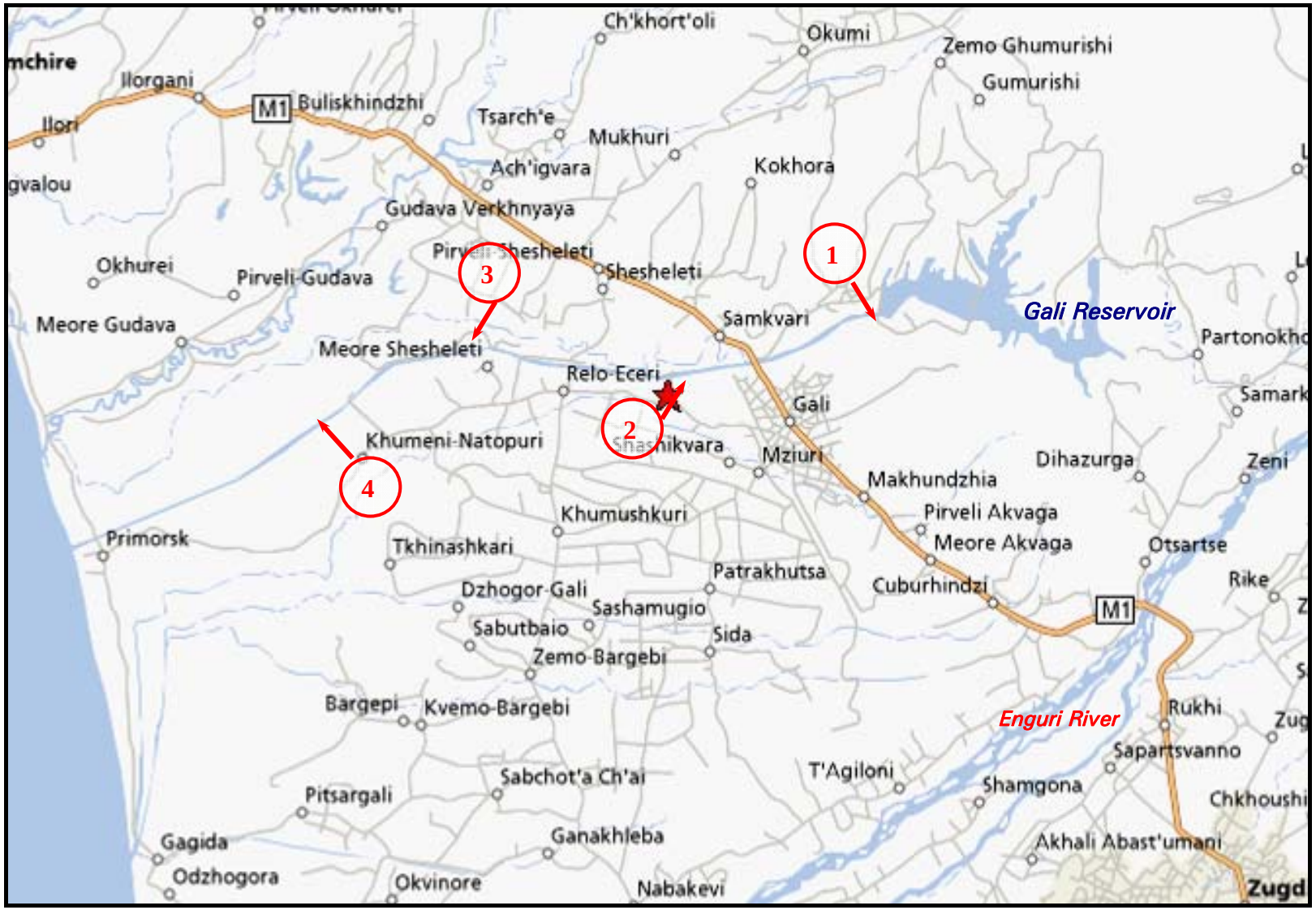


Figure 1.1.2. Schematic map (1 – Vardnili 1, 2-Vardnili 2, 3- Vardnili 3, 4-Vardnili 4)

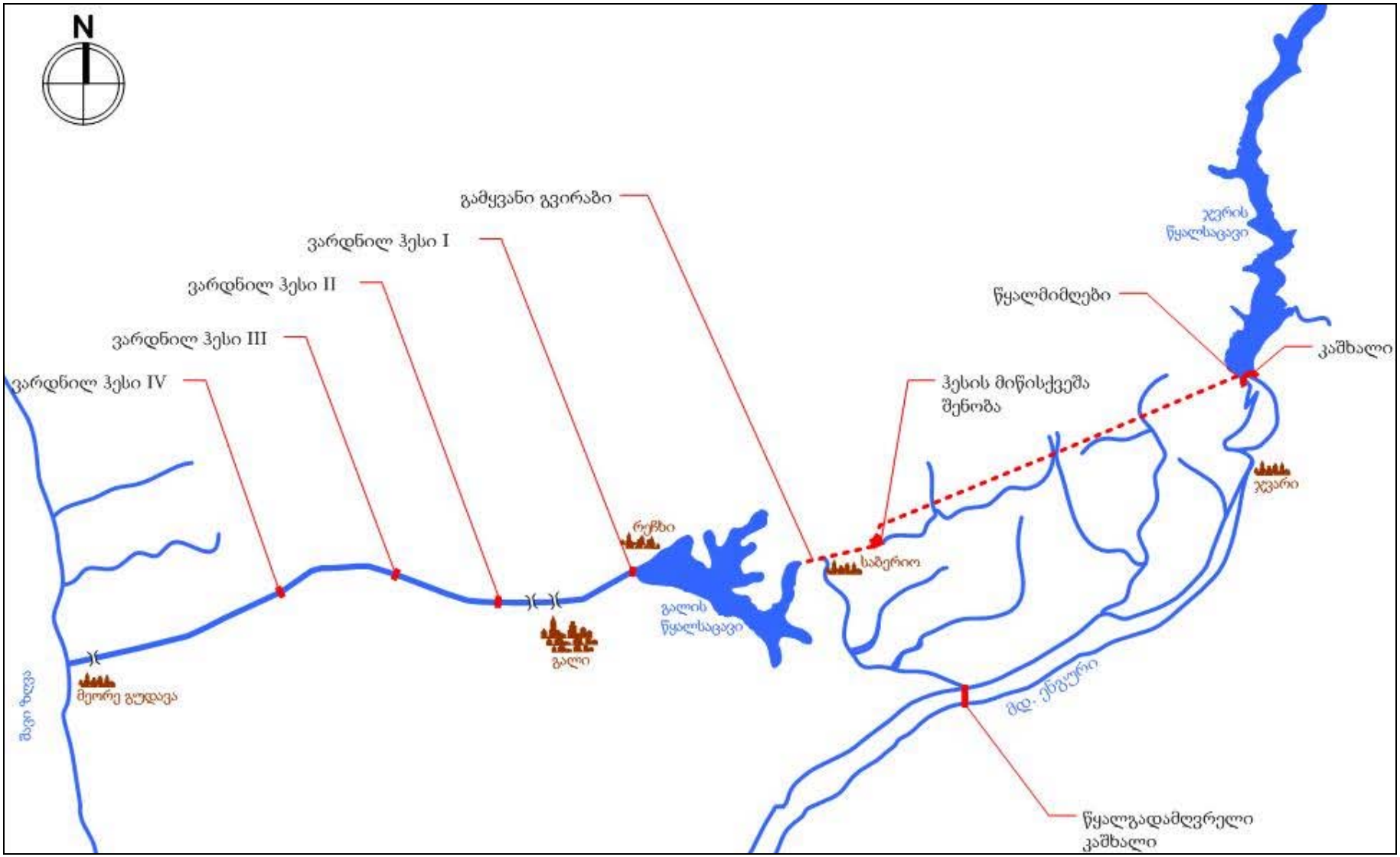


Figure 1.1.3. Location scheme – Enguri and Vardnili HPP

Facility operation and history

The Vardnili HPPs were damaged in 90-es, during the civil war in Abkhazia. Since the end of the war in 1994 only one of four plants has functioned; the other three were completely vandalized.

In 2000 some works were carried out at Vardnili #1 water diversion canal, including earth and rock excavation, earth earning/removal to the canal borders and earth bund arrangement. Also some diversion concrete and reinforced concrete works at the tailrace canal were performed.

in 2006-2007 the Ministry of Energy of Georgia financed partial rehabilitation of Unit #2. this included replacement of stator winding, stator core, etc. However some important components of the unit (e.g. the excitation system, control/protection system) were not replaced. the original 73 MW Unit #2 came back into operation by mid-2007.

By end of 2007 Enguri HPP together with the Vardnili #1 contributed 36.27% of total power generation in Georgia.

Rehabilitation of two remaining units of Vardnili 1 as well as replacement of the old common auxiliary (electrical) equipment was set as priority by the Ministry of Energy for 2008-2009. With this, instead of max 40 MW current capacity on each old unit, will reach its design capacity of 73 MW. Rehabilitation of Unit #1 is currently in progress under the state financing.

In parallel, full-scale rehabilitation of civil structures of Vardnili 1 (dam and waterways) has been set as top priority urgent task for 2008-2011 as to allow full capacity operation of the largest 1300 MW Enguri HPP upstream of Gali reservoir.

The canal from the Gali reservoir through the Vardnili 1 plant and farther through the Vardnili 2, 3 and 4 plants is in a dangerous state. In the course of time, due to sedimentation its capacity has reduced to around 67%-70% of the design value. The derivation tunnel has narrowed due to landslides and accumulation of solid sediment, in one location an artificial island has built up. The banks of the canal and the island are heavily encroached by trees and bushes.

Table 1.1.2. Annual average electricity generation and average production design capacities by source in Georgia 2000-2007

Producers	Average generation design capacity TWh	Average TWh	In % of total
Enguri HPP	3.800	2.57	31.44 %
Vartsikhe HPP	1.000	0.66	8.13 %
Vardnil HPP	0.660	0.40	4.83 %
Jinvali HPP	0.473	0.33	4.02 %
Rioni HPP	0.325	0.30	3.73 %
Khrami-2 HPP	0.184	0.20	2.46 %
Gumati HPP	0.376	0.19	2.35 %
Khrami-1 HPP	0.184	0.18	2.17 %
Lajanuri HPP	0.438	0.16	1.90 %
Dzevrul HPP	0.117	0.13	1.64 %
Shaori HPP	0.114	0.10	1.26 %
Energy Invest TPP	information N/A	0.04	0.55 %
AES Mtkvari TPP	information N/A	0.72	8.80 %
Tbilsresi TPP	information N/A	0.34	4.14 %
Imports	information N/A	1.15	14.03 %
Other HPPs	0.700	0.70	8.55 %
Total average	8.371	8.18	100 %

Rehabilitation of Vardnili waterways, canal and civil structures is scheduled for 2009-2011. Works include:

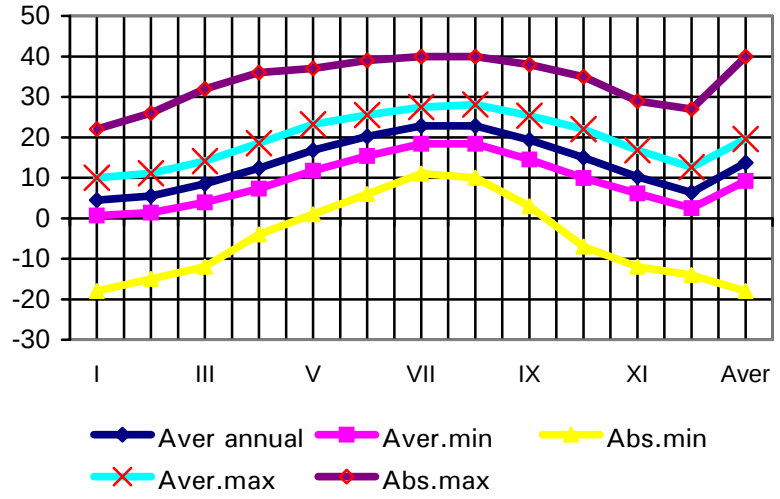
- measures for improvement safety of the dam and facilities of the cascade.
- rehabilitation of civil works of Vardnili 1 waterway
- rehabilitation of hydromechanical works (Vardnili 1)
- rehabilitation of penstocks
- rehabilitation of the monitoring facilities of the dam and the tail water
- provision of dredger for the clean up of the canal (Vardnili HPP 1-4)
- rehabilitation of drainage canal of II-IV HPPs which includes
    - reinforcement of the slopes with concrete, earth and reinforcement works;
    - clean up of the canal from vegetation,
    - removal of the isle downstream the HPP 3 (earth and blasting works)
- electromechanical works (Vardnili 1)
- rehabilitation of hydromechanical facilities (Vardnili II)
- rehabilitation of roads and bridges (Vardnili II, III and IV)

The works will be contracted out to the construction/electrical companies identified through the international tenders.

Environmental setting

CLIMATE AND AMBIENT AIR TEMPERATURE

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Aver.
Average annual, ^{0}C	4,5	5,5	8,5	12,4	16,8	20,2	22,8	22,8	19,3	15,0	10,2	6,4	13,7
Average annual min, ^{0}C	0,7	1,4	3,9	7,3	11,7	15,4	18,4	18,4	14,5	9,9	6,1	2,5	9,2
Absolute annual min, ^{0}C	-18	-15	-12	-4	1	6	11	10	3	-7	-12	-14	-18
Average annual max, ^{0}C	10,0	11,1	14,1	18,5	23,2	25,5	27,5	28,1	25,3	22,0	16,8	12,6	19,6
Absolute annual max ^{0}C	22	26	32	36	37	39	40	40	38	35	29	27	40



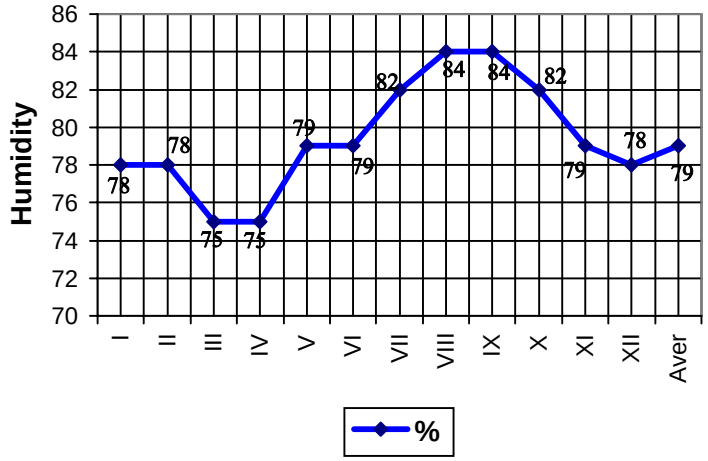
Climate is mild humid subtropical. Because of proximity to the Black Sea and the shield of the Caucasus Mountains, the region's climate is very mild. Average temperature in the coastal areas is around 15 C. The climate at higher elevations varies from maritime mountainous to cold and summerless.

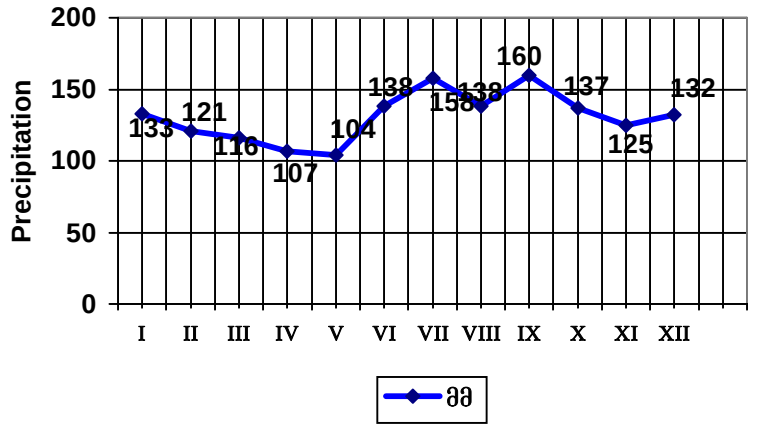
RELATIVE HUMIDITY

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Aver
%	78	78	75	75	79	79	82	84	84	82	79	78	79

PRECIPITATION

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual.
mm	133	121	116	107	104	138	158	138	160	137	125	132	1569

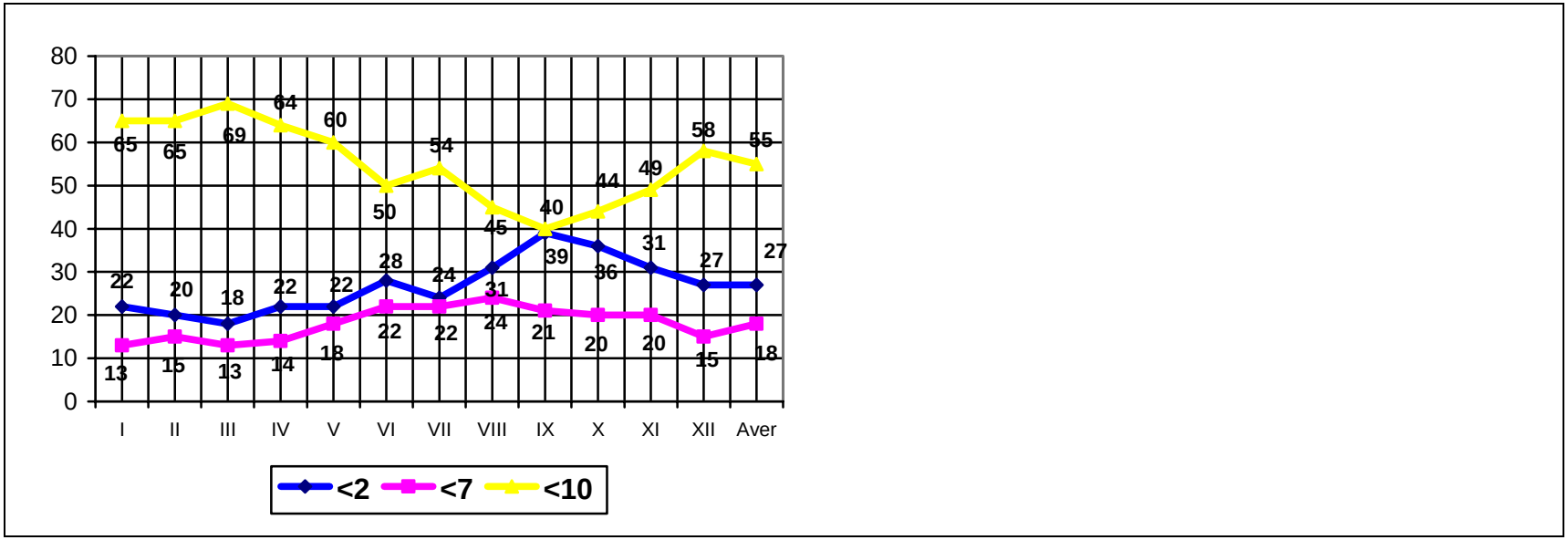




Region receives high amounts of precipitation, but the level of humidity is not high. The annual precipitation vacillates from 1,100-1,500 mm along the coast to 1,700-3,500 mm in the higher mountainous areas. In winter seasons, in the mountain areas of the region snow cover is rather steady.

TOTAL NEBULOCITY, %

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
0-2	22	20	18	22	22	28	24	31	39	36	31	27	27
3-7	13	15	13	14	18	22	22	24	21	20	20	15	18
8-10	65	65	69	64	60	50	54	45	40	44	49	58	55

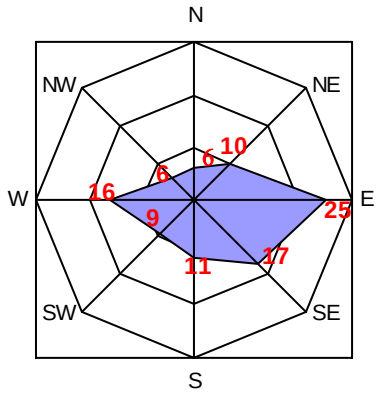


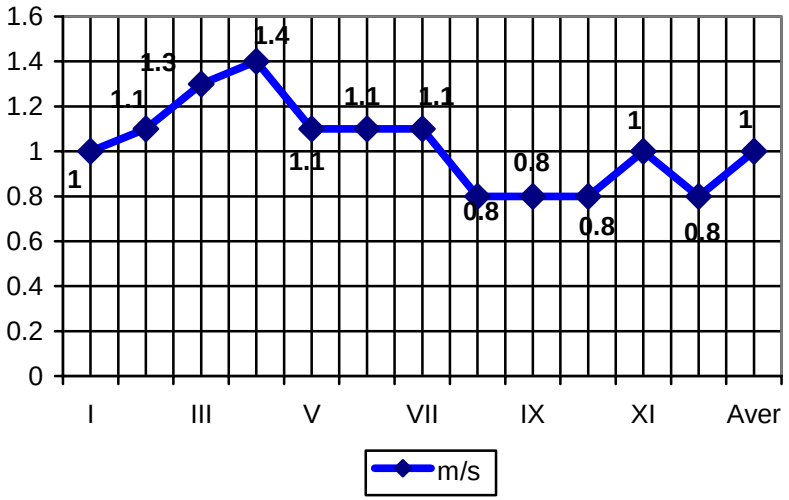
WIND RECURRENCY

N.	NE	E	SE	S	SW	W	NW	Calm
6	10	25	17	11	9	16	6	68

WIND VELOCITY

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Aver.
m/s	1,0	1,1	1,3	1,4	1,1	1,1	1,1	0,8	0,8	0,8	1,0	0,8	1,0





Air quality

No historic data on air quality in the area is available. Evaluating the status, taking into account limited industrial activities and traffic in the area one can assume that the air quality in the area is satisfactory.

As for the greenhouse gases effect, their emission in case of hydropower production is mainly related to reservoirs capable to produce carbon dioxide and CH4. This is especially the case when due to decay of vegetation anaerobic conditions persist. Since Vardnili and Enguri HPPs history dates back to 70-es of the last century production of gas as a result of deterioration of vegetation is minimal.

