APPENDICES

With the Advisory review of the Environmental and
Social Impact Assessment Reports for the
Baku-Tbilisi-Ceyhan Oil Pipeline and
South Caucasian Gas Pipeline in Georgia

(appendices 1 to 10)

APPENDIX 1

Letter from the Ministry of VROM 5 September 2000 in which the Commission has been asked to submit Advisory review.

Ministerie van Volkshuisvesting,
Ruimtelijke Ordening en Milieubeheer
Rijnstraat 8
2515 XP Den Haag
Interne postcode 660
Tel : 3394097
Fax: 3391302

Directoraat Generaal Milieubeheer
Directie Strategie en Bestuur
Afdeling Bestuur en Maatschappij

Aan de Voorzitter van de Commissie
voor de milieu-effectrapportage
dhr. Ketting
Postbus 2345
3500 GH Utrecht

Uw kenmerk	Uw brief	Kenmerk	Datum
		DGM/B/BMB/ 2000095803	-5 SEP. 2000

Onderwerp

Advisering olieleiding Georgië

Geachte heer Ketting,

De Minister van Milieu van Georgië heeft Nederland om assistentie gevraagd bij de beoordeling van de milieugevolgen van de Bakoe-Ceyhan ruwe olieleiding (zie bijlage alsmede het separaat verzonden dossier).
Ik wil u verzoeken om de toetsing van de komende milieu-effectrapportage uit te voeren en daarbij ook bij te dragen aan de gewenste kennisoverdracht.
Gaarne verneem ik van U hoe deze toetsing opgezet zal worden alsmede de kosten (in de vorm van een begroting) die daaraan verbonden zullen zijn.
Deze begroting kunt U richten aan de directeur Internationale Milieuzaken, t.a.v. de heer H. van Meijenfeldt (IPC 670).

Hoogachtend,

De Minister van Volkshuisvesting,
Ruimtelijke Ordening en Milieubeheer,
voor deze,
De directeur Strategie en Bestuur,

mr. J.H. Enter

Bijlagen:

APPENDIX 2

Project information

Proposed activity: To advise on the Environmental Impact assessment of the Baku-Tbilisi-Ceyhan Main Export Oil Pipeline and the South Caucasus Gas Pipeline in Georgia

Categories: DAC/CRS code 71400

Project numbers:

Ministerie van VROM DGM.B/BMB/200095803
Commission for EIA 1120

Procedural information:

Request for advice: 5 September 2