Currently measured gaseous and particulate concentrations are found to comply with EU ambient air quality standards at the sampling locations.

Noise and vibration

Economic activities in the area are in decay because of political instability in there. As there are no industrial developments in the area and because of the limited traffic noise and vibration levels are not of any concern. Furthermore, even in case single cases of level evidence are observed, which is less likely to happen at all, because of low density of population this will not be a nuisance.

Geology

According to geotechnical zoning the study area belongs to Gagra-Java zone (which in its turn is located in the limits of folded system of the south slope of Caucasus) and partly to Kolkheti zone (part of the Georgian Block).

Gagra-Java zone is built of sandy-clay sediments, Baiosian volcanogenic series (porphyrite series) and upper Jurassic and Cretaceous terrigeneous and carbonate deposits. The linear folds in the area are less compressed compared with those of the rest of the folded zone. It is believed that prior to the Liass the zone was a part of the outermost north edge of the intermountain massive which split up in early Apt and later was “involved” in development of the Caucasus geosyncline.

A Baiosian stratum is built of thick volcanogenic-sediment formations – so called porphyrite. The volcanogenic-sediment and terrigeneous facies ends in narrow strip built of tuffs, tiff-breccias and diabasalt slate alternation.

Within the study area lower Cretaceous formations dominate. All facies in the area are similar, but in horizontal direction significant facial differences are observed. Quarts-arkosic sandstones transform into conglomerates with granite boulders. The sandstones are pinkish, sometimes weakly cemented or friable.

Limestones are massive, sometimes thick layered, organogenic, mainly recristalized. In limestones fractions of petrified remains of bivalve molluscs are often met. Upper Cretaceous is represented mainly by carbonate facies.

Within the limits of Kolkheti zone Neogene-Quaternary molasses are observed. Of Neogene system within the region mentioned are to be lower Miocene (sandy-clay sediments rich with

molluscs and microforaminiferes) and Sarmatian (presented by coarse grain sandstones and conglomerates).

Of Quaternary sediments the most widespread are alluvial formations found along the river terraces and intermountain depressions. Within the limits of Enguri River 4 terraces are available - each covered with thick alluvium.

Area north-east to Gali is hilly, south-west – flat lowland. The hilly area is composed of Cretaceous limestones; the outermost north strip – of Jurassic porphyrites, tuff-sandstones and tuff-breccias; the hilly zone is built of Palaeocene-Eocene, Miocene-Pliocene limestones, marls, conglomerates and sandstones. Samurzakano flat lowland is built of Quaternary cobbles, sands and clays. In the north area of the district located in intensely karst Okhachkue, Oisired and Akibo ridges. To the south located is hilly zone. South-east to Gali – anticline hillock Satanjo (506 m), farther south – up to river Enguri- 20-30m high Samurzakano flat lowland.

Natural resources

The natural resources of the Gali area include limestone, brick clay, sand-gravels, gypsum and water. Based on information of the Ministry of Environment Protection and Natural Resources of Georgia by category are as follows:

Type of mineral and	Location of the deposit	Resource (as of 01.01.2001)
Chalk limestone	Okumi	3,962 x1000m3
	Gali	3,800x1000m3
Brick clays	Achigvari	4,063x1000m3
	Gali	119x1000m3
Building sand-gravel	Enguri II	61,500x1000m3
Gypsum	Okumi	810x1000 t
Artesian fresh waters	Rechkhi-Tskiriri	107x1000 m^3/d

Source: Ministry of Environment Protection and Natural Resources

Soil

The soil of Gali region is diverse. In the coastal zone of Samurzakano, between the Enguri and Gagida rivers marsh silty soil is met. For these soil heavy mechanical composition and humidification of the profile is typical. The soils have acid, neutral or alcaline reaction with low or medium content of humus. The soil is contaminated with radionucludes.

At 3-4 from the sea – between the Enguri and Okumi rivers soil is wetland-peat with peat horizons, has heavy mechanical composition. At 250m, hilly zone, under the broadleaf forest red soils on the top of weathered crust are observed. Characteristics: red colour, clayed, powerful profile, medium content of humus, volume weight in the 1.19-1.34 range, with medium and high capacity, with low concentration of exchangeable potassium.

Within the limits of the study area yellow soil is widely spread. The yellow soil is available up to 500m or higher elevations. It develops under the broadleaf forest cover on Palaeogene-Neogene clay-slates and clays. The soil is claying has thick profile, acid reaction, medium humus content, volume weight varies from 1.16 to 1.26. Content of hydrolyzed nitrogen in

the soil is very low. The soil is rich in absorbed phosphorus and poor in exchangeable potassium.

Enguri River terraces are built of acid alluvial and alluvial rich soil. Farther from the riverbed zonality of soil increases. Soils of different type, different regime, structure and properties are available.

In some areas humus-carbonate soils are found. Spreading of this soil coincides with that of the calcium carbonate containing rocks (limestone, marble, dolomites, marls, etc.). For this type of soil well-expressed humus horizons, neutral or weakly alkaline reaction is characteristic.

On the slopes of Akibi and Okhuchkue ridges podzol forest black soils are observed.

Hazardous geological processes

The main hazardous geological processes in the are include landslide risks, in particular in the limits of the villages (Lukukhona, Dakhazurga, Saberio, Mziuri, Chuburkhinji, and environs of Gali) of the foothills. River bank erosion is an issue for the Eristskali River especially in the section near vil.Etseri. Soil settlement is rather often observed in vil.Dakhazurga, Saberio and Gali. The hazardous geological processes are given in Figure 1.1.4.

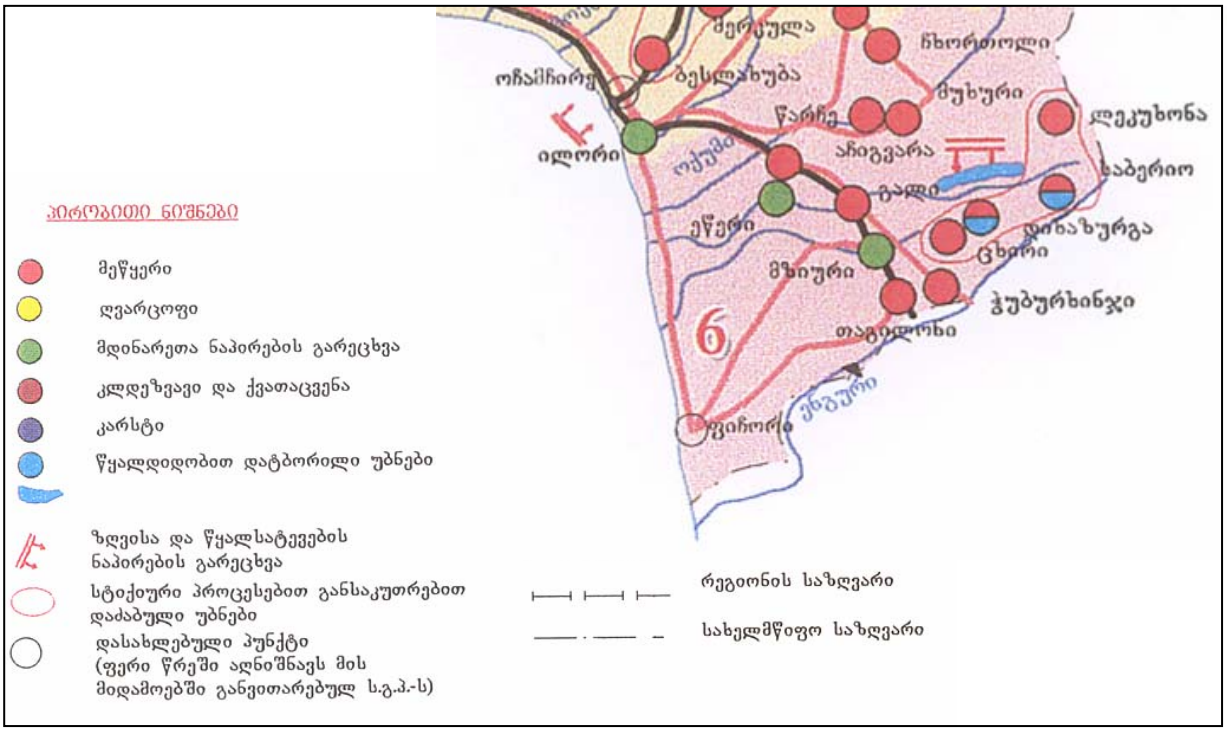


Figure 1.1.4. Hazardous geological processes – fragment of the map

By seismic conditions the study area belongs to the zone with 9 strong seismic intensity (according to the MSK-64 scale).

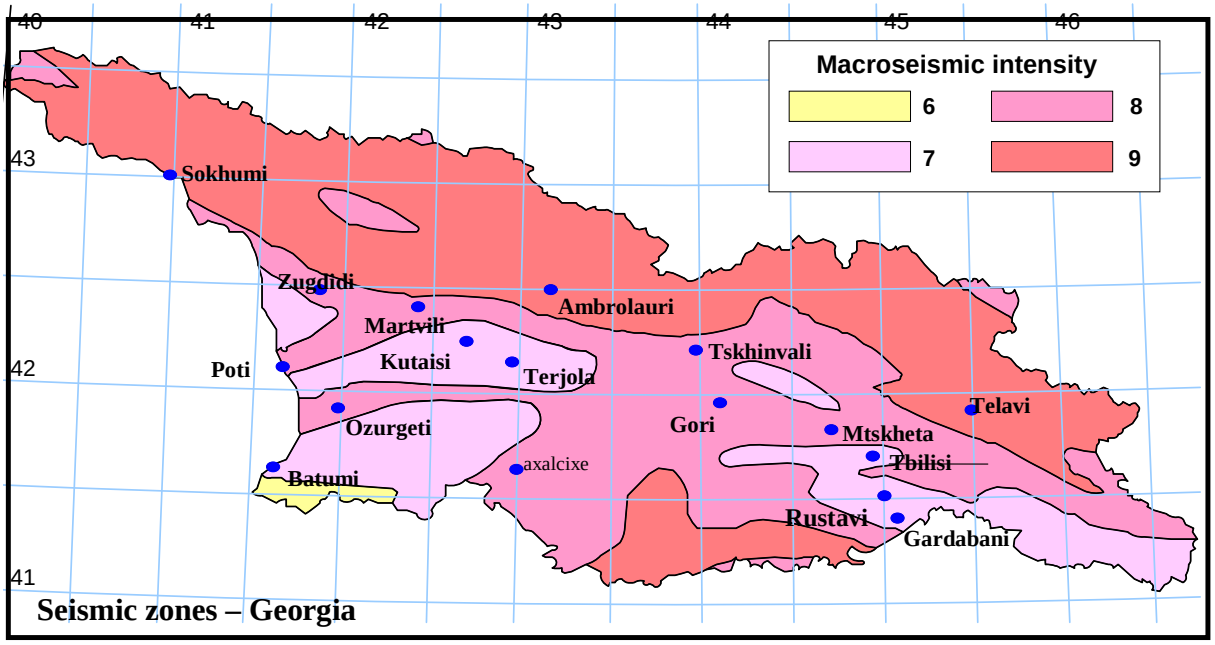


Figure 1.1.5. Hazardous geological processes – fragment of the map

Seismologists confirm modern tectonic activity in the region, which are differentially expressed and depend on intensity of activity of the single blocks of the Georgian block.

Hydrology

The river system in Gali region is dense. The most water abundant is Okumi River which originates from the south slope of Akibi ridge. Its left tributary, Eristskali originates from the south-east foothills of Okhuchkue karst massive, at 560m asl. The right tributaries are Obuja and Ckhartali rivers.

Average annual outflow of water in the Enguri estuary has decreased since 1976 from 165 m3/sec to 39.5 m3/sec. This change has not significantly affected the overall situation in the Kolkheti area of the Black Sea as the waters of the river are canalled into the Eristskali, supplying 3.15 km3 annually.

River	Area of basin, km2	Average altitude of basin, m	Outflow		
			Average annual outflow, m3/s	Unit discharge, l/s·km2	Annual volume, km3
Psou	421	1 110	19.2	45.6	0.606
Khashupse	200	1 210	9.5	47.5	0.300
Zhove-Kvara	72	1 520	6.11	84.8	0.193
Bzyb	1 510	1 570	120	79.5	3.79
Mchishta	169	720	7.71	45.6	0.243
Khipsta	166	1 220	9.76	58.8	0.308
Aapsta	243	670	10.8	44.4	0.341
Gumista	576	1050	33.3	57.8	1.051
Besleti	81.5	340	3.53	43.3	0.111
Kelasuri	220	1 280	13.2	60.0	0.416
Majarka	114	408	5.1	44.7	0.161
Kodori	2 030	1 680	132	65.0	4.170

Tumish	62.2	174	1.64	26.3	0.052
Dgamysh	120	350	4.32	36.0	0.136
Tskhenistskali	61	171	1.61	2.64	0.051
Mokva	336	700	18.1	53.9	0.571
Galidzga	483	880	29.4	60.9	0.928
Okumi	265	520	14.5	54.7	0.458
Eristskali Canal		100			3.15
Enguri	4 060	1 840	39.5 165*	- 40.6*	1.247 5.207*
Khobi	1340	560	60.1	44.8	1.895
Rioni: north			305		9.62
delta south arm	13 400	1 084	119	31.6	3.75
Supsa	1 130	970	50.1	44.3	1.581
Natanebi	657	830	24.5	37.3	0.773
Kintrishi	291	835	16.7	57.4	0.527
Chakvistskali	172.6	740	12.5	72.4	0.394
Korolistskali	55	500	3.8	69.1	0.200
Chorokhi	22 100	1 530	276	12.5	8.71

* before control

Small rivers: Anaria, Gagida, etc. originate from the hilly zone and flow through the coastal lowland. The rivers recharge by atmospheric water, the Okumi River – partly by snow, while Eristskali River – partly by karst waters. The lowland rivers are abundant throughout a year, for mountain rivers – high-water in spring is generally observed.

In the lower flow basin of Okumi, right side, 15-20m asl is located a group of Bebesiri lakes. Didi Bebesiri and Bebesiri are located on the right to Okumi, Patara Bebesiri – on the left side. The lakes were formed as a result of damming up by dunes. Didi Bebesiri area is 0.61 km^2, largest depth 4.5 m; Bebesiri – 0.14km2, 4.6m; Patara Bebesiri – 0.1 km2, 1.7 m. The lakes are fed by rain and underground water. The surface is “covered” with algae. Lakes are rich in fish (pike, sheat-fish, bream, etc.). Within the Okhachkue karst massive small karst lakes are available.

Enguri River

Originates from Enguri glassier at 2614m asl. Flows into the Black Sea near Anaklia. Length 213 km, watershed area 4060 km2. Main tributaries:

- Adishischala, Khaldechala, Mulkha, Dolrachala, Nakra, Nanskra (right tributaries)
- Tkheishi, Khumpresi, Lasili, Magana, Jumi, etc (left tributaries)

The river is fed by snow and glassier water (66%), ground water (22%) and rain water (12%).

Figure given below, shows a declining trend in water flow in the past 80 years. This trend is likely to continue due to the expected effects of climate change in the Caucasus region.

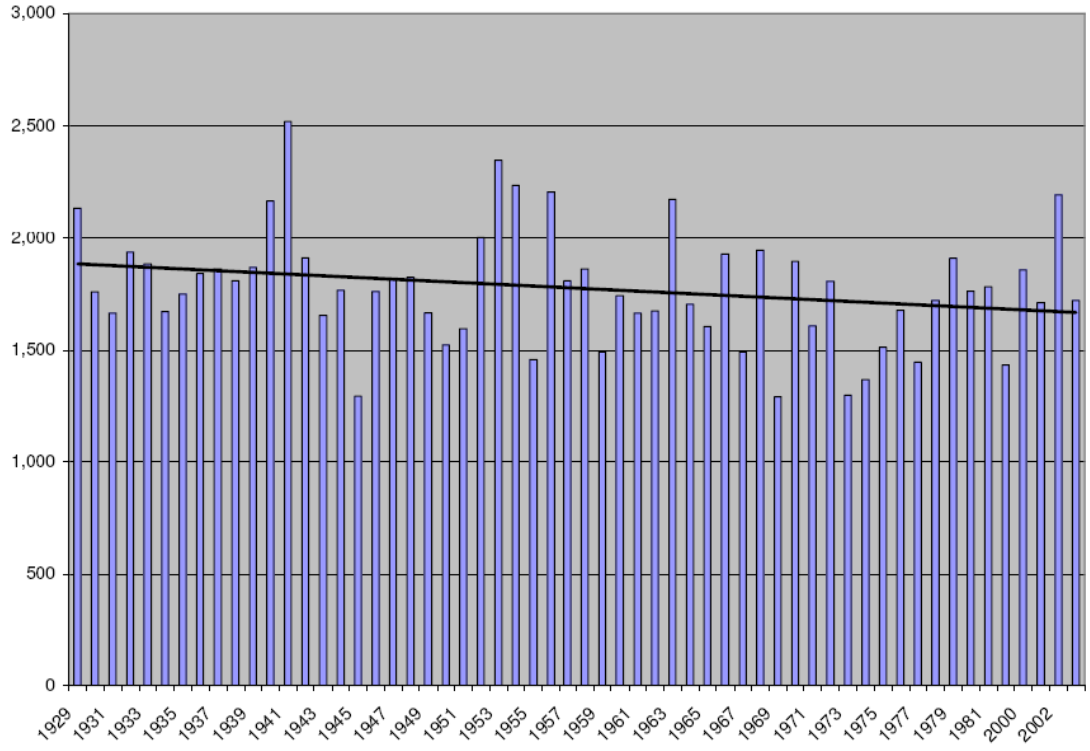


Figure 1.1.6. Enguri river water flow in 1929-2002 in m3/sec.
Source: USAID 2006, "Energy balance of Georgia power sector: analysis and proposals"

As shown in the table below, water flow variability, measured statistically through standard deviation, increased to 276 m3/sec in recent years (1999-2003) compared to the level of 259 m3/sec in the 1929-1981 period. It can be reasonably expected that the variability of water flow will be exacerbated by climate change in years to come.

Formerly historic data suggests that the volume of solid sediment brought by the river Enguri to the sea was 1,500,000 m3/year, 490,000 m3/year from this amount was beach-bearing sediments. Now the river Enguri brings about 260,000 m3/year, where the beach-bearing sediments are in the volume of 78,000 m3/year. Consequently, the coastal zone between the mouths of the rivers Enguri and Khobistskali experiences the lack of beach-bearing materials.

STATISTICAL CHARACTERISTICS OF HISTORY OF ENGURI RIVER FLOW. AVERAGE AND STANDARD DEVIATIONS, M3/SEC													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Full Year
MONTHLY AVERAGE													
1929-1981	37.16	36.13	49.42	134.23	267.00	306.72	329.15	253.62	148.06	96.64	68.64	48.06	1774.73
1999-2003	39.80	44.00	51.60	159.40	269.40	354.00	327.40	219.40	116.20	87.80	75.00	39.40	1783.40

all data	37.39	36.81	49.60	136.40	267.21	310.79	329.00	250.67	145.31	95.79	69.19	47.32	1775.48
MONTHLY STANDARD DEVIATION													
1929-1981	9.69	9.54	15.81	41.80	64.02	66.49	57.97	50.20	35.43	46.10	25.66	13.34	259.01
1999-2003	15.01	18.87	30.37	28.32	62.18	69.70	80.24	12.10	39.89	34.82	22.08	12.40	276.24
all data	10.10	10.63	17.12	41.24	63.33	67.48	59.31	49.03	36.58	35.78	25.26	13.39	257.99

The compensation flow downstream Enguri Dam has been maintained at 10% of the average river flow, however the rule of reserved compensation is not respected. There is no reserved compensation downstream Gali whose outlet is constituted only by the canal replacing the Eristskali river.

Eristskali River

The Eristskali River is the left tributary of the Okumi River.

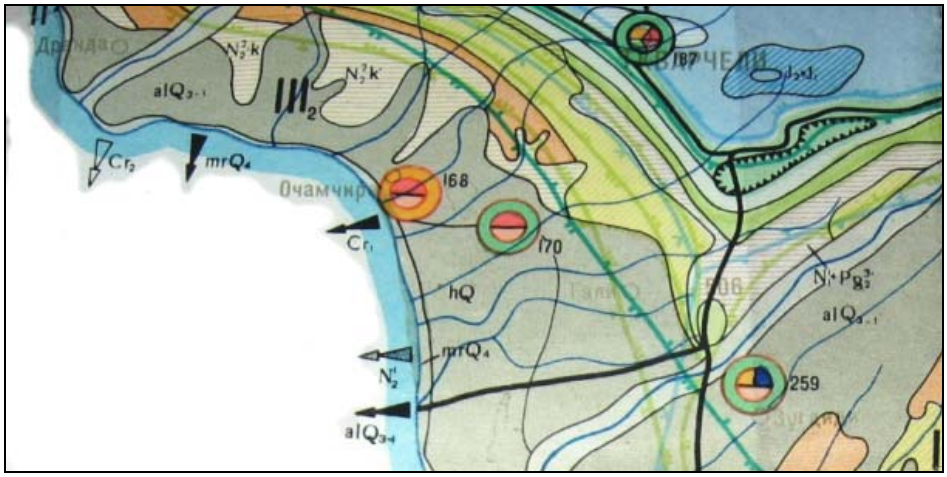
Eristskali is 75 km long, the area of the river basin - 296 km2. The river originates from the foothills of the south-east slope Okhachkue karst massive, at 560 m asl. The river recharges by atmospheric and underground karts waters. High water is typical. Average annual flow near the river mouth 12 m3/s. Tributaries of the Eristskali River are Rtomistskali, Patara Eristskali, etc.

The course of the Eristskali river has been completely modified by excavation of the canal which led to formation of the new water balance.

Hydrogeology of the region

The area belongs to Kolkheti artesian basin of porous, fissure and fissure-cavern water. Structurally the region represents a deep syncline depression complicated with sharp folds and faults formed in Cretaceous layer. The basin includes three main artesian aquifers comprising multiple waterbearing strata.

- Aquifer of fissured and fissure-cavern waters of lower Cretaceous limestones.
- Aquifer of fissure and fissure-cavern waters of Upper Cretaceous
- Aquifer of the Quaternary formations.



hQ waterbearing Quaternary aquifer of marsh sediments clayey, clays

mrQ_4 water bearing aquifer of beach formations: pebbles, sands

Figure 1.1.7. Fragment of hydrogeological map of the area

The area belongs to Colchis artesian basin of porous, fissure and fissure-cavern water. From the view of morphology the region is lowland "irrigated" by Rioni, Enguri, Khobi and others. The area is covered with about 400m thick quaternary sandy-pebble and clayey layer. Lower sited are clay-sandy formations of Neogene and Palaeogene (3000m thick) which are underplayed with more than 2500 m thick carbonate-terrigeneous and volcanogenic formations of Cretaceous.

Structurally the region represents a deep syncline depression complicated with sharp folds and faults formed in Cretaceous layer. The basin includes three main artesian aquifers comprising multiple waterbearing strata.

Aquifer of fissured and fissure-cavern waters of lower Cretaceous limestones. The aquifer is rather abundant; the flow detected in some of the boreholes is around 12 l/s. This aquifer contains bicarbonate or bicarbonate-sulphate thermal water (T=100C) with low mineralization. Closer to the west of the Qvaloni thrust, which acts as a screen for waters of lower Cretaceous formation the situation changes. In this area high mineralized (around 70 g/l) methane containing chloride sodium waters are found. The reserve of the aquifer is estimated as 3 m^3/s. Aquifer of fissure and fissure-cavern waters of Upper Cretaceous is spread over entire basin. For this aquifer low head is typical. Mineralization is high (up to 100 g/l), water type chloride sodium, temperature ranges from 25 to 50C. Sandy-clayey sediments of Pliocene are sporadically watered. Water is highly mineralized (up to 60 j/l), water type – chloride-sodium.

Widely spread are sandy-pebble Quaternary formations. The latter contain low mineralized bicarbonate calcium waters (potable quality). Maximum flow of the boreholes 15-20l/s. Depth to 350m, total capacity of the aquifers around 100m. Resource is estimated as 4 m^3/s.

Upper part of the Quaternary formations – modern alluvial, marsh and marine bottom sediments. Marsh ground water has high mineralization, high content of organic matter, hardness, contain marsh gas and are not fit for consumption.

Water of alluvial sediments is widely met in the north periphery of the region and is of good potable quality. In the central and western part of the region alluvium is presented by thin fraction with low permeability. Total resources of the region can be estimated as 10 m^3/sec.

Closer to the surface water bodies water abundance of alluvial sediments increases. In Kolkheti lowland pressure water flows from north-east to south-west. Composition of ground water is calcium-sodium or sodium-calcium with mineralization ranging from 0.2 to 0.5 g/l. The most abundant discharge is observed in the Enguri River delta. The flow of the sources is stable (no seasonal or annual variation observed). The recharge area of the artesian aquifer is located on the north and east peripheries of Colchis lowland. The sources of recharge are surface water and atmospheric water. In some of the sections the water from Pliocene "mix" with water from Lower Quaternary sediments.

Underground waters aquifers of modern alluvial sediments are unconfined, sloping toward the river flow. The depth of the ground water varies from 0.5 to 1.5m. Water abundance varies by location and depends on the grain size. Filtration coefficients are:

- boulder-pebbles - from 100 to 300 m/day and above
- sands from 30 to 50m/day,
- clayey and clay formations – less than 1 m/day.

Total mineralization is from 0.5 to 1 g/l. The groundwater is recharged by surface flows, atmospheric water and partly ground water. Water regime strongly depends on variation of surface water level and atmospheric water regime.

Total resources of the region can be estimated as 10 m^3/sec.

Landscape and land use

The subtropic area of Kolkheti lowland to which the region belongs represents lowland and foothills with humid forests and mountain-flatland landscape.

The following landscape types can be pointed out:

1. coastal sand-gravel dunes with psamophylic vegetation;
2. waterlogged lowland with alder and silt-wetland soil;
3. slightly sloping flat lowland with Colchic vegetation, alluvial and subtropic podzol soil;
4. hilly terrace foothills with Colchic vegetation on red, yellow and humus-carbonate soils;
5. carstic low hills with hornbeam-oak forests and humus-carbonate soils;
6. medium high mountains with beach forests and humus-carbonate soils;
7. sub-alpine forest-meadow with mountain meadow humus-carbonate soils.

According to the agrobotanical map the area belongs to the tea and subtropic fruit growing region (I-3; I-6). The coastal strip used to be used for subtropic technical crops- growing.

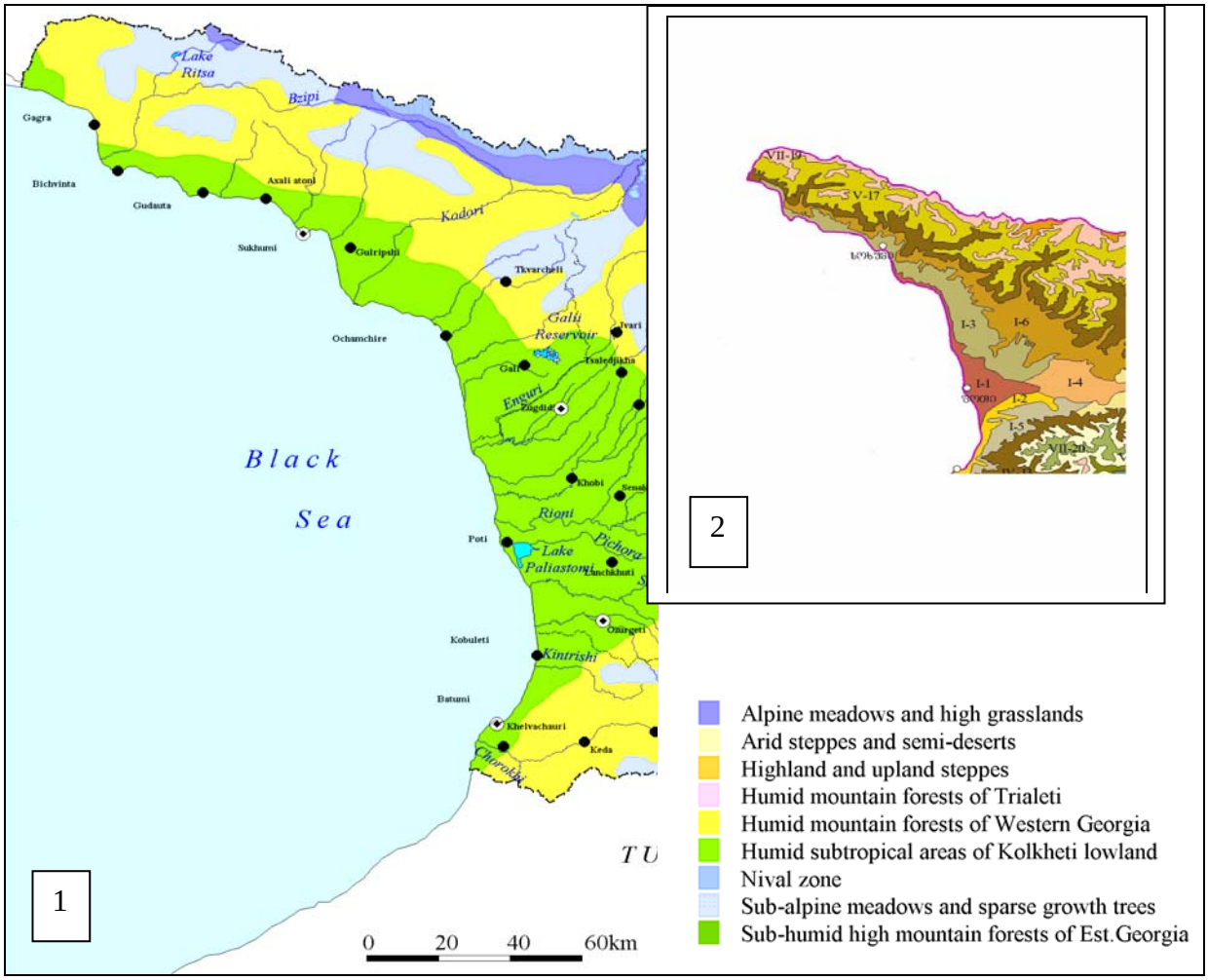


Figure 1.1.8. Fragments of the map of the major biomes (1) and agrobotanical map (2)

Protected areas

There are no protected areas close to the site. The nearest, Kolkheti National Park is in XXX km from the canal. Distance to potential protected area in Svaneti is XXX km.

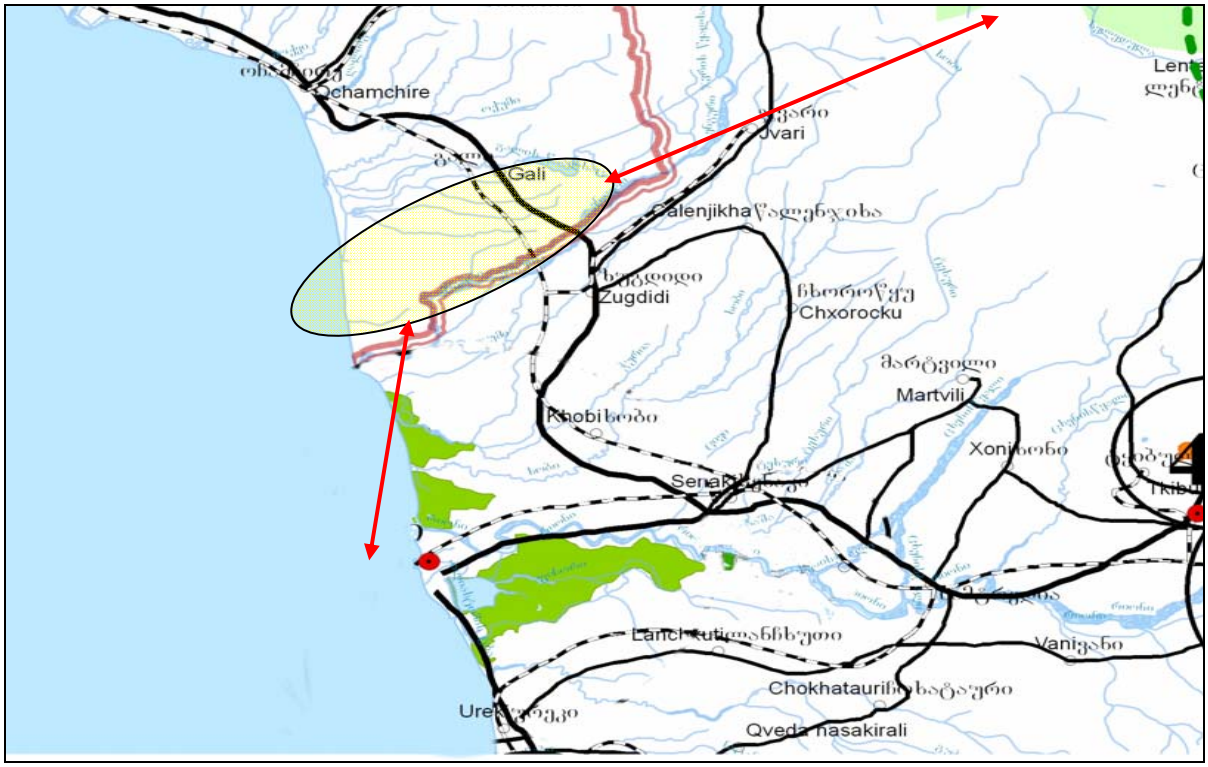


Figure 1.1.9. Map showing distance of the site from protected areas

Flora

In the Gali district zonality of vegetation is observed. According to the elevation the following regularity is noticed:

1. lowland vegetation (up to 30m asl);
2. lowland and foothill Colchis forests (30-700 m);
3. mountain forests (above 700 m).

In the coastal zone psamophylic vegetation is met: on dunes - Enphorbia, Cirsium, Carex, etc; on old dunes, farther from the sea - Rubus, Paliurus Spina-christi, Crataegus, Barberis, etc. Of lianas - Valeriana officinalis, Periploca greca, Smalix excelsa. In the river delta - Hippophae rhamnoides and Tamarix. Near the Didi Bebesiri lake endemic pontic hibiscus, relict Trapa. In Samurzakhano wetlands several varieties of Juncus – Typha, Iris, Bolboschoenus maritimus, Arundo donax grow. In the same area Pterocarya pterocarpa, Morus alba, Fraxinus and other can also be found. In the underwood evergreen and deciduous bushes: Rhododendron ponticum, flavum, Viburnum opulus; lianas are widely met. In the south-east where the wetlands are still existent vast areas are covered with forests.

The major edificators of the lowland and foothill Colchis forests are Georgian and Imeretian oak, chestnut, Carpinus , buk Fagus, klen Acer, Tilia, Alnus, etc. In humid gorges are found. There are many fruit trees: Doryenium intermedium, fig, Malus orientalis, Mentha, Prunus divaricata, etc. Of tertiary flora relicts mentioned are to be Rhododendron ponticum,

Laurocerasus officinalis, Ilex colchica, Ruscus ponticus; of deciduous bushes Staphylea, Coryius, Rhubus coriaria are often available. Lianas are presented by: Hedera, Periploca graeca, etc. The Colchic forests are now destroyed and replaced with citruses, fruit orchards and corn fields.

The upper boundary of the mountain forests covering majority of the regions is at 1900-2000 m. From 700 m to 1400 m hornbeam- beech and beach dominate. In the underforest presented are Rhododendron flavus, Laurocerasus officinalis, Vaccinium myrtillus, Rhododendron ponticum, Ilex colchica, Ruscus ponticus. Herbaceous cover is composed of Euphorbia, Festica gigantea and ferns. Above 1200-1400 m along with the braodleaf conifereous plants are available. On the slopes of Okhachkue limestone massive along with the Colchis forests the forests with where Rhododendron ponticum in the underforest is replaced with frost resistant bushes: Rhododendron flavum, Vaccinium myrtillus, Rhamnus pallasii, Daphne mezereum, etc. The local endangered species include Ulmus foliacea and others. The local forests were affected by irregulat wood cutting during the civil war and later – in the period of energy crises.

Above subalpine meadows with alpine vegetation such as Calamagrostis epigeios, Ranunculus, Salvia verticillata, Thymus, etc.

The vegetation along the banks and on the island is presented by alder, which constitutes 85-90% of the growth. Of the species met are Paliurus Spina-christi, hawthorn, ash-tree, etc. No species under special protection (endangered, relict) have been found in the limits of the study area.

Figure 1.1.10. View of vegetation along the canal bed

<u>Fauna</u>

Rich and diverse landscapes favour development of diverse fauna, which also depends on zonality. Available are plain, mountain forest and high mountain animal species.

In the lowland forests met are wild boar, deer, jackal, fox, Caucasian mole and others. Of birds presented are sparrow, Emberiza aurreola, bald-coot Fulica, heron and others. In autumn such species as quail fly in. Reptiles are represented by ordinary and Natrix natrix, grass-snake, lake turtle, etc; Amphibians - Rana ridibunda, Bombina bombina, Hyla arborea; fish –

endemic Colchic Phoxinus phoxinus, Cyprinus carpio, bullhead, Abramis brama , Chalcalburnus chalcoides, etc.

Mountain forests are richer. Wolf, jackal, fox, marten, beaver, weasel, badger, wild cat, rat, hare, wild boar, deer are met; of birds – goldfinch, thrush, woodpecker, jay, hawk, kite, Fringilla coelebs, Carduelis carduelis, Parus, Parus coeruleus , Garrulus glandarius, Accipiter badius, etc.; of reptiles - lizards, Vipera ursini, tortoise; of amphybians - vasaka. In mountain streams – nase, trout, etc. are found.

In subalpine and alpine zone aurochs and chamois are available. According to the reference data and other information obtained on this issue, in the project impact zone no species requiring special protection are reported.

Archaeological heritage

From the view of archaeological value the most important is vil.Tagiloni, the right bank of the Enguri River where the copper pan and remains of the copper mould of the Colchis axe, parts of the weapon, Colchis axe and fragment of the plate. Another monument worth to mention is a part of burial dated by I-II BC. Unearthed were remains of chain armour and helmet, iron bridle, fragments of golden sword-hilt, golden decorations fragments of belt or halter, head of the ritual golden figure of deer, silver crockery and its fragments, etc. Silver vessel is of Roman origin and is similar to Borealis and Holdeshaim articles. Majority of the golden articles are adorned with colour stones. Similar golden articles are met in the early Sarmatian burial of north Caucasus and Kuban. The found artefacts point to its links with Sarmatian and other world west Georgia had at that time, the fact proved by ancient manuscripts. Artefacts from both excavations are kept in Zugdidi museum of history and ethnography.

In the project impact zone no historic and/or archaeological monuments are available.

Traffic and Infrastructure

The sensitive receptors which may be affected by potential increase of the traffic flow generally include the residential areas and through traffic flows if any.

Access to the sites of Vardnili cascade is either via the road on the right bank of the Gali reservoir from the Saberio settlement which is the location of the Enguri HEPP (one hour to Vardnili 1) or via the border between Abkhazia and Georgia at the Zugdidi Bridge. Access roads along the right bank of the dredged canal are in good condition. Some local access to the power houses needs to be re established. An access track is also built on the right bank of the canal but not passable in wet weather conditions or with heavy trucks. Gali railway station is in total disrepair there transport for equipment or personnel by road is the only feasible solution for the project implementation.

The main settlements along the canal are Gali, Mziuri and Etseri located downstream the Gali reservoir, south to the canal. The main road runs practically parallel to the canal along the left bank of the latter.

Since the conflict in the region, the traffic along the main road is not high.

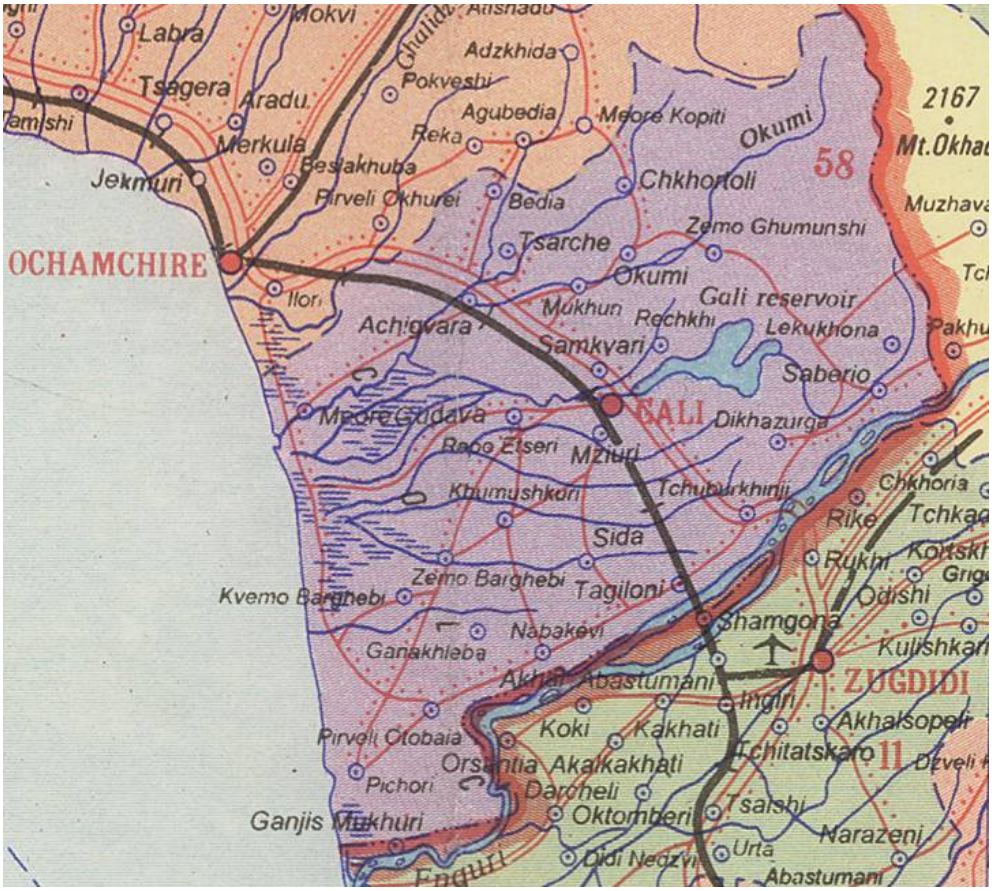


Figure 1.1.11. Map with indication of roads

<u>Socio-Economics</u>

Population of Gali region is mainly Georgian. There is no official statistics available on demographic situation in Gali District and in Abkhazia in general. It is known, however, that in 1996-1997 around 40,000 IDPs returned to Gali district. In 1998 many were displaced again as a result of briefly renewed fighting between Georgian partisans and the Abkhaz Militia in Gali. Many of the IDPs residing in Samegrelo are "permanent" migrants, crossing the Enguri River separating Abkhazia from Samegrelo, in order to cultivate land or harvest hazelnuts in the Gali area.

Impact on health and safety (if any) of community during construction/rehabilitation will be mitigated through utilisation of the best practice grievance mechanism for any health, safety or other issues raised by the community surrounding the proposed project.

1.2 Technical details of the project, planned activities and technical options

Objective of the planned development is restoration of capacity of the derivation canal. Audit of the canal was carried out 28 June 2008, when Vardnili 1 was stopped to drain the canal, while water level in the Gali reservoir was lowered to the elevation of 100.95 m.s.l. as to accumulate water from discharged the Enguri HPP. Regulation of water in the reservoir enabled to cut off the flow in the canal for 10 hours. In the course of this time the

measurements within the canal between Vardnili 1 and Vardnili 2 and visual audit of the rest of the canal were performed.

The canal is open, total length 22 km. Cross section is vee-type, dimensions are different in different locations. (Detailed sectional description of the canal and sediments is given below in the report.) The canal area is built of proluvial, alluvial and alluvial-proluvial sediments. According to the original design the slops of the canal are not concrete lined, but these are concrete lined only on limited areas - 50-100 m upstream and downstream of each power house.

On the upper berm of the canal service road is available. The road is damaged and needs rehabilitation. Damaged is majority of the berms along the canal and require rehabilitation.

Slopes of canal and berms are vegetated. The plants species within considered area do not belong to the category of protected species. Vegetation grown on slopes and berms of the canal hinder operation of the canal and reduce its flow capacity. Taking this into consideration the slopes and the berms must be de-grubbed. One of the reasons of reduction of flow capacity of the tailrace canal is accumulation of sediments. Taking into account that water from Enguri River flows through the Enguri reservoir of 1.1 billion m3 capacity and smaller Gali reservoirs, which, in this case represent tripping basins, getting of sediments from Enguri River into the canal is excluded. The sediments get into the canal from tributaries and through erosion.

According to the survey carried out in June 2008 the volume of sediments (sand and gravel) currently accumulated in the canal is estimated at 300,000 m3. In some areas – household waste is detected.

Sediment Removal – Methodology Options

Mechanical Dredging:

There are two primary methods to dredge a canal, mechanical and hydraulic. Mechanical dredging uses normal excavation equipment located on the shoreline or on barges in the canal to dig the sediment out of the canal. The wet spoils are then placed on the barge or deposited on the adjacent upland shore areas. Mechanical dredging has numerous logistical problems and is not considered cost effective.

Hydraulic Dredging:

Hydraulic dredging equipment utilizes a cutter head that breaks through the sediment and suspends the soils into the water column where they are vacuumed through a large pumping system. The sediment laden water is then pumped through a network of pipes floating in the canal to the disposal area. Filter bags at the outlet pipe are the most common way to collect the sediment and release the water back into the canal. Earthen embankment or impoundment areas are another way to dewater the dredged slurry.

The dredging equipment will be installed on a barge. The unit will be electric power driven which is justified from economical and ecological point of view.

As indicated above, Vardnili canal sedimentation problem is related not with the Enguri HPP discharged water or the Gali reservoir sedimentation, but with the erosion at the tributary entries to the canal and erosion of the canal slopes, which produces an alluvial inert material and not slack.

Treatment of Dredged Material

As a widespread and approved method, the dredged inert material (from each section) may be temporarily moved to the spoil area on the specially allocated sites along the canal for de-watering. The spoil areas are generally earthen impoundments constructed using dikes. For sedimentation, depending on location - pits and/or mobile type sheet metal construction can be used. After settling, the drained water will return to the canal.

Nevertheless, as the most efficient way of treating removed material both economically and technically, as well as the friendliest solution from the environmental perspective, it has been proposed to use the dredged alluvial material for strengthening the berms at both sides of the Vardnili canal.

The cross section of the canal illustrated below shows location and dimensions of the original berms (shoulders) which were created during excavation of the original canal that follow on both sides of the canal at its whole length.

With the purpose of dewatering the material back into the canal, small passages will be excavated along the berms. With the removed material of around 300 thousand m3, shoulders on one or the other side of the canal will be extended to max one meter in heigh and max one meter in width, or min 0.3 m in height and 1.4 m in width, depending on the condition of the existing shoulder intervals. Some sections of the canal banks (around 10% of total length) will not be used for sediment treatment due to natural hills and heights.

From the engineering viewpoint, such application of the removed alluvial material will increase slope reliability and stability against flooding and canal overflow. In total it is around 15-17 m3 material that needs to be placed at one lengthy meter of a shoulder, either at one bank or another. Upon full dewatering, a bulldozer will flatten the shoulder back.

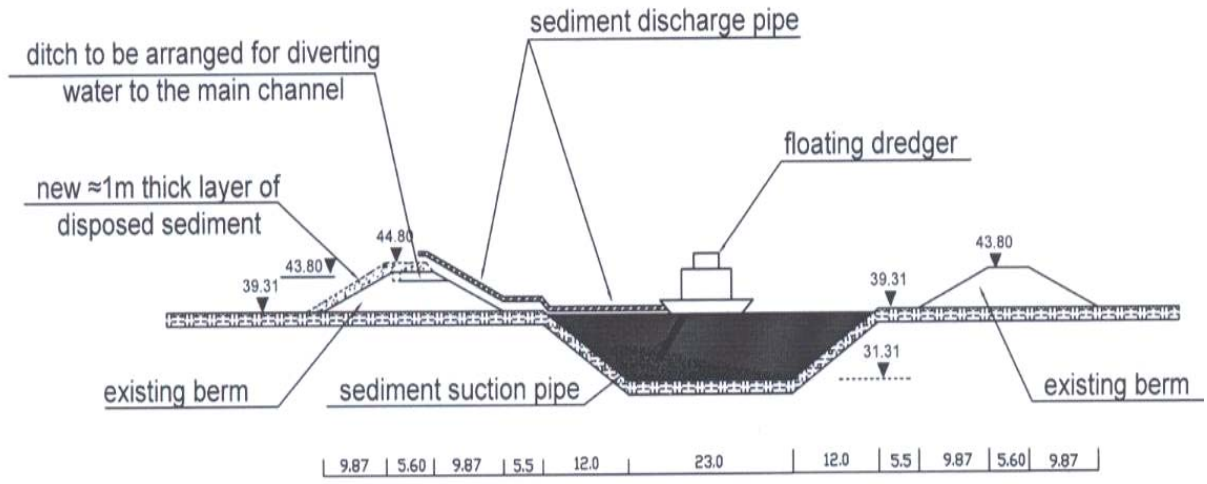


Figure 1.2.1. Vardnili Canal. Dredging (Cross section)

1.3. Project implementation schedule and costs

Prior to development of the detailed plan/schedule of works, the canal has been dewatered in order to evaluate amount of sediments subject to removal. As silting is not uniform, the volume of planned works differs by location.

On construction stage the camp will be arranged in vicinity to the village Rechkhi. The area will be paved with gravel, equipped with lighting and fenced. Facilities for the labourers, engineers and technical staff.

Oil and lubricants will be stored in the closed containers in separate corner of the area. Diesel will be stored in 50m3 capacity metal, above ground; horizontal tanks equipped with secondary containment to avoid spreading of the spilled product over the camp area in case of emergency.

Technical water supply will be from the source in vil.Rechkhi. The water will be transported by tank cars. For the onsite storage – 10m3 capacity metal tank will be provided. For drinking – bottled water will be used.

For waste water management tight septic pit (40-50m3) will be arranged. The pit will be empted using the cesspoolage truck. Discharge of waste water will be agreed with the local environmental protection authorities.

Household waste will be collected in closed bins. Waste removed from the site not less than 3 times a week to Gali municipal landfill. Hazardous waste (lubricants, oily rugs, etc) will be temporarily stored in protected container prior to disposal of neutralization. Waste will be removed by licensed contractor.

The works are scheduled for 2009. The total assignment is to take up 5 months. To avoid impact on ichtyofauna spawning season (April-May to July) will be avoided.

Total estimated sediment quantity – 300,000 m3. Sediment treatment section – 14,000 l.m.

Unlike a standard dredging/canal cleaning work budgets, which include, among other, the costs of mobilization, dewatering location preparation, soil erosion and sedimentation control, filter bags, tributary curtains, trucking and landfill, restoration, etc., the major costs of the proposed activities are related to supplying a dredger, excavator, bulldozer and their maintenance.

Table 1.3.1. Vardnili Canal Rehabilitation - Cost Estimate

Stabilization of canal slopes with concrete structures: excavation and reinforced concrete works, 4400 l.m.	380,000 €
Supply of a dredger, excavator and a bulldozer	1,150,000 €
Removal of vegetation cover from the entire canal (2X22000m): auxiliary and handling equipment and cleaning works	150,000 €
Removal of island from downstream of HPP III; excavation works (2800 m2) to canal invert	120,000 €
Treatment of removed sediments: handling and disposal of about 300,000 m3 alluvial material	1,200,000 €
Labour and maintenance of equipment (5 months of works)	70,000 €
Implementation of environment protection measures - restoration of dewatering areas.	30,000 €
Physical Contingencies	300,000 €
Total Canal Works Budget	**3,400,000 €**

ENVIRONMENTAL INFORMATION REVIEW

2. ENVIRONMENTAL INFORMATION REVIEW

2.1 Description of old impacts of the installations

The exploitation of the Enguri dam and the cascade of the facilities of Vardnili from 1978 provoked important modifications of the environment due to :

- the flooding of a part of the valley transforming the natural features of the Enguri river in a vast reservoir with large meanders (of the order of 100 m),
- the large reduction of the flow in the Enguri river to the downstream of the dam: this flow is generally the order of 10% of the average natural flow of the river,
- the flooding of a part of the valley transforming the natural features of the Eristskali river in a vast ponding reservoir (reservoir of Gali),
- the disappearance (or strong modifications) of the Eristskali river and the humid zones associated where the canal of the set of Vardnili plants is situated.
- Lack of a sediment action plan.
- Lack of properly planned disposal areas.

2.2 Environmental conditions on site and the results of old impacts

ENVIRONMENT/RECEPTOR	IMPACT
River estuary, canal and hydrological conditions Nor is any inclinometers installed that would allow to access the depth of the slip and design the required measures for stabilization – again unusual and dangerous operations.	• The river banks are overgrown, as for a long time the banks have not been de-grubbed, vegetation reduces the outflow. • In the middle of the canal downstream Vardnili 3 island has built up of the sediment material which changed the shape of the canal and cause flooding of the banks; • Bank erosion reduced “capacity” of the canal. • Displaced reinforced concrete slabs affect the water flow • There is a landslide area on the downstream of the Vardnili I powerhouse. No monitoring of this land slip is done to allow the assessment if it is active, stable or accelerating. • Accumulated sediments may cause flooding in case the water flow increases • Flooding of the area adjacent to the canal may have negative impact on arable lands (where available) and endanger stability of the infrastructure.
Geology and geo hazard, stability of structures	• No geo hazards were related to operation of the canal in the past. • The inner slopes of the canal in some places are eroded • In some locations the reinforcement slabs are damaged, and “washed off”
Soil, vegetation, landscape	• As no de-grubbing was done the bank of the canal are vegetation which affects/reduces the out-flow. • No impact on soil and vegetation related to the past operation of facility is known • Impact on soil – bank erosion. • Since construction, the canal does not have any

	impact on environment as it merges into the background. Besides no recipients/viewers are available who may be affected by any change.
Impact on atmosphere	• No impact on atmosphere related to operation of facility has been observed
Water and soil pollution	• At the time of the vandalism of Varnili powerhouse during the war (years 1992-93), the transformers have been destroyed or removed. Obviously, the oil from cooling of the transformers has been spilt into soil and has eventually found its way to the water course in the canal. An estimate of 40 tons of oil has been made. Currently, the traces of possible pollutions of soil by the oils of transformer are not visible on the site except some places near to the switch yard. • It is possible that the oil of the transformers was from the family of the PCB • Pollution of water and sediments with fuel and lubricants stored/used on the site of the power plants may be the case.
Flora and fauna issues	• No impact on flora and fauna related to the past operation of facility is known.
Protected areas	• No protected areas are available close to the project area

LEGISLATION, POLICY & REGULATORY BACKGROUND

3. LEGISLATION, POLICY & REGULATORY BACKGROUND

3.1 Legal background

The Georgian and international (EU) environmental laws providing the background for determining the main issues that should be considered during the environmental appraisal process for the project under consideration.

Environmental regulations, standards and guidelines provide practical information concerning emission limits, permitting requirements, pollution abatement and control techniques and equipment, best management and operational practices, etc., against which the investment proposal should be benchmarked.

3.2 National legislation

3.2.1 Power Policy

The Ministry of Energy has elaborated "Main Directions of State Policy in Georgian Power Sector" on the basis of the Resolution of the Parliament of Georgia 25/37 of 27 December of 2005. The document was approved by Parliament on 7 June of 2006 and determined main directions of energy policy.

The main goal of the "Main Directions of State Policy in Georgian Power Sector" is the full satisfaction of the demand of industrial and domestic-communal sector on energy resources on the basis of full utilization of energy resources existing in the country and diversification of imported energy carriers, as well as, achievement of economic independence and sustainability of the sector, provision of energy security (technical, economic and political factors).

Under the document, the great attention in the utilization of local energy resources is to be attributed to the application of main natural resources of the country. At the same time the long term goal of energy policy is to satisfy demand on electric energy by the power generated at local hydro power plants. The document defines effective development of rich hydro resources of the country as the main direction for development of the power sector of Georgia.

3.2.2 Overview of environmental legislation of Georgia

The national Georgian legislation comprises the Constitution and laws of Georgia, international agreements, subordinate legislation, normative acts, presidential orders and governmental decrees, ministerial orders, instructions and regulations. Georgia is signatory of a number of International Conventions, including those related to environmental protection issues.

The Constitution of Georgia (1995) lays down the legal framework that guarantees public access to information and forms a vital component of the overall public consultation process with regards to environmental conditions.

Article 37 of the Constitution states that “any person has the right to live in a healthy environment, use natural and cultural resources. Any person is obliged to care for natural and

cultural environment". According to Part 5 of the same article, "an individual has the right to obtain full, unbiased and timely information regarding his working and living environment". According to the Constitution, the Georgian Government must secure the rational use of natural resources and protection of the environment.

Article 41, part 1 of the Constitution states that "a citizen of Georgia is entitled to access information on such citizen as well as official documents available in State Institutions provided it does not contain confidential information of state, professional or commercial importance, in accordance with the applicable legal rules"

The list of environmental laws and regulations in Georgia, as of June 2008 is provided in Table 3.2.2.1. below:

Table 3.2.2.1 Environmental Laws and Regulations in Georgia

Year	Law / Regulation
1994	on Soil Protection (amend.1997, 2002)
1994	on Protection of Plants from Harmful Organisms
1996	on System of Protected Areas (amend.2003, 2004, 2005, 2006, 2007)
1996	on Natural Resources
1996	on Protection of Environment (amend 2000, 2003, 2007)
1997	on Wildlife (amend.2001, 2003, 2004)
1997	on Tourism and Recreation
1997	on Water (amend.2003, 2004, 2005, 2006)
1998	on Sanitary Protection Zones and Resort Areas
1998	on Hazardous Chemicals (amend. 2006,2007)
1998	on Pesticides and Agrochemicals
1999	on State Complex Expertise and Approval of Construction Projects
1999	on Protection of Ambient Air (amend. 2000, 2007)
1999	Forestry Code
1999	on Protection of Cultural Heritage
1999	on Compensation of Damage from Hazardous Substances (amend 2002, 2003)
1999	on Licensing Design-Construction Activities
2000	on Regulating and Engineering Protection of Coastline and River Banks
2003	on Red List and Red Book of Georgia (amend.2006)
2005	on Licences and Permits
2007	on Status of Protected Areas
2007	on Ecological Examination
2007	on Service of Environmental Protection
2007	on Environmental Impact Permit

3.2.3 Georgian Laws

A brief summary of the Georgian national laws of relevance to this EDD are described below:

Law of Georgia on Protection of Environment (enacted 1996, amended 2000, 2003, 2007)
This law regulates the legal relationship between the bodies of the state authority and the physical persons or legal entities (without distinction-legal form) in the scope of environmental protection and in the use of nature on all Georgia's territory including its territorial waters, airspace, continental shelf and special economic zone. The law deals with education and scientific research in the scope of environment, environmental management aspects, economic mechanisms, licensing, standards, EIA and related issues. The law considers different aspects on protection of ecosystems, protected areas, issues of global and

regional management, protection of ozone layer, biodiversity, protection of the Black Sea and international cooperation aspects.

Law of Georgia on Environmental Impact Permit (adopted October 15, 1996, replaced by the law adopted in 2007). The law gives a complete list of activities subject to obligatory ecological examination. According to the sub-clause (e), Clause 1, Article 4, Chapter II (Permit issuance Procedures), processing of solid waste and / or arrangement of landfills is subject to ecological examination of issuance of impact permit. The law on Environmental Impact Permit sets the legal basis for issuance of environmental permit, implementation of ecological examination, as well as public awareness and public participation in these processes. In this law, an Environmental Impact Permit is defined as perpetual authorisation for implementation of the planned development. A permit is issued by the Ministry of Environment Protection and Natural Resources after consideration / examination of the documents and application presented by developer.

Law on Public Health (enacted 27 June, 2007; supersedes the Sanitary Code of 8 May, 2007; and order of the Minister of Labour, Health and Social Affairs on approval of zones of sanitary protection of industrial objects and constructions and sanitary classification). The objective of the law is to favour healthy life style, to ensure an environment safe for human health, to prevent/avoid the spreading of contagious and non-contagious diseases. The law defines the rights and responsibilities of community and juridical persons in the sphere of public health. For guaranteeing safe environment the Ministry sets the qualitative standards for air, water, soil, noise, vibration, electromagnetic fields, which include permissible concentrations and norms of potential hazardous impacts. The norms are obligatory and every person is obliged to refrain from any activity capable of resulting in the spreading of contagious/non-contagious diseases or causing risk to human health, to maintain sanitary and epidemiological norms; to inform public health authorities of any emergency situation of standard violation, etc. Keeping to the norms is controlled by relevant government bodies. Responsibility for internal control and external audit of water, air and/or soil rests with certified independent laboratory.

Law of Georgia on Licenses and Permits (adopted June 24, 2005) in conjunction with Resolution of the Government of Georgia #154 dated September 1, 2005 "On Approval of Regulations Regarding Rules and Conditions for the Issuance of Environmental Impact Permits". This law stipulates an exhaustive list of licenses and permits, including a so-called "Environmental Impact Permit", while the Resolution of the Government of Georgia #154 describes procedures for its issuance as well procedures for approval of respective EIAs. This law regulates entrepreneurial activities, any organised and some non-organised activities directly related to the fields of human health, state and public interest and is related to the use of the state-owned natural resources. The law regulates the issuance of licenses or permits, gives an exhaustive list of licences and permits, sets the rules for issuing, amending and cessation thereof. According to the law of Georgia on Licences and Permits, the activity is regulated by licences or permits only when these activities are directly related to the risk to human health, or state and public interest. The state regulation is involved in the license or permit only when the activity has a higher risk to human health considering the state or the public interest.

Objective and the main principles of regulation by licence or permit are as follows:

- Security and protection of human health;
- Security and protection of life conditions and cultural environment of humans; and

- Protection of state and public interests.

The law defines new principles for issuance of the license:

- "One-window" principle (one shop stop) – which is a new concept in this law and means that the administrative body issuing the license shall ensure the approval of additional licensing conditions by the other administrative body on its own;
- "Silence gives consent" – the administrative body issuing the license is obliged to make a decision in due term after the submission of the application. The license shall be deemed issued if a decision is not made in the determined time period; and
- An "umbrella principle" – the holder of the general license is not obliged to apply for a specialised license too.

In compliance with the law, the licence or permit issued by a foreign country under the international agreement or law shall be recognised by Georgia and shall have a status similar to that granted to the documents issued in Georgia.

Law of Georgia on Ecological Assessment (adopted on October 18, 1996, replaced by the law adopted in 2007). In this law, ecological assessment is obligatory step in impact permit or construction permit issuance process. The objective of an ecological assessment is to preserve an ecological balance with consideration of environmental requirements, sound use of natural resources and sustainable development principles. A positive conclusion of the ecological assessment is mandatory to obtain an environmental and/or a construction permit. Ecological assessments are regulated by the Ministry of Environment Protection and Natural Resources.

Law of Georgia on Natural Resources (adopted on May 17, 1996) defines the status of natural resources, describes their use, sets out the types of licences and rights and obligations of the users. The law allocated responsibilities for protection of the lands from contamination and ensures conformity of agricultural lands with relevant legal requirements. The law describes licensing procedures and determines the amount of tax and economical principles of the use of natural resources. According to Article 2 of this law, upstream oil and gas operations are excluded.

Law of Georgia on Water (adopted on October 16, 1997 with amendments of 2003, 2004, 2005, 2006). The Law regulates the legal aspects of:

- Relationships of governmental bodies, physical and legal persons in the filed of water protection;
- Water protection, restoration and use on the land, in the continental shelf, territorial waters and in the special economic zone;
- Commercial production and international trade in water;
- Competence of the autonomous republics, as well as the local self-government and administration bodies in the sphere of relations associated with water;
- Relationships in underground water protection, study and use with consideration of the law of Georgia on Natural Resources;
- Relationships in protection, study, reproduction and use of fauna with consideration of requirements of the law of Georgia on Wild Life; and
- Regulates legal aspects related to flora, fauna, and natural resources in the course of water use.

The law regulates water use, defines rights and obligations of the users, the types and rules of licensing, conditions of the licence, licence invalidation and refusal aspects, cessation and termination of the licence, regulated quotas of water use.

According to this law, water is the state property and can be provided for use only. Prohibited is any activity, which, directly or indirectly, violates the state ownership rights.

Law on Soil Protection (1994, amend.1997, 2002)
The objective of this law is to ensure preservation of integrity and improve fertility of soil; define obligation and responsibility of the land users and the state in provision of conditions for protection of soil and production of ecologically safe products. The law sets the maximum allowable limits of hazardous matter in soil.

The law prevents the use of fertile soil for non-agricultural development; prohibits implementation of any activity without removal and preservation of productive top layer, bans open quarry processing without subsequent re-cultivation of the site; forbids terracing without preliminary survey of the area and relevant approved design; outlaws overgrazing; prohibits wood cutting and damaging of soil protection facilities, prohibits any activity deteriorating the quality of soil (such as use of unauthorised chemicals/fertilizers, any pollution and littering of the soil).

Law on Protection of Atmospheric Air (valid from June 22, 1999, amend. 2000, 2007) . This law regulates the protection of atmospheric air from hazardous man-caused impact (Table 2.2.2: Part I, Chapter I, Article 1.1). As defined under the law pollution of the atmospheric air with harmful matter means emission of any kind capable to cause negative impact on human healthy and environment (Part II, Chapter IV, Article I2.I) whereas the harmful man-caused impact is any impact on atmospheric air resulting or potentially originating from any activity capable to have negative impact on human health or environment (Part II, Chapter IV, Article II.I).

Table 3.2.3.1. Types of negative man-caused impact (Part II, Chapter IV, Article II.2)

Pollution of environment with hazardous matter
Radiation pollution of atmospheric air
Pollution with micro organisms and biologically active matter of microbial origin
Noise, vibration, electromagnetic fields and other physical impact

Law of Georgia on the System of Protected Areas (adopted on March 7, 1996, amend.2003, 2004, 2005, 2006). This law sets categories of the protected area (e.g. National Park, State Reserve, etc) and defines the limits of activities allowed in their boundaries. Permitted activity is determined with consideration of the purpose of the area, requirements set out in legislation, statements and regulations, protected areas management plans, international agreements and conventions to which Georgia is a part of. The law provides restrictions for the exploration/use of natural resources in national parks and other protected areas.

In general within the protected territory, it is prohibited to:
- Negatively impact or modify natural ecosystems;
- Destroy (exterminate), extract (seize), ruin, damage (injure) or scare any natural resource for the purpose of exploitation or for any other reason;

- Damage natural ecosystems or species as a result of pollution;
- Introduce and multiply alien and exotic species of living organisms;
- Import into the territory explosive or poisonous materials; and
- Carry out any other activity prevented by the regulations or the management plan of the protected territory.

Forest Code on Georgia (adopted in 1999, new version is under consideration). This code attempts to provide a broad framework covering the multiple functions and uses of forests, including protection, watershed management, and timber production. It allows private ownership of forests and commercial harvesting of private forests. Under the document, Georgia's State Department of Forestry (SDF) does not directly undertake commercial harvesting as it seeks to separate control and management functions, delegating the latter to private enterprises. However, the SDF is still responsible for carrying out "sanitary" cutting and similar forest management activities. The responsibility for the issuance of logging licenses is transferred from the Ministry of Environment to the SDF under the Code. The Forest Code defines additional categories of protected forests, including those with special soil and watershed regulation functions, floodplain and sub alpine strip forests, and those containing Red List plant species. As for many environmental laws in Georgia, the Forest Code is a framework law that requires detailed implementing regulations.

3.3 International agreements and conventions signed by Georgia

Georgia is signatory of the following international agreements and conventions, which are of relevance to this project include:

- UN Framework Convention on Climate Change (signatory by the Resolution Number 302 of the Cabinet of Ministers of Georgia) ratified on 1994 and entered into force in October, 1994;
- Kyoto Protocol to UNFCCC (acceded by the Parliamentary Resolution Number 1995), ratified, 1999;
- Montreal Protocol on Substances that Deplete the Ozone Layer (with London, Copenhagen, Montreal amendments) (acceded by Resolution Number 711 of the Cabinet of Ministers of Georgia, acceded to London, Copenhagen and Montreal amendments by Parliamentary Resolution umber 376, 377, 37), 1996, became a party of amendments in 2000;
- Vienna Convention on the Protection of Ozone Layer (acceded by the Resolution Number 711 of the Cabinet of Ministers of Georgia), 1996;
- Geneva Convention on Long-term Transboundary Air Pollution (acceded by the Presidential Decree Number 8), 1996;
- Ramsar Convention on Wetlands of International Importance Especially as Wildlife Habitat (acceded by the Parliamentary Resolution Number 201 as amended by the Parliamentary Resolution Number 1039), 1996;
- UN (Rio) Convention on Biological Diversity (ratified by Parliamentary Resolution), ratified 1994;
- Convention on International Trade of Endangers Species of Wild Flora and Fauna (acceded By Presidential Decree Number 524), 1996;
- Convention on Migratory Species of Wild Animals, 2000;

- Paris Convention on Protection of the World Cultural and Natural Heritage (acceded by Parliamentary Resolution), succession 1992;
- European Convention on the Protection of Archaeological Heritage, 2000;
- International Convention on Civil Liability for Oil Pollution Damage (and Amendments) (acceded by the Resolution Number 85), 2000;
- International Convention on Oil Spill Preparedness, Response and Cooperation (acceded by Resolution Number 711 of the Cabinet of Ministers of Georgia), 1996;
- International Convention on Establishment of an International Fund for Compensation for Oil Pollution Damage, Protocol and Amendments (acceded by Parliamentary Resolution Number 207), 1993;
- International Convention to Combat Deforestation (acceded by Resolution Number 711 of Cabinet of Ministers of Georgia) signed in 1994, ratified in 1999;
- Party to the UNCDD after the Parliament of Georgia ratified the Convention. Basel Convention on Transboundary Movement of Hazardous Wastes and their Disposal (acceded by Presidential Decree Number 232), 1999;
- Aarhus Convention on Access to Information, Public Participation and Decision 0making and Access to Justice in Environmental Matters - signed June 1998 and ratified it in April 2000; and
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, ratified in 1998.

3.4 EU Environmental Legislation

Pollution Prevention

- Directive 96 61 EC on Integrated Pollution Prevention and Control (IPPC);
- Council Directive 200 1/80/EC on the limitation of certain pollutants into the air for large combustion plants;
- 96 62 EC Framework Directive on Ambient Air Quality Assessment and Management (and daughter Directives 99/30/EC [relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air] and 00/69/EC [relating to benzene and carbon monoxide]);
- EC Regulation 203 7/2000 on substances that deplete the ozone layer;
- Directive 1999/96/EC of the European Parliament and of the Council of 13 Dec 1999 on the approximation of the laws of the Member States relating to measures to be taken against emissions of gaseous and particulate pollutants from compression ignition engines for use in [heavy] vehicles, and the emission of gaseous pollutants from positive ignition engines fuelled with natural gas or liquid petroleum gas for use in vehicles and amending Directives 88/ 77/EEC;
- Directives 98/69/EC and 93/59 relating to passenger cars and light commercial vehicles and amending Council Directives 94/12 and 70/220/EEC, and Directive 96/96 and Amendments relating to roadworthiness tests for motor vehicles and their trailers;
- Directive 2000/14 EC of the European Parliament and of the Council of 8 May 2000 on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors;
- Directive 86/188/EEC on the protection of workers from the risks related to exposure to noise at work;
- Council Directive 75/440/EEC of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States;

- Council Directive 98 83/EC of 3 November 1998 on the quality of water intended for human consumption, to replace Council Directive 80/778/EEC of the same name on 25.12.2003;
- Directive 2000/60 EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, as amended by an updated list of dangerous substances in Decision No 2455/2001/EC; and
- Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances.

Ecological Management

- Council Directive 78/659/EEC of 18 July 1978 on the quality of fresh waters needing protection or improvement in order to support fish life;
- Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds; and
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, together with Commission Decision 97/266 Concerning a site information for proposed Natural 2000 sites, and Council Directive 97/62 amending Annexes 1 and 11 of 92/43.

General

- Directive 97/11/EC f 3 March 1997 amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment

3.5 Environmental Standards and Statutory Acts

Environmental standards set out requirements of the quantitative status of environment and define maximum permitted concentrations in water, air and soil of the substances hazardous to human health and environment.

Georgian soil values are given in Table 3.5.1 below.

Table 3.5.1 Soil Screening Values – Georgia

Determinant	Units	Georgian
Metals and Miscellaneous		
Boron	mg/kg	-
Arsenic	mg/kg	2-10*
Cadmium	mg/kg	2*
Copper	mg/kg	3-132*
Mercury	mg/kg	2.1
Nickel	mg/kg	4-80*
Lead	mg/kg	32-130*
Selenium	mg/kg	-
Zinc	mg/kg	23-220*
Total Petroleum Hydrocarbons	mg/kg	0.1
Phenols (total)	mg/kg	-
Cyanide	mg/kg	-
Sulphate	mg/kg	-
Chloride	mg/kg	-
Ammoniacal nitrogen	mg/kg	-
Volatile Organic Compounds		
Benzene	mg/kg	0.3

Toluene	mg/kg	0.3
Ethylbenzene	mg/kg	-
Total xylenes	mg/kg	0.3
Semi Volatile Compounds		
Benzo(a)pyrene	mg/kg	0.02-0.2
Isopropylbenzene	mg/kg	0.5
Pesticides		
Atrazine	mg/kg	0.01-0.5
Lindane	mg/kg	0.1
DDT (and its metabolite)	mg/kg	0.1

Reference: *Method for assessment of the level of chemical pollution of soil" (MI 2.1.7.004-02), approved by the Ministry of Labour, Health and Social Affairs, 2003*

* *Sodium and neutral (clay and clayey) pH >5.5*

\- *No screening value available*

For groundwater quality drinking water quality standards are commonly used instead as an assessment criteria for groundwater, as given in Table 3.5.2 below.

Table 3.5.2. Georgia Drinking Water Standards

Determinand	**Units**	**Georgian**
Metals and Miscellaneous		
Boron	mg/l	0.5
Arsenic	mg/l	0.01
Cadmium	mg/l	0.003
Chromium	mg/l	-
Copper	mg/l	2
Mercury	mg/l	0.006
Nickel	mg/l	0.07
Lead	mg/l	0.01
Selenium	mg/l	0.01
Zinc	mg/l	3
Total Petroleum Hydrocarbons	mg/l	0.1
Phenols (total)	mg/l	-
Cyanide	mg/l	0.07
Sulphate	mg/l	250
Chloride	mg/l	250
Ammoniacal nitrogen	mg/l	-
pH	pH value	6-9
BOD	mg/l	-
COD	mg/l	-
TOC	mg/l	-
Sodium	mg/l	200
EC	S/cm	-

Reference: *Order of the Minister of Labour, health and Social Affairs, #349/n on Approval of the Technical Regulations for Drinking Water, (17.12.2007)*

Georgian air quality standards are given in Table 3.5.3 below.

Table 3.5.3: Air Quality Limits – Georgia

Substance	Maximum Permitted Concentration (MPC), mg/m3	
	Max single	Average daily
Asbestos containing dust	0	0.06
Inorganic dust:		
Silicon dioxide >70%	0.15	0.05
Silicon dioxide 70%-20%	0.3	0.1
Silicon dioxide <20%	0.5	0.15
Carbon Monoxide	3	5
Nitrogen Oxides	0.4	0.06
Nitrogen Dioxide	0.085	0.04
Sulphur Dioxide	0.5	0.05

Note: *the "maximum single" limit refers to the instantaneous concentration that must not be exceeded.*

Quotas for emission/discharge (into water, air, soil environment) of hazardous substances define the values of maximum permitted emission/discharge for each source of pollution. The list of the substances is given in the provisions on approval of relative hazard coefficients for hazardous matter emitted from stationary source of pollution, approved by the order (Number 139, 25.11.1997) of the MoE.

The quotas for maximum permitted concentration (MPC) of hazardous substances discharged into the water bodies are defined under the law of Georgia on Water. MPCs are set on a Site specific basis. Water quality standards in Georgia are in accordance with the ISO recommendations.

EU and International Environmental Quality Standards

Surface Water

EU Drinking Water Standards, and EU EQS for selected parameters are given in Table 3.5.4. below.

Table 3.5.4 EU Water Quality Standards

Determinant	Units	EU DWS	EQS
Metals and Miscellaneous			
Boron	mg/l	1	2
Arsenic	mg/l	0.01	0.05
Cadmium	mg/l	0.005	0.005
Chromium	mg/l	0.05	0.25
Copper	mg/l	2	0.112
Mercury	mg/l	0.001	0.001
Nickel	mg/l	0.02	0.2
Lead	mg/l	0.01	0.25
Selenium	mg/l	0.01	-
Zinc	mg/l	-	2
Total Petroleum Hydrocarbons	mg/l	-	-
Phenols (total)	mg/l	-	-
Cyanide	mg/l	0.05	-
Sulphate	mg/l	250	-
Chloride	mg/l	250	-
Ammoniacal nitrogen	mg/l	0.5	-
pH	pH value	6.5-9.5	6-9

BOD	mg/l	-	-
COD	mg/l	-	-
TOC	mg/l	-	-
Sodium	mg/l	200	-
EC	S/cm	0.0025	-
Volatile Organic Compounds			
Benzene	mg/l	0.001	0.03
Toluene	mg/l	-	0.05
Ethylbenzene	mg/l	-	-
Total xylenes	mg/l	-	0.03
Semi Volatile Compounds			
Benzo(a)pyrene	mg/l	0.00001	-
Isopropylbenzene	mg/l	-	-
Pesticides			
Atrazine	mg/l	-	0.002*
Lindane	mg/l	-	-
DDT (and its metabolite)	mg/l	-	-
Triazines			

Soil

There are no published EU soil quality guidelines.

Air

EU National Air Quality Objectives are given in Table 3.5.5 below. These are limit values that are legally binding and that must not be exceeded. Limit values are set for individual pollutants and are made up of a concentration value, an averaging time over which it is to be measured, the number of exceedences allowed per year, if any, and a date by which each value must be achieved.

Table 3.5.5 EU Air Quality Objectives

Pollutant	Applies	Objective	Measured as	To achieved by
National Air Quality Objectives for the protection of Human Health				
Benzene	EU	5 µg/m^3	Running annual mean	01.01.2010
Carbon Monoxide	EU	10 mg/m^3	Max. Daily Running 8 hour mean	01.01.2005
Lead	EU	0.5 µg/m^3	Annual mean	01.01.2005
Nitrogen Dioxide	EU	200 µg/m^3 not to be exceeded more than 18 times per year	1 hour mean	01.01.2010
	EU	40 µg/m^3	Annual mean	01.01.2010
Ozone	EU	120 µg/m^3 not to be exceeded more than 25 times a year over a 3 year average	8 Hour Mean	31.12.2010
Particles (PM_{10})**	EU	50 µg/m^3 Not to be exceeded more than 35 times per year	24 hour mean	01.01.2005
	EU	40 µg/m^3	Annual mean	01.01.2005
Sulphur Dioxide	EU	350 µg/m^3 Not to be exceeded more than 24 times per year	1 Hour Mean	01.01.2005

	EU	125 µg/m^3 not to be exceeded more than 3 times a year	24 Hour Mean	01.01.2005
National Air Quality Objectives for the protection of Vegetation and Ecosystems				
Nitrogen Oxides	EU	30 µg/m^3	Annual Mean	01.01.2010
Sulphur Dioxide	EU	20 µg/m^3	Winter Average	19.07.2001*
	EU	Target value of 18,000 µg/m^3 based on AOT40 to be calculated from 1 hour values from May to July, and to be achieved, so far as possible by 2010	Average over 5 years	19.07.2001*
Ozone: Protection of Vegetation and Ecosystems	EU	Target value of 18,000 µg/m^3 based on AOT40 to be calculated from 1 hour values from May to July, and to be achieved, so far as possible by 2010	Average over 5 years	01.01.2010
µg/m^3 - micrograms per cubic metre *mg/m^3 - milligrams per cubic metre* ** in accordance with the 1st Daughter Directive* *** PM2.5 exposure reduction target value of 25 µg/m^3 by 2010 is still under negotiation within the EU.*				

Noise

Guideline values IFC EHS (IFC EHS Guidelines: Noise Management, April 2007) on noise impact are reproduced in Table 3.5.6 below. The IFC require that project noise impacts do not exceed these levels, or result in an increase of more than 3 dB in background levels at the nearest receptor location off-site.

Table 3.5.6 IFC EHS Guidance Noise Values

Noise Level Guidelines		
	One Hour L_{eq} (dBA)	
Receptor	Daytime 07:00 – 22:00	Night time 22:00 – 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

The World Health Organisation, 1999, Guidelines for Community Noise are set with the intention of preventing serious annoyance during the daytime period and sleep disturbance during the night time period. These guidelines are given in Table 3.5.7 below.

Table 3.5.7 WHO Guidelines for Community Noise

Specific environment	**Critical health effect(s)**	**LAeq [dB]**	**Time base [hours]**	**LAmax, fast [dB]**
Outdoor living area	Serious annoyance, daytime and evening Moderate annoyance, daytime and evening	55 50	16 16	- -
Dwelling, indoors Inside bedrooms	Speech intelligibility and moderate annoyance, daytime and evening Sleep disturbance, night-time	35 30	16 8	- 45
Industrial, commercial, shopping and traffic areas, indoors and outdoors	Hearing impairment	70	24	110
Outdoors in parkland and conservation areas	Disruption of tranquillity	#1		

#1 existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low;

Vibration

There are no international standards or guidance relating to the control of ground borne vibration.

ENVIRONMENTAL APPRISAL

4. ENVIRONMENTAL APPRISAL

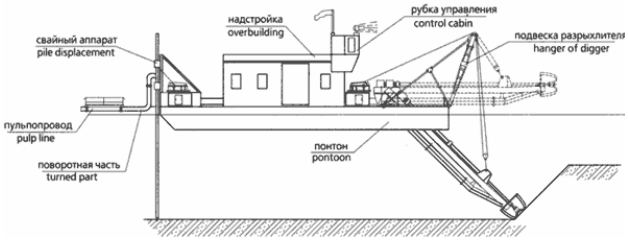
The impact related to the planned development and their analysis is given below. The following aspects are considered:

- impact on atmospheric air (exhaust, dust and noise emissions);
- impact on soil (stability/integrity and quality)
- impact on surface and ground water (flow and quality);
- impact on local flora and fauna (direct and indirect impact);

The sources of these impacts – spilled oil and/or lubricants/oil, solid and liquid waste generated in the course of rehabilitation activities, traffic.

4.1 Air

Provisional duration of works is estimated as 5 months. For the needs of the project dredger (electric driven), bulldozer, excavator and two dump trucks will be used.



4.1.1 Calculation of exhaust emissions generated by vehicles and machinery

Calculation of exhaust emissions from car engines (bulldozers, dump-trucks, etc.) is done according to [1]. The mentioned method does not allow for different operation regimes. In this case suggested is approach [2], when maximum single emission is calculated in 30 min interval, the period within which all operation regimes are available.

This interval includes the following periods:

- unloaded vehicle traffic, t_{traff};
- loaded vehicles, $t_{load.}$;

- idling (engine is on, no traffic), $t_{idl..}$

Duration of the periods depends on the type of works and the type of machinery. The average values are as below [2]:

Work interval	$t_{traf.}$	t_{load}	t_{idl}
time, min	15	11	4

Maximum value of a single emission from an engine, for each emitted substance is calculated as:

$$G_i = \sum[(M_{trafi} \times t_{trafi}) + 1{,}3(M_{loadi} \times t_{loadi}) + (M_{idl}i \times t_{idli})] / (30 \times 60) \text{ g/sec.}$$

where

M_{trafi} – and $M_{idl}i$ - stand for specific emission from moving vehicle and the vehicle in the idling regime [1] **;**

1,3 M_{loadi}- specific emission of the loaded vehicle, is calculated taking into account that the heavier is the load, the higher is fuel consumption.

As capacity of the vehicles to be used on the site is below 100 kW, below are given values of specific emission for 61-100 kW units (values given according to the [1]).

Category of the vehicle	**Nominal capacity of the diesel engine kW**	**Specific emission of pollutants from moving vehicles (g/min)**				
		Carbon dioxide	**Hydrocarbons**	**Nitrogen oxides**	**Soot**	**Sulphur dioxide**
4	61↔100	1.29	0.43	2.47	0.27	0.19
Specific emission of pollutants in idling regime (g/min)						
4	61↔100	2.40	0.30	0.48	0.06	0.097

With consideration of the mentioned above the sources of atmospheric air pollution are identified, quantitative evaluation of expected emission is based on the current normative and reference data.

Exhaust (emitted gas) from bulldozers, excavators, dump-cars, etc. is calculated according to [1]; emission of inorganic dust – in compliance with [4], welding – according to [3].

Results of calculation by source of emission are given below.

Table 4.1.1. Calculation of emission - excavator

Substance code	Name	Max. emission (g/sec)	Total emission (g/year)
337	Carbon oxide (CO)	0.0260	0.12
330	Sulphur dioxide (SO_2)	0.0033	0.014
328	Soot (C)	0.0045	0.019
301	Nitrogen dioxide (NO_2)	0.0328	0.141
304	Nitrogen oxide (NO)	0.0053	0.023
2732	Hydrocarbons (CH)	0.0076	0.033
2902	Inorganic dust	0.082	0.355

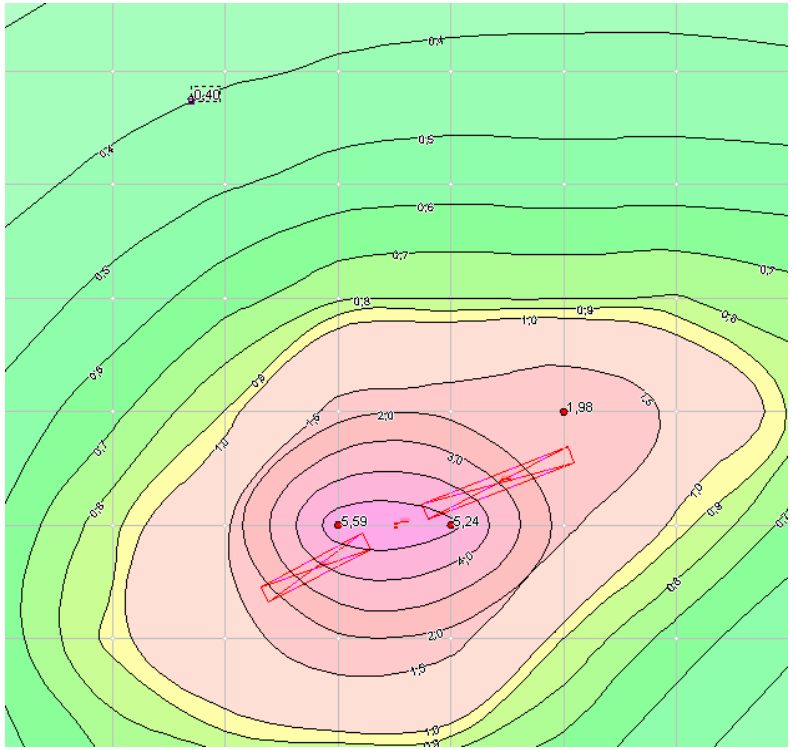
Table 4.1.2. Calculation of emission - bulldozer

Substance code	Name	Max. emission (g/sec)	Total emission (g/year)
337	Carbon oxide (CO)	0,0260	0.112
330	Sulphur dioxide (SO_2)	0,0033	0.014
328	Soot (C)	0,0045	0.019
301	Nitrogen dioxide (NO_2)	0,0328	0.141
304	Nitrogen oxide (NO)	0,0053	0.023
2732	Hydrocarbons (CH)	0,0076	0.033
2902	Inorganic dust	0.051	0.065

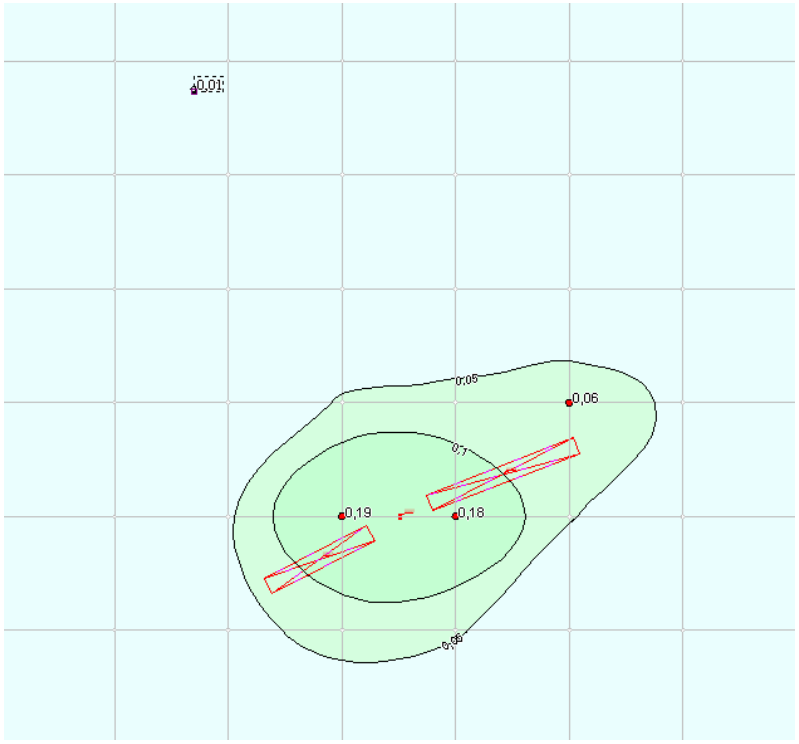
Table 4.1.3. Calculation of emission – vehicle

Substance code	Name	Max. emission (g/sec)	Total emission (g/year)
337	Carbon oxide (CO)	0.006375	0.027
330	Sulphur dioxide (SO_2)	0.0009375	0.004
328	Soot (C)	0.000225	0.001
301	Nitrogen dioxide (NO_2)	0.00342222	0.014
304	Nitrogen oxide (NO)	0.00055611	0.002
2732	Hydrocarbons (CH)	0.0045	0.019
2902	Inorganic dust	0.0001575	0.00068

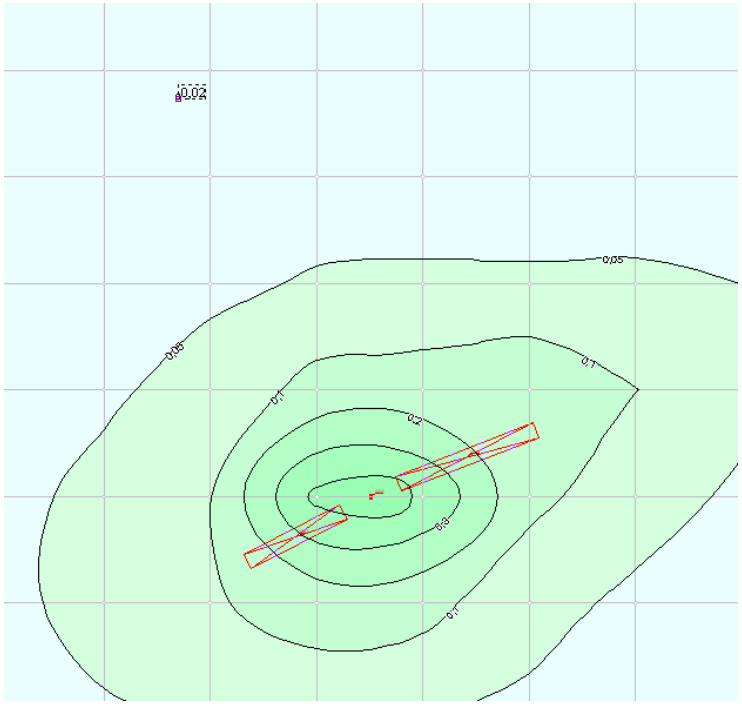
Graphical representation of results of calculation – emission of hazardous substances



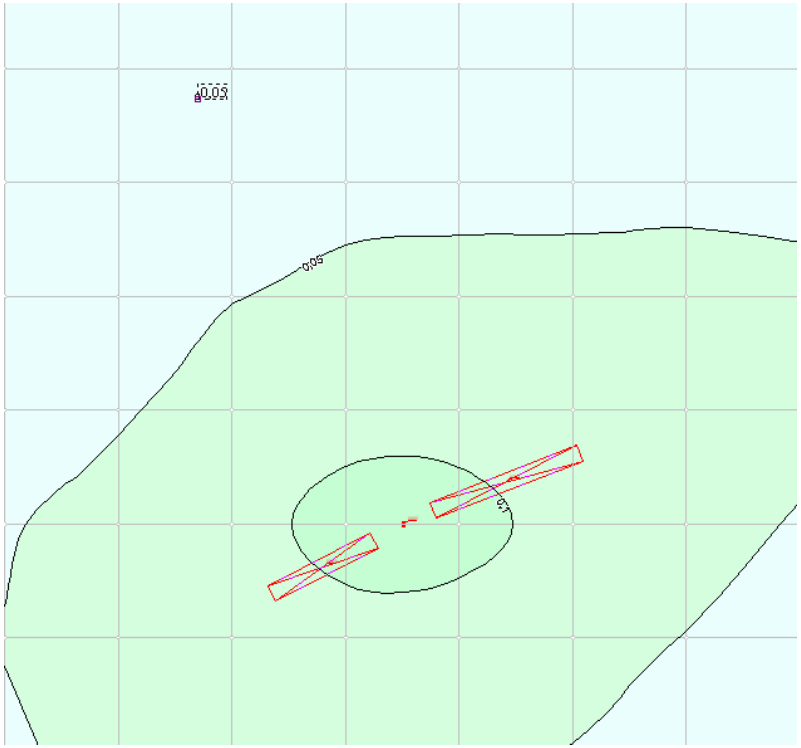
Nitrogen dioxide- spatial distribution (Code 301)



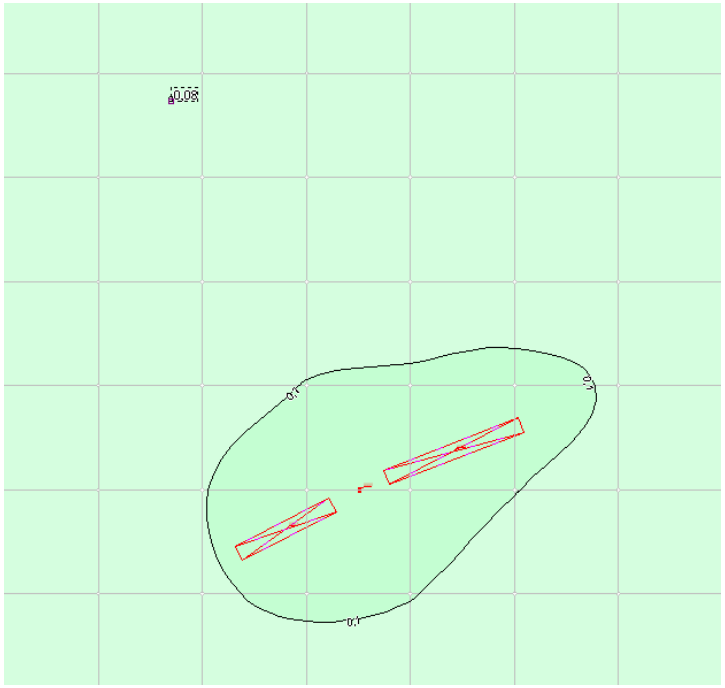
Nitrogen oxide- spatial distribution (Code 304)



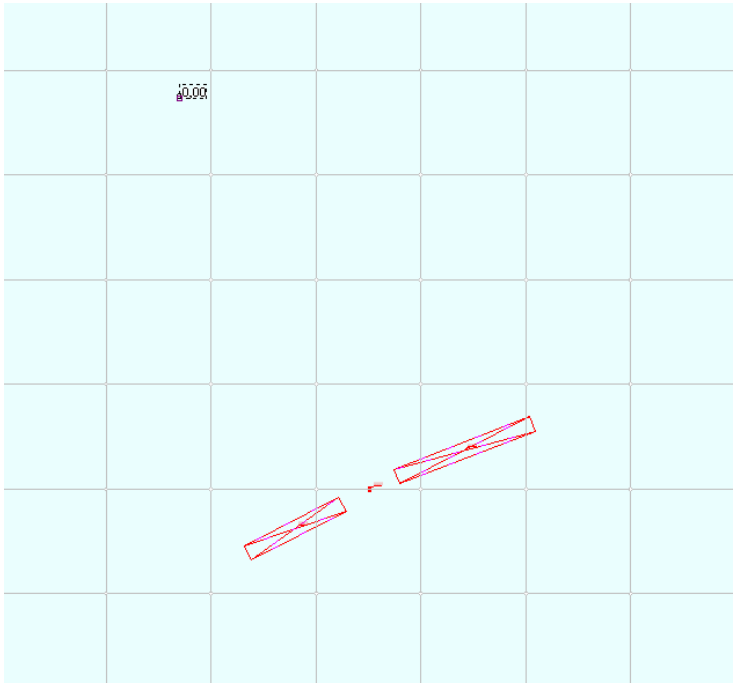
Soot – spatial distribution (Code 328)



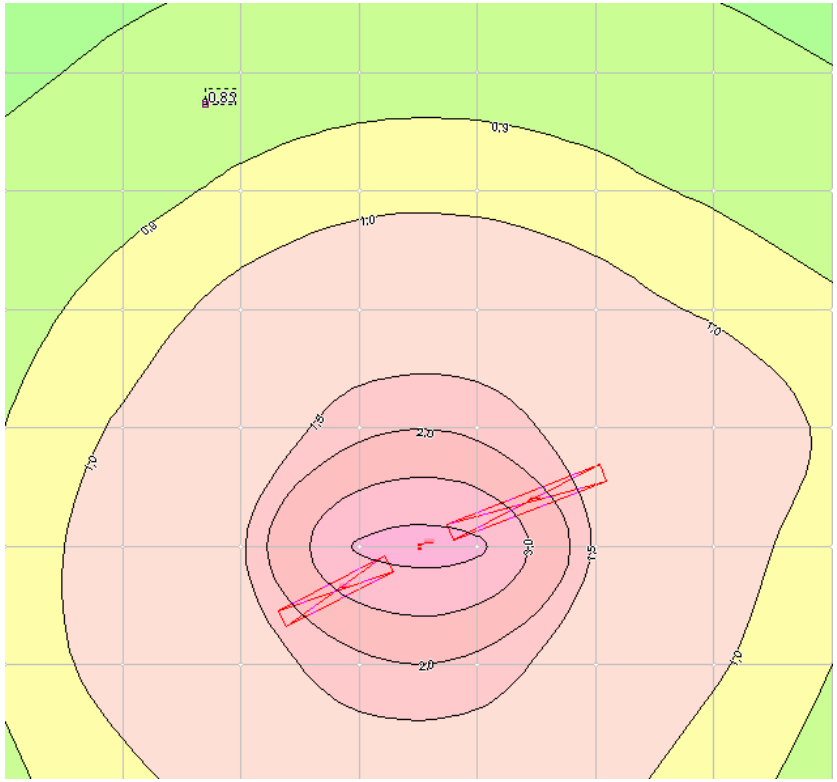
Sulphur dioxide – spatial distribution (Code 330)



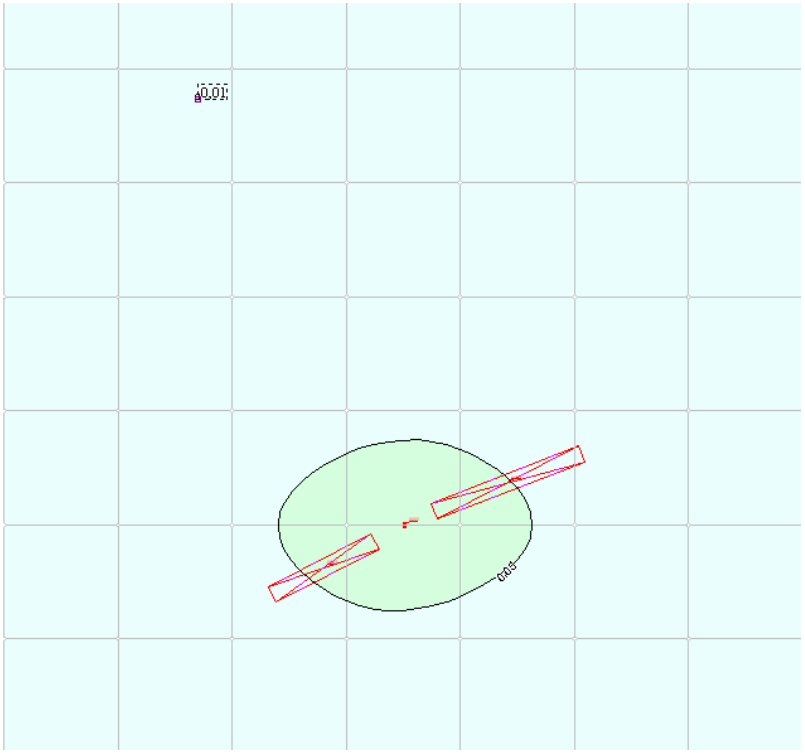
Carbon oxide – spatial distribution (Code 337)



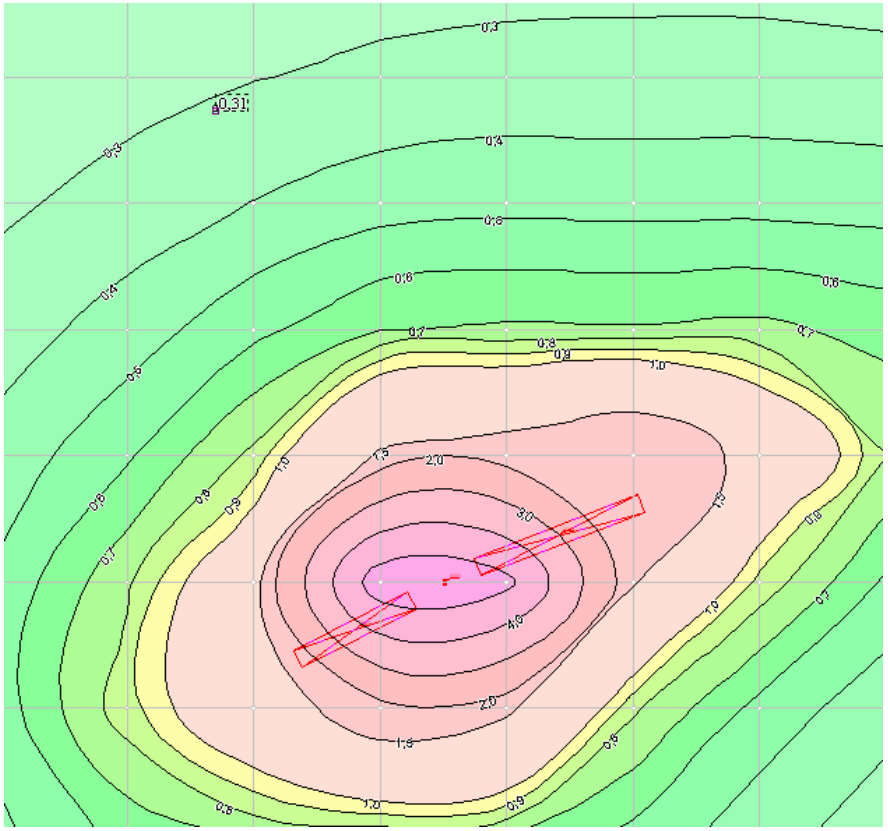
Spatial distribution (Code 1325)



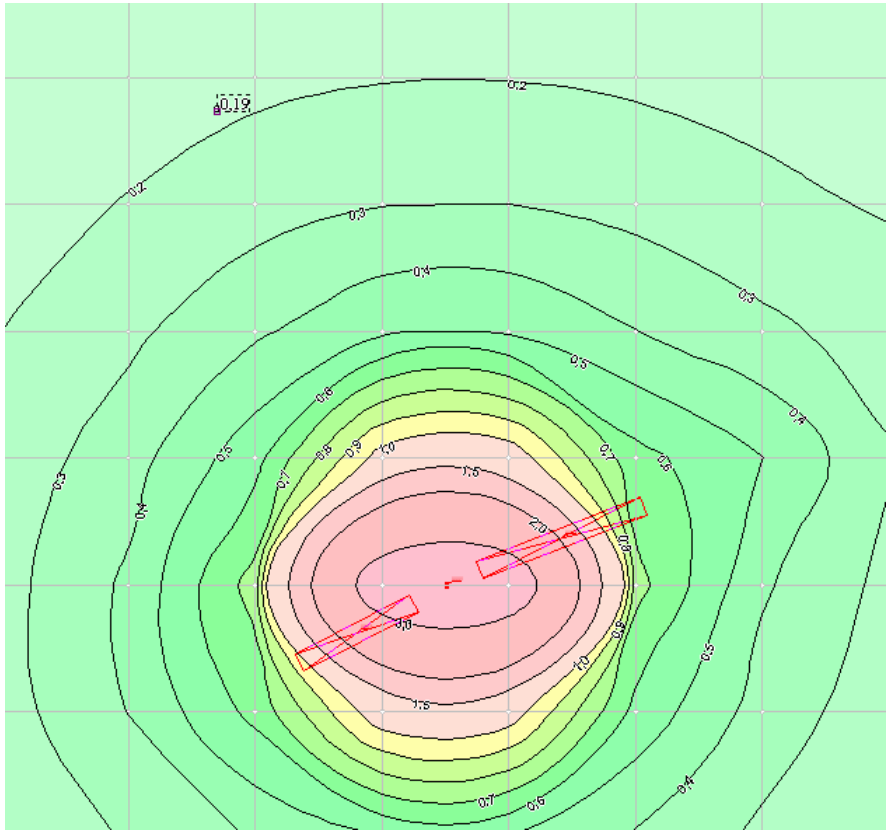
Dust – spatial distribution (Code 2909)



Saturated hydrocarbons – spatial distribution (Code 2732)



Summary impact group 6009 – spatial distribution (Codes 301+330)



Summary impact group 6046 – spatial distribution (Codes 2908+337)

Table 4.1.4. Results of calculation of dispersion in the control points (with consideration of the background)

Substance code	Substance	Concentration in the control point in shares of MPC
301	Nitrogen dioxide	0.4
304	Nitrogen oxide	0.01
328	Soot	0.02
330	Sulphur dioxide	0.05
337	carbon oxide	0.08
1325	Formaldehyde	0.00
2732	Fraction of hydrocarbons	0.01
2909	Dust	0.85
6009	Summary impact group (Codes 301+330)	0.31
6046	Summary impact group (Code 2908+337)	0.19

Calculation of emissions reveals that in the course of rehabilitation concentration of pollutants at the nearest recipient hill not exceed permissible limits.

4.1.2 Odour

The level of detection and response to odour is a subjective measurement, there being large variations between individuals both in the detection of odour, and in the nature, intensity, duration and frequency of an odour required to constitute a nuisance. Along with that, the potential for odour to cause annoyance varies depending on the nature of the process considered. Natural odours, occurring primarily as a result of the anaerobic decomposition of organic materials in the uncontaminated dredged sediments, may pose slightly objectionable impacts in the vicinity of the disposal sites. The degree of odour impact generally depends on such parameters as temperature (colder temperatures slow bacterial growth on dredge material and lessen odour impacts) wind direction, and proximity of the impact recipient. In case of the Vardnili cascade taking into account vicinity of the project site to the residential area (for the sections between Vardnili 1 and Vardnili 3) obnoxious impact on the residents may be an issue.

4.1.3 Propagation of noise

The main sources of noise will be 2 dump trucks (90 dba each), 1 excavator (95 dba) and 1 bulldozer (92 dba). As the dredger will be electric driven the noise related to its operation will be low and is not considered in calculation.

The total estimated level of noise is :

$$10\lg\sum_{i=1}^{n}10^{0,1Lpi} = 10\lg(10^{0.1x90}+10^{0.1x90}+10^{0.1x95}+10^{0.1x92})=98.3\text{dba}$$

According to the layout scheme the mentioned sources are located in 420m from the dwelling zone.

In compliance with the sanitary norms on noise at workplaces, dwelling and public places and the built up area, permissible noise level in the area adjacent to the dwellings must be below 55 dba and 45 dba in the day and the night time respectively.

Identification of the noise level La at the boundary of the dwelling area is calculated in compliance with the building norms and rules II-12-77M.

The following equation was use:

$$L_A=L_{A,eq} - \Delta L_{A,calc} - \Delta L_{A,scr} - \Delta L_{A,\ plant}$$

where,

- $L_{A,eq}$– total coefficient of the source (dBA.) $L_{A,экв}$ = 98.3 dBA.
- $\Delta L_{A,calc}$ – attenuation/reduction (dBA) of noise depending on the distance between the source and the control point (recipient), r=420m, $\Delta L_{A,calc=}$32 sBA;
- $\Delta L_{A,scr}$ – reduction using a screen (dBA)= 0
- $\Delta L_{A,\ plant}$– reduction by plant barrier (dBA). The width of one row of plantation 10-15m – reduction 4-5 dBA. In case of Vardnili HPPS the width is about 40m, i.e. the noise will be educed by 15 dBA.

Taking this into account L_A in case of Vardnili canal rehabilitation will total

$$L_A=L_{A,eq} - \Delta L_{A,calc} - \Delta L_{A,scr} - \Delta L_{A,\ plant}= (98.3-32-0)-15 = 51.3 \text{ dBA}.$$

This means that the noise level determined in the control point is below allowable limit for the daytime. According to the schedule, the works will be carried out only during the day. In case of emergency the schedule of works will be revised so to perform the most noisy operations in the daytime.

4.2 Impact on soil

The planned rehabilitation envisages:

- rehabilitation of the concrete facing of the canal slopes next to the Vardnili 1
- removal of the island in the tail water of Vardnili 3
- removal/dredging of the canal, temporary storage and draining the dredged material, transportation to the final “destination” and use for reinforcement of the bunds

The works will be carried out in the boundaries of the canal and its banks. For transportation of the dredged material existing service roads will be used. As no activities outside the boundaries of existing development is planned i.e. neither additional impact on soil integrity nor loss of productive soil layer is expected.

Pollution of soil on project implementation stage may be due to:

- fuel and oil spill from vehicles machinery (potential causes reason: poor state of maintenance, accidental spill while servicing/fuelling, leakage from fuel/oil storage (in case available));
- poor waste management practices.

Contractor is obliged to keep to the traffic routes (traffic is allowed only via existing service road) and to ensure proper state of maintenance of vehicles/machinery.

4.3 Impact on water

Impact on water quality may be observed while dredging. Abstraction of deposit will increase turbidity. Certain increase of turbidity will be observed during sedimentation/drainage of abstracted material in case the drained flow discharges without settlement. According to the project the dredged material will be temporarily stored in specially allocated areas where the settlement/sedimentation pits will be provided to remove suspended particles prior to discharge of the drained water back into the canal.

The water may get polluted with

- spilled petroleum products (source- damaged vehicles, machinery and/or any onsite storage of fuel/lubricant materials);
- wash water from car washing facility (in case provided);
- household and construction waste if not managed properly.

It must be mentioned that as electric driven dredger will be provided, the risk of the surface water pollution with petroleum products will be less.

4.4 Impact on biodiversity

4.4.1 Impact on aquatic life

In order to determine a possible impact of dredging works on the water quality and aquatic life in the Black Sea, it is essential to consider properties of the proposed activities, as follows:

1. The spatial extend of the project - the planned activity will cover the section from Vardnili 1 up to Vardnili 4 only;
2. The distance from the outermost project site to the outfall of the canal – 12 km.
3. Level of the canal tail to the sea being 1,5 - 2 m below the sea level itself, and that the sea has created large bay at the end of Vardnili 4 tailrace canal;
4. Stepwise implementation schedule of dredging works (section by section dredging);
5. The flow rate in the canal.

Considering the abovementioned, we shall assume that suspended particles will gradually settle within the canal downstream of Vardnili 4 and the sediment plums will not reach the sea. This, in turn, allows to suppose that the project-related increase of the sea water turbidity is not expected to be of concern in terms of deterioration of the Black Sea water quality and possible impact on the aquatic life. Nevertheless, avoiding the spawning/breeding season (April-July) shall be considered as an environmental preventative measure.

4.4.2 Impact on flora

According to the project the canal rehabilitation includes de-grubbing of the banks and removal of the island formed in the tail water of Vardnili 3. Exact number of trees to be cut

has not been done. By visual evaluation the area of the island downstream Vardnili 3 totals 17,000 m^2, of that 1,000m^2 is vegetated. The width of the area along the canal which must be stripped of vegetation is 3-4 m. With consideration of the total length of the canal (22km) the area from which vegetation is to be grubbed will be 22,000 x 2 x 4 = 176,000 m^2. In total plants will be cut at 177,000 m^2 area. Flora along the canal is secondary (trees and bushes). Assuming that 1 plant takes up around 2-3m, in the course of rehabilitation about 59,000 trees/bushes will be cut. According to visual inspection and available reference date none of these plants are endangered or relict.

Eradication of vegetation is to be carried out with adequate care to avoid damage of ecosystem that has developed and reduce the risk of bank erosion. The outer slopes of the bunds can be planted/seeded to minimize erosion and merge the bunds with the background.

4.4.3 Impact on fauna

Vardnili rehabilitation works will be carried out within the boundaries of the bed of the canal and in alienation strip. The traffic will use existing service road running parallel to the canal. Total duration of works will be 4-5 months. The works will be limited in space and time, thus disturbance of local fauna will be negligible and short term. Impact will mainly be due to the traffic and onsite generated noise and vibration. Certain impact on ichtyofauna related to increase of turbidity, besides removal of sediments and the island will affect aquatic system (through impact on habitats).

Impact on migration of species is not an issue due to the fact that the dams are located at the borders of different aquatic environments thus the fish from one environment does not migrate to another one.

4.5 Impact on protected areas

No protected areas are available close to the project site.

4.6 Impact on archaeological and cultural heritage

In the limits of the project impact area no archaeological /cultural heritage sites are reported.

4.7 Impact on social systems

- Enguri and Vardnili HPP installations have always been accepted well by the local population.
- During the project temporary workplaces will be made available to the locals.
- Workers will benefit from socio-cultural facilities for them and their families.
- The project will not undermine existing activities
- Dredging and maintenance of the canal will reduce the risk of flooding of the land along the canal and lower the risk of the local infrastructure damage.

No resettlement or inflow of workforce is expected.

Health and safety - Task specific H&S rules will be applied. No adverse impact on health and safety of the staff and local residents is expected.

4.8 Impact on traffic

Project related traffic will be limited to the project area. Material dredged from the canal will be used for reinforcement of the bunds along the canal, about 20,000m3 – used in concrete facing works. Inert material will be transported along the existing service roads.

The project will not have any impact on the traffic flow in the region.

4.9 Waste management

The waste stream will comprise: household waste, construction waste, general waste, food waste and felled wood. Waste dumped into the canal will be scooped, drained and removed to the landfill in Gali. Felled trees/bushes can be used by local population as fire wood.

Residue of potentially hazardous waste – fuel and lubricants will be collected, in tight containers and disposed off by contractor (certified waste removal company)

Household waste will be collected in tight containers and removed to the Gali landfill facility not less then three times a week.

4.10 Transformer oil (PCB)

No traces of PCB in soil/water sampled collected from the canal area is detected

4.11 Asbestos

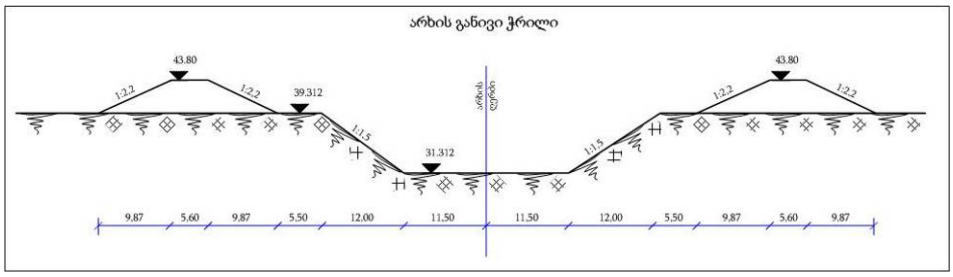
No deposits of asbestos observed.

VARDNILI CANAL - AUDIT

A1. VARDNILI CANAL AUDIT

Description of the canal

The canal is open, total length 22 km. Cross section is vee-type, dimensions are different in different locations.



The canal area is built of proluvial, alluvial and alluvial-proluvial sediments. According to the project the slops of the canal are not concrete lined, but slopes are concrete lined only on limited areas - 50-100 m upstream and downstream of each power house.

On the upper berm of the canal service road is available. The road is damaged and needs rehabilitation. Damaged is majority of the berms along the canal and required rehabilitation.

Slopes of canal and berms are vegetated. The plants species within considered area do not belong to the category of protected species. Vegetation grown on slopes and berms of canal hinder operation of the canal and reduce its flow capacity. Taking this into consideration the slopes and the bers must be de-grubbed. One of the reasons of reduction of flow capacity of the tail raise canal is accumulation of the sediments. Taking into account that water from Enguri River flows through the Enguri and Gali reservoirs, which in this case represent tripping basins, getting of sediments from Enguri River into the canal is excluded. The sediments get into the canal from tributaries and through erosion.

According to the survey carried out in June 2008 the volume of sediments (sand and gravel) currently accumulated in the canal is estimated at 300,000 m3. In some areas – household waste is detected.

Description of the canals by section is given below (while splitting into the sections taken into account are the sections between HPPs and the section from Vardnili 4 to the Black Sea).

Design characteristics of the canal

The canal is open, the share - trapezoidal

Section №	Length, m	Design flow, m3/s	Max. permeability, m3/s	Soil type along the canal terrace	Dimensions of cross section	Slope inclination	Sloping	Bottom mark, m		Facing type	Water level in conditions of design flow - 430 m3/s, m	
I	5400	430	670	Proluvial and alluvial-proluvial sediments: clayey, clay, and sands;; Alluvial sediments; coarse grain boulder-pebble, matrix – sand, sandstone, clayey and clays. Rocks in some places cemented as “weak” conglomerates; “weak”conglomerates: coarse boulder-pebble with sand, sandstones, clayey and clay matrix. The rocks are weakened and presented by pebbles.	Varies along the canal 28.6 x 5.92 m; 40.0 x 5.92 m	1:1.5; 1:2.0 (PK 64+00–PK 100+24.44)	0.000387– 0.000218	start 31.00	end 29.9	0.3 m reinforced concrete	start - 5,92	End of the canal –5.92

II	3869,5	430	670	proluvial and alluvial-proluvial sediments: clayey, clay, sandstone; alluvial sediments: coarse boulder-pebble, matrix- sand, sandstone, clayey and clay. in some places the rocks are cemented in weak conglomerates; weak conglomerates: coarse boulder-pebble sands, sandstone, clayey and clay matrix. In some places the rocks are loose/weakened and presented by pebbles.	Varies along the canal 28,6 X 5,92 m; 40,0 X 5.92 m	1:1,5; (pk 56+11.30–pk 64+00); 1:2,0 (pk 64+00–pk 100+24,44)	0,000387 (pk 56+11.30- to pk 70+00); 0,000218 (pk 70+00-to pk 99+86.	start 20,907	end 19,85	0,3 m reinforced concrete	stert - 5,92	end of canal -5,92
III	4808,66	430	690	alluvial-ballast sediments clayey, clay, sandstones (mobile consistence); alluvial and marine sediments: medium grain pebbles (seldom coarse grain), matrix - sand, clay sands and clays.	Varies along the canal : 34,5 X 6,0 m; 34,5 X 5,75 m.	1:3,0 (pk 102+27,64– 128+00 pk 144+00–pk 143+33,1); 1:5,0 (pk 128+00 –pk 144+00)	0,000218	start 8,7	end 7,656	0,3 m reinforced concrete	start - 6,00	end of canal-5,75

IV	8350,0	430	756	Proluvial and alluvial-proluvial sediments: clays, clayey and sandstones; alluvial-ballast sediments: clayey, clay, sandtones (mobile consistence); marine sediments: sandstones, sands with fine grain stones; with sand and sandstone matrix; alluvial and marine sediments: medium grain stones (seldom coarse grain), matrix – sand, clay sands and clayey.	Varies along the canal 34,5 X 6,0 m; 34,5 X 4,85 m	1:3,0 (pk 150+36,00– 128+00 and pk 171+00); 1:10,0 (pk 171+00–pk 195+00) 1:3 (pk 195+00 -– pk 232 + 50)	0,000218	start – 3,583	end – 5,320	0,3 m reinforced concrete	start - 6,00	end of the canal-6,00

Audit report

Audit of the canal was carried out on 28 June 2008 when Vardnili 1 was stopped to drain the canal, while water level in the Gali reservoir was lowered to the elevation 100.95 to accumulate water from Enguri HPP. Regulation of water in the reservoir enabled to cut off the flow in the canal for 10 hours. In the course of this time the measurements within the canal between Vardnili 1 and Vardnili 2 and visual audit of the rest of the canal were performed.

It must be mentioned that complete draining of the canal was not possible as along the canal numerous streams flow in, besides certain volume still flows from Vardnili 1 spillway gate.

The audit revealed that the "initial" section of the tail race canal up to the conjuction with spillway canal is damaged. The main concern is landslide at the right slope (Figure A1.1.)

Figure A.1.1 View on landslide on right bank

The "sliding" earth damages the concrete lining of the slopes and the canal bottom. As revealed by the visual examination the landslide crosses the canal bed, presses on the left slope and damages reinforced concrete lining of the latter, while water displaces the reinforced concrete slabs in direction of the flow (Figures A.1.2. and A1.3.).

Figure A.1.2 The slopes damaged by the landslide

Figure A.1.3 Displaced reinforced concrete slabs

SECTION 1 (BETWEEN VARDNILI 1 AND VARDNILI 2)	
 **Figure A1.4 Accumulation of the sediment near the confluence**	Within this section two tributaries flow in. In the confluence vast volume of sediment is accumulated. Along the rest of the canal accumulation of the sediments is caused by the bank erosion. The bed of the canal at about 5-6m height is naturally faced with coarse boulders and gravel. Upper, the slopes and berms are covered with vegetation, in some places – overgrown. The slopes of the canal are uneven, slopes in some placed washed off. The volume of the sediment accumulated in the first section of the canal estimated during the survey carried out in June 2008, totals 60,000–65,000 m^3. This sediment is to be removed.  **Figure A1.5 Accumulation of the sediment**

Section 2 (between Vardnili 2 and Vardnili 3)	
 **Figure A1.6 "Peninsula" in the section 2 of the system**	The slopes are nonlinear. In some locations – washed off. The bed of the canal at about 5-6m height is naturally faced with coarse boulders and gravel. Upper, the berm and the slopes of the second berm are covered with vegetation. In some areas the sediment is accumulated. Mentioned is to be the „peninsula" formed in the tail water of Vardnili 2 in 50m from the concrete-lined section, the left bank of the canal. The island is formed by the slope erosion material and the sediment brought in by the left tributary. By visual inspection in this area the volume of accumulated material totals 5 000 m3 (200 x 25 x 1 m). In about 1.5 km from the HPP about 40,000m3 of the sediment is observed. . Total volume of sediment within the section 2 is estimated as 45,000-50,000 m^3.
Section 3 (between Varnili 3 and Vardnili 4)	
 **Figure A1.7 View of the island**	Complete inspection of Vardnili 3 canal has not been carried out because of the limited time and poor accessibility. The status of the section is similar to those of the section 1 and 2. Several tributaries flow into the canal within this section. In the tail water of Vardnili 3 in about 100m from the concrete-lined section island with 150m diameter and about 17,000m2 surface is formed. The island built of the carried in sediment and material formed through bank erosion. According to the personnel the formation of island started about 15 years ago. Accumulated layer is around 2-3 m thick, total volume of sediment is around 40,000-50,000m3. Total volume of the sediment accumulated within the limits of this section is 80 000 m. As one can see from the Figure A8, the banks of the canal are strongly altered by erosion. The banks and the island are covered with growth.

Section 4 (from Vardnili 4 to the Black Sea)
Complete inspection of Vardnili 4 canal has not been carried out because of the limited time. According to the staff and the reference information within this section of the system several tributaries flow in. Accumulation of the sediment is observed in confluences and the bank of the canal where erosion has developed. The volume of the sediment is estimated as 80,000m^3.

Description of the sediment

Accumulated sediments are formed by the material flowing in through the tributaries and inert material generated by erosion of the banks. The sediment is composed of pebbles and gravel with sand matrix. Typical view of the inert material is given in Figure A1.9.

Figure A1.8 View of accumulated inert material

In June 2008 the samples of the inert material were collected for analysis - two samples from the section 1. Grain size and physical characteristics studied. The samples were collected from 1) under the Gali-Sokhumi bridge the left bank of the canal 2) from the right confluence of the canal. Besides 3 samples were collected from the second section – petroleum hydrocarbons, heavy metals and PCBs identified.

Grain size and physical characteristics were studied by Geotechservice, pollutants – measured by Gamma lab. Results are given in tables below:

Results of analyses (grain size, physical characteristics)

Table A1.1 Sample 1, results of grain size analysis (sieve)

Method:	**BS 1377 : Part 2 : 1990 : 9.3**		**Date**	**26.06.2008**
Initial dry weight, m_1	4767 g			
BS sieve	Remaining weight, g		Retained by the sieve%	Total percent of the strained fraction
	Factual	Corrected, m		
400 mm	-	-	-	
200 mm				
120 mm				
100 mm				
75mm				100,00
63 mm	255,0	255,0	5,35	94,65
50 mm	216,0	216,0	4,53	90,12
37,5 mm	233,9	233,9	4,91	85,21
28 mm	301,5	301,5	6,32	78,89
20 mm	393,5	393,5	8,25	70,63
"strained" 20 mm m_2	3367,1			
Total (approved m_1)	4767,0			
parted m_3	2000,0			
parted and washed m_4				
correction coefficient $\frac{m_2}{m_3}$	1,68			
14 mm	193,0	325,0	6,82	63,82
10 mm	232,8	392,0	8,22	55,59
6,3 mm	151,5	255,0	5,35	50,24
"strained" 6.3 mm m_5	1422,6			
Total (approved m_4)	2000,0			
parted m_6	200,0			
correction coefficient $\left(\frac{m_2}{m_3}\times\frac{m_5}{m_6}\right)$	11,98			
5 mm	9,8	116,9	2,45	47,79
3,35 mm	13,1	156,6	3,29	44,51
2 mm	12,8	152,8	3,21	41,30
1,18 mm	30,8	368,8	7,74	33,56
600 μm	19,4	232,3	4,87	28,69
425 μm	14,4	172,9	3,63	25,06
300 μm	21,2	254,3	5,33	19,73
250 μm	20,8	249,1	5,23	14,50
150 μm	26,8	320,5	6,72	7,78
63 μm	8,1	97,2	2,04	5,74
"strained" 63 μm m_F or m_E	22,9	273,7	5,74 %	
Total (approvedm_6)	200,0	2395,1	100,00 %	

Table A1.2 Graphical representation – grain size analysis, Sample 1

Method:	BS 1377 : Part : 1990 : 9.3/9.5	Date 26.06.2008

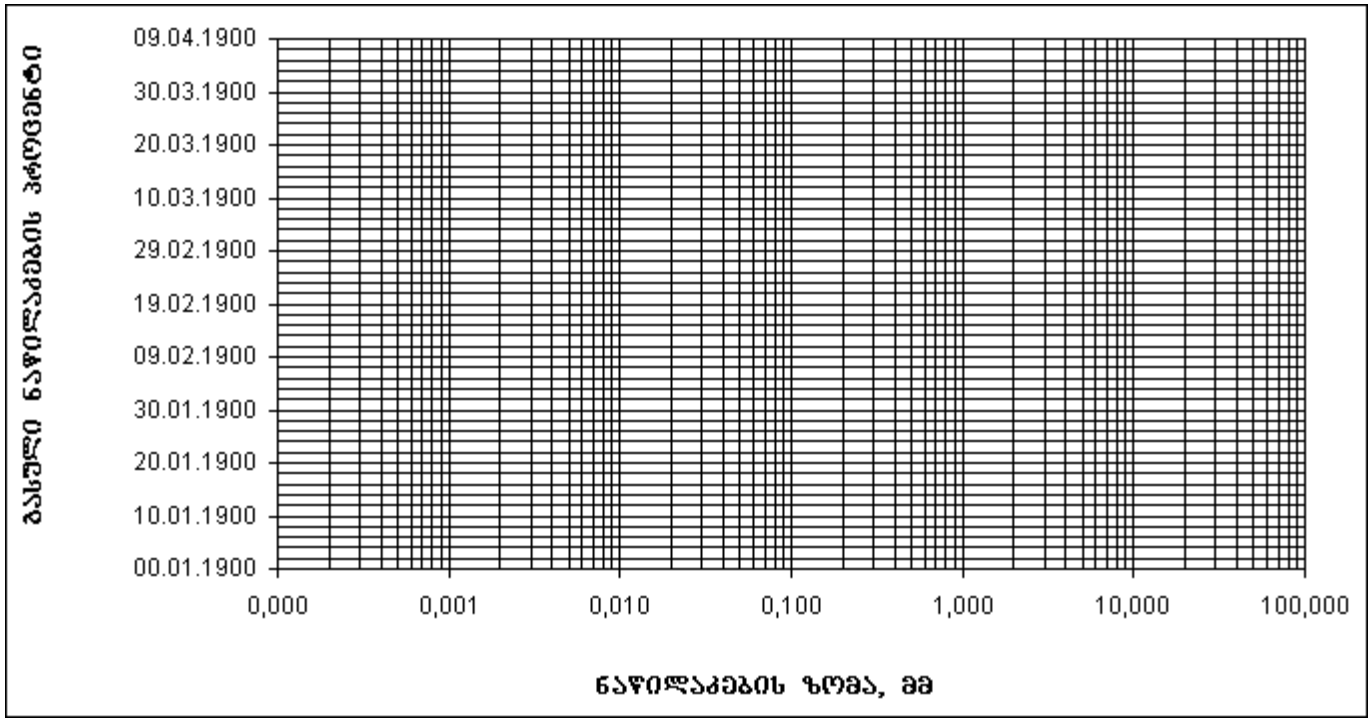


Table A1.3. Sample 1, results of the grain size analysis (sieve)

Method:	**BS 1377 : Part 2 : 1990 : 9.3**		**Date**	**26.06.2008**
Initial dry weight, m_1	3375,0 g			
BS sieve	Remaining weight, g		Retained by the sieve %	Total percent of the strained fraction
	Factual	Corrected, m		
400 mm	-	-	-	
200 mm				
120 mm				
100 mm				
75 mm				
63 mm				
50 mm				100,00
37,5 mm	100,0	100,0	2,96	97,04
28 mm	214,4	214,4	6,35	90,68
20 mm	260,6	260,6	7,72	82,96
"strained" 20 mm m_2	2800,0			
Total (approved m_1)	3375,0			
parted m_3	2000,0			
parted and washed m_4				
correction coefficient $\frac{m_2}{m_3}$	1,40			
14 mm	178,8	250,3	7,42	75,55
10 mm	124,8	174,7	5,18	70,37
6,3 mm	150,0	210,0	6,22	64,15
"strained" 6.3 mm m_5	1546,4			
Total (approved m_4)	2000,0			
parted m_6	200,0			
correction coefficient $\left(\frac{m_2}{m_3}\times\frac{m_5}{m_6}\right)$	10,83			
5 mm	6,9	74,9	2,22	61,93
3,35 mm	14,4	156,3	4,63	57,30
2 mm	14,4	156,3	4,63	52,67
1,18 mm	25,8	279,3	8,28	44,39
600 μm	13,1	141,8	4,20	40,19
425 μm	14,1	153,0	4,53	35,66
300 μm	16,5	178,2	5,28	30,38
250 μm	17,0	183,8	5,45	24,93
150 μm	20,7	223,9	6,63	18,30
63 μm	9,7	104,8	3,11	15,19
"strained" 63 mm m_F or m_E	47,4	512,7	15,19 %	
Total (approved m_6)	200,0	2165,0	100,00 %	

Table A1.4 Graphical representation – the grain size analysis, Sample 2

Method:	BS 1377 : Part : 1990 : 9.3/9.5	Date 26.06.2008

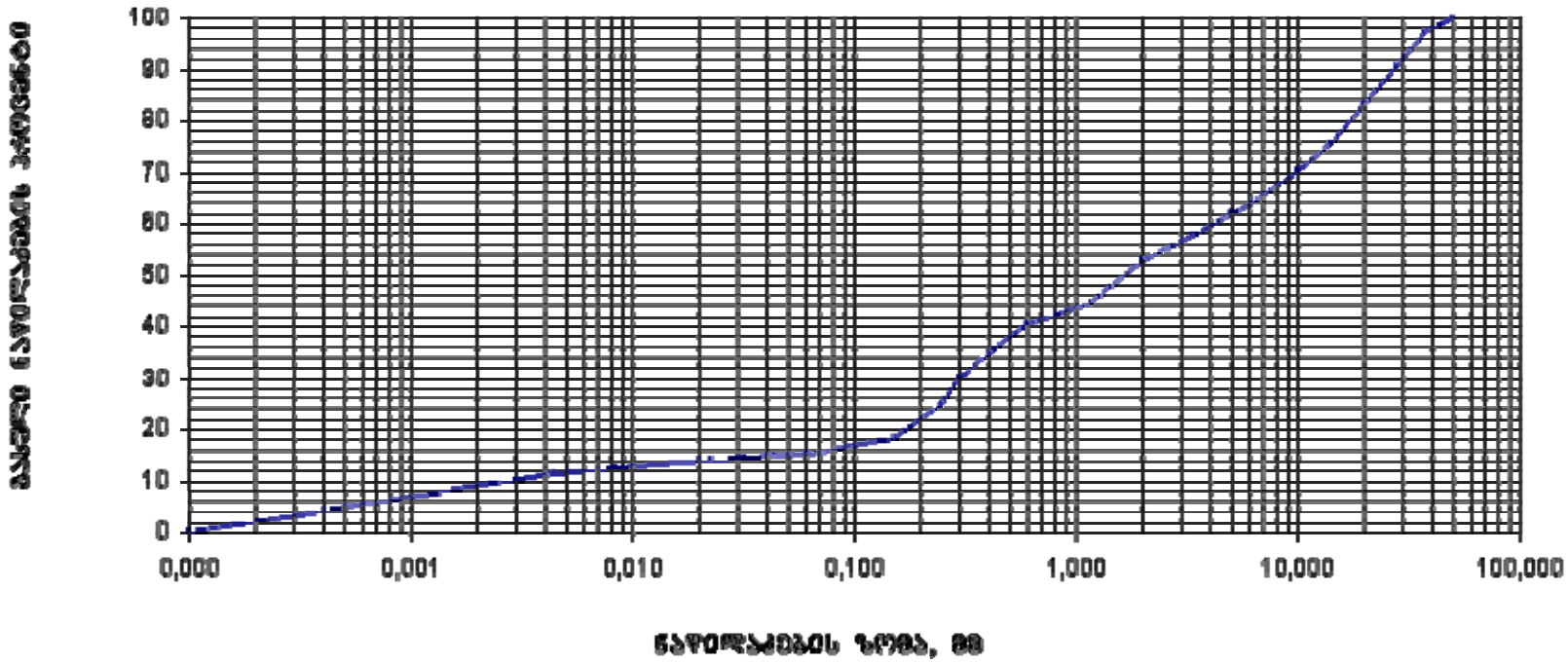
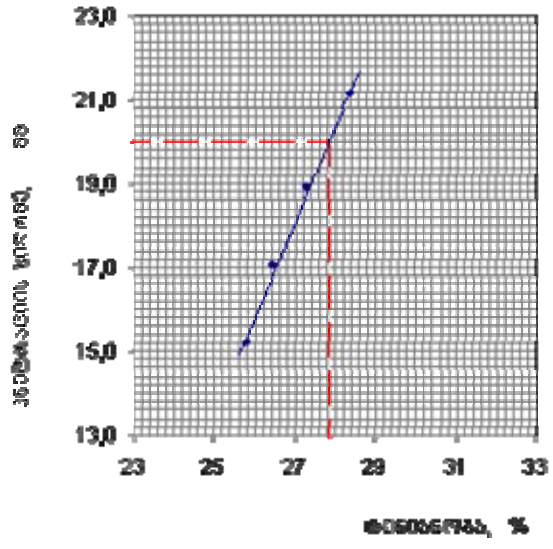


Table A1.5 Moisture at yield strength and plastic limit – samples 1 and 2

Method:	**BS 1377 : Part 2 : 1990 : 4.3/5**	**Date**	**26.06.2008**

Plastic limit, text #		1	2	3	4	Average
Weighing bottle #		862	601			
Weight soil + weighing bottle	g	40,91	40,25			
Weight dry soil + weighing bottle	g	37,30	36,82			
Weight of the weighing bottle	g	19,92	20,51			
Weight - water	g	3,61	3,43			
Weight - dry soil	g	17,38	16,31			
Humidity	%	20,8	21,0			20,9

Yield strength, text #		1			2			3			4		
Initial reading	mm	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Final reading	mm	15,2	15,2	15,2	17,0	17,0	17,1	18,9	18,8	19,0	21,2	21,1	21,1
Average penetration	mm	15,2			17,0			18,9			21,1		
Weighing bottle #		388			258			389			156		
Weight of the humid soil + weighing bottle	g	49,33			48.48			57.88			59.95		
Weight of the dry soil+ weighing bottle	g	43,65			42.92			50.34			51.5		
Weight of the weighing bottle	g	21,67			21,93			22.73			21.73		
Weight - water	g	5,68			5,56			7,54			8,45		
Weight - dry soil	g	21,98			20,99			27,61			29,77		
Humidity	%	25,8			26,5			27,3			28,4		



Sample preparation		
as accepted		
washed in 425 mm sieve		
air dried		°C
furnace dried	105	°C
unknown		
retained on 425 µm ssieve		%
yield strength	27,8	%
plastic limit	20,9	%
plasticity	6,9	

Results of the analysis revealed that the inert material meets the standard requirement s set for construction materials and can be used in construction or for rehabilitation of roads.

Results of pollution analysis

In the course of the audit bottom sediment samples were collected from the canal at Vardnili 1. The purpose of sampling was identification of toxic metals, petroleum hydrocarbons and polychlorinated bypheniles in the dredged material. Results of the analysis carried by scientific research firma Gamma are as follows:

№	Toxic metals (stable forms)						Toxic metals (mobile forms)		TPH, mg/kg	PCB, mkg/kg
	Cu, mg/kg	Zn, mg/kg	Pb, mg/kg	Cd, mg/kg	Hg, mg/kg	As, mg/kg	Cu, mg/kg	Zn, mg/kg		
1	27.5	71.5	< 20	< 2	0.22	9.0	5.25	8.05	< 2.5	< 10
2	25.0	68.0	25	< 2	0.15	7.0	4.55	7.50	< 2.5	< 10
3	30.0	59.0	< 20	< 2	0.10	9.0	0.85	1.70	< 2.5	< 10
MPC	**3**	**37**	**32.0**	**1-3**	**5.0**	**10.0**	**3**	**37**	**1000**	**10**

The survey revealed heightened concentration of copper (Cu) and zinc (Zn) which is typical for the Enguri River sediments l. (The soil in the river basin is rich in the mentioned metals, besides several deposits of copper and zinc are available).

IMPACT, MITIGATION, MANAGEMENT & MONITORING

5 IMPACT VS MITIGATION

A summary of impacts requiring mitigation identified during this project for

- air quality (A),
- soil, geology and hydrogeology (GEO),
- hydrology and flood risk (H),
- terrestrial and aquatic ecology (EC),
- traffic and infrastructure (T),
- noise and vibration (NV),
- waste and wastewater management (W),
- landscape and visual (LV),
- archaeology and cultural heritage (ARC) and
- socio-economics (SE)

are shown below, along with proposed mitigation and an assessment of residual impacts:

Table 5.1. Summary of Environmental and Social Impact Assessment

Item No.	Impact	Phase			Unforeseen Events	Potential Significance	Mitigation Measure	Residual Impact	Significance of Residual Impact
		Mobilisation	Rehabilitation/ construction	Demobilisation					
Air									
A1	Dust	Yes	Yes	Yes	N/A	Medium/ Low	In case of necessity cover truck to reduce dust emission during transportation. If appropriate - reduce the speed of the traffic. Minimise drop heights	No	N/A
A2	Combustion emission	Yes	Yes	Yes	N/A	Medium/ Low	Ensure proper status of maintenance of the vehicles, machinery	No	N/A
A3	Odour	No	Yes	Yes	N/A	Medium/Low	Sniff testing (olfactometry) and monitoring of complaints can be suggested as the simplest ways of the nuisance control. In case of necessity the odour can be controlled/mitigated, by spreading lime over the sediment load, which neutralizes natural uncontaminated dredged material odours.	NO	N/A
Soil, Geology and Hydrogeology (GEO)									
GEO1	Soil stability	No	Yes	No	N/A – if appropriate factors of safety are used	Medium	All slopes to be designed and constructed using appropriate factors of safety Stockpiles/bunds seeded and re-vegetated Landslide affected area (the right bank of the canal downstream Vardnili 1 near the spillway), sediments accumulated in the bed of the canal near the confluences, island downstream Vardnili 3 affecting the flow through the canal and leading to development of hazardous geodynamic processes must be removed. The rate of sediment accumulation monitoring is recommended to be introduced to identify the schedule of subsequent de-silting, de-grubbing operations.	No	N/A

Item No.	Impact	Phase			Unforeseen Events	Potential Significance	Mitigation Measure	Residual Impact	Significance of Residual Impact
		Mobilisation	Rehabilitation/ construction	Demobilisation					
GEO2	Soil productivity	Yes	Yes	Yes	No	Low	In case the fly camps are arranged or earthworks required remove the top soil layer, temporarily store and reintroduce, re-vegetate	No	N/A
GEO3	Soil contamination resulting from hydrocarbon spills from vehicles or site facilities equipment, or other potentially contaminating liquids	Yes	Yes	Yes	Yes -accidental hydrocarbon or other liquid spills	Medium	Re-fuelling in designated areas on hardstanding with available spill kits; proper maintenance of vehicles and equipment; proper waste management	No	N/A
GEO4	Groundwater contamination from contaminants in stockpiled soil, hydrocarbon spills from vehicles or Site facilities equipment, or other potentially contaminating liquids	Yes	Yes	Yes	Yes -accidental hydrocarbon or other liquid spills	Medium	Re-fuelling in designated areas on hardstanding with available spill kits, Proper waste management	No	N/A
Hydrology and Food Risk (H)									
H1	Surface water contamination	Yes	Yes	Yes	Yes -accidental hydrocarbon or other liquid spills	Medium/ Low	Re-fuelling in designated areas on hardstanding with available spill kits; proper waste management Adequate bank protection in the catchment area to prevent erosion (replanting and maintenance of vegetation), extraction of coarse material from the river bed, use of sediment trapping devices, establishment and maintenance of optimum levels of water flow to minimize erosion		
H2	Flood risk[3]	No	No	No	N/A	N/A	N/A	N/A	N/A

[3] risk of flood may be observed in case the freding is not implemented

Item No.	Impact	Phase			Unforeseen Events	Potential Significance	Mitigation Measure	Residual Impact	Significance of Residual Impact
		Mobilisation	Rehabilitation/ construction	Demobilisation					
Terrestrial and Aquatic Ecology (EC),									
EC1	Impact on vegetation	Yes- in case the temporary camp and earthworks is required	Yes	Yes	N/A	Medium	Keep the boundaries of the camp (if any), and operation area to reduce extend of the damage Estimate exact qty of trees to be cleared to avoid excess felling/damage. Do not allow shortcuts to avoid direct impact (damage of plants) Maintain proper level of maintenance of vehicles and machinery to avoid/reduce indirect impact by emission Re-vegetation	Yes	Medium
EC2	Impact on fauna (including ichtyofauna)	Yes	Yes	Yes	Direct impact (injury), disturbance	Medium/Low	Reduce traffic speed to optimum Works to avoid the spawning season (April-May to July)	N/A	N/A
Traffic and Infrastructure (T)									
T1	Impact on traffic flows	Yes	Yes	Yes	N/A	N/A	N/A		
T2	Impact on infrastructure	Yes	Yes	Yes	Deterioration of road pavement quality	Low	N/A		
Noise and Vibration (NV)									
NV1	Increased noise levels at residential receptors due to operational and decommissioning activities.	Yes	Yes	Yes	N/A	Medium	Plant will be maintained in efficient working order; Plant will be shut down or throttled to a minimum when not in use Works will be carried out during the day time	No	N/A
Waste and Wastewater Management (W)									
W1	Household solid and liquid waste from temporary camps (if available)	Yes	Yes	Yes	N/A	Medium	Maintain adequate waste bins for disposal to landfill and ensure proper waste management/disposal	No	N/A

Item No.	Impact	Phase			Unforeseen Events	Potential Significance	Mitigation Measure	Residual Impact	Significance of Residual Impact
		Mobilisation	Rehabilitation/ construction	Demobilisation					
W2	Used oils and greases from vehicles and machinery	Yes	Yes	Yes	N/A	Medium	Provide equipment servicing off site when possible. Adequate secondary containment, spillage protection and emergency clean up equipment to be maintained on site.	No	N/A
W3	Vegetation waste from site clearance	Yes	Yes	No	N/A	Low	Dispose on site or remove waste vegetation off site Felled wood may be used by locals as firewood		
Landscape and Visual (LV)									
LV1	Impact on landscape and visual amenity	Yes	Yes	Yes	N/A	Medium	Appropriate mitigation measures include: preservation of existing vegetation and keeping to the boundaries of the project area and access road should be undertaken; reclamation/ planting of greenery along /on the bunds to merge them into the background.	Yes	Low
Archaeology and Cultural Heritage (ARC)									
ARC 1	Impact on archaeological excavations and cultural monuments	No	No	No	Adequate care is to be taken during .earthworks – it is not likely to be the case but any findings if unearthed are to be reported to relevant authorities	Low	N/A	N/A	N/A
Socio-economics (SE)									
SE1	Community health and safety during rehabilitation/construction						Utilise existing best practice grievance mechanism for any health, safety or other issues raised by the community surrounding the proposed project		

6 MANAGEMENT AND MONITORING

An environmental and social monitoring plan of the project is shown in Table below:

Table 6.1 Summary of Potential Monitoring Measures

Item No.	Impact	Monitoring Measure
Air, Odour and Emissions (A)		
A1	Dust emission	Good management practice at the Site would aim to minimise dust impacts by, for example: • Adequate sheeting of vehicle loads up until tipping point when moving around the Site; • Securely cover skips and minimise drop heights, regularly dampen down surfaces with water; • Provision of upturned exhausts for vehicles/mobile plant on-Site; • Use of dust filters on fixed plant and machinery.
A2	Combustion/exhaust emission	
A3	Odour	Sniff testing (olfactometry) and monitoring of complaints can be suggested as the simplest ways of the nuisance control. In case of necessity the odour can be controlled/mitigated, by spreading lime over the sediment load, which neutralizes natural uncontaminated dredged material odours.
Soil, Geology and Hydrogeology (GEO)		
GEO1	Soil stability	Note any visual impacts to surrounding areas .
GEO2	Soil productivity	N/A
GEO3	Soil contamination resulting from hydrocarbon spills from vehicles or site facilities equipment, or other potentially contaminating liquids	During rehabilitation
GEO4	Groundwater contamination from contaminants in stockpiled soil, hydrocarbon spills from vehicles or Site facilities equipment, or other potentially contaminating liquids	May be introduced in case any doubt regarding possible impact/complains occurs
GEO4	Sediment Transport to Water Courses	• Monitor sediment (total dissolved solids) within irrigation canal. • If total dissolve solids are above baseline conditions identify source and implement appropriate mitigation, which might include re-seeding or providing other protection to stockpiles of earth, reseeding closed section of the banks, etc
Hydrology and Flood Risk (H)		
H1	Surface water contamination - Change in physical, chemical, and biological quality	Visual control Monitor sediment (total dissolved solids) within canal – is deemed advisable Check water quality – if deemed required
H2	Flood risk[4]	Visual control

[4] risk of flood may be observed in case the dredging is not implemented

Terrestrial and Aquatic Ecology (EC)		
EC1	Impact on vegetation	Visual control
EC2	Impact on fauna (including ichtyofauna)	Visual control
Traffic and Infrastructure (T)		
T1	Impact on traffic flows	N/A
T2	Impact on infrastructure	End of the project – visual control
Noise and Vibration (NV)		
NV1	Increased noise levels at residential receptors due to operational and decommissioning activities.	Occasionally, during the project
Waste and Wastewater Management (W)		
W1	Household solid and liquid waste from temporary camps (if available)	According to the waste management plan/procedure
W2	Used oils and greases from vehicles and machinery	According to the waste management plan/procedure
W3	Vegetation waste from site clearance	Control throughout rehabilitation to avoid excess damage of vegetation
Landscape and Visual (LV)		
LV1	Impact on landscape and visual amenity	N/A
Archaeological and Cultural Heritage (ARC)		
ARC 1	Discovery of, and possible damage to, unforeseen buried cultural heritage resources revealed during construction.	Provide a monitoring archaeologist undertaking a watching brief during construction activities to record any discovered heritage resources.
Socio-economics (SE)		
SE1	Community health and safety during construction and operation	Compliance with international, local, and national health and safety regulations Training of personnel Emergency plans in place

CONCLUSIONS & RECOMMENDATIONS

Conclusions

- The right bank of the canal downstream Vardnili 1 near the spillway is damaged by landslide. This affects flow capacity of the canal, the bed is instable, the risk of development of hazardous geodynamic processes is existent;
- In the tail water of Vardnili 3, in about 100m from the concrete lined section of the canal island built of sediments carried in as a result of erosion affects flow capacity of the canal and favours development of bank erosion;
- Along the canal (in particular in the confluences and next to eroded slopes of the canal) vast amount of sediments is accumulated. As a result flow capacity of the section is reduced and favour development of hazardous geodynamic processes;
- Flow capacity of the canal is affected by overgrowth (unmanaged growth of vegetation along the canal bed);
- In order to restore design flow capacity of the canal the sediment (accumulated sediments) and vegetation are to be removed;
- No worth to mention negative impact on soil is expected. Higher will be impact on surface water quality, dredging and liquidation of the island downstream the Vardnili 3 will result in increase of water turbidity;
- Taking into account: 1). the spatial extend of the project - the planned activity will cover the section from Vardnili 1 up to Vardnili 4 only; 2) the distance from the outermost project site to the outfall of the canal – 12 km.; 3) the fact that the level of the canal tail to the sea is 1.5 - 2 m below the sea level, and that the sea has created large bay at the end of Vardnili 4 tailrace canal; 4) stepwise implementation schedule of dredging works (section by section dredging); 5) the flow rate in the canal it is assumed that suspended particles will gradually settle within the canal downstream of Vardnili 4 without having impact on sea water quality in the area next to the confluence. The project related impact on the Black Sea aquatic ecology will not be an observed;
- Certain impact on ichtyofauna and damage of hydrocole is likely to occur due to increase in water turbidity;
- During the project approximately 59,000 trees and bushes will be cut along the canal and the island. This impact will be significant; however as the vegetation is secondary no endangered or relict species will be lost. As mitigation/compensation of this loss after completion of the project the outer slopes of the canal can be planted with greenery;
- As the works will be limited to the alienation strip of the canal no impact on fauna will be the case. Disturbance (noise, vibration) of animal species will be temporary;
- The planned development will not have any negative impact on air quality. Modelling reveals that concentration of all hazardous matter emitted in the course of development at the nearest recipient (the residential area) is in allowable limits;
- Noise level at the nearest residential area will be below 51 dBA, which is less than allowable limit for the daytime (55 dBA). No works will be performed at night time;
- Taking into account vicinity of the project site to the residential area (for the sections between Vardnili 1 and Vardnili 3) obnoxious impact on the residents may be an issue;

- Social impact of the project will be positive – temporary workplaces will be provided. Dredging of the canal and restoration of the canal capacity will enable to avoid the risk of floods and damage of land/infrastructure in case of high water.

Recommendations:

- Grubbed vegetation to be rehabilitated by planting of greenery in the outer reaches of the alienation zone;
- With consideration of results of the analysis (grain size, friability) extracted inert material can be used in construction and/or for road rehabilitation purposes.
- Floating household waste and household waste found in dredged material to be disposed to the Gali landfill.
- To reduce impact of works on ichtyofauna the spawning season (April-July) depending on the species will be avoided.
- Sniff testing (olfactometry) and monitoring of complaints can be suggested as the simplest ways of the nuisance control. In case of necessity the odour can be controlled/mitigated, by spreading lime over the sediment load, which neutralizes natural uncontaminated dredged material odours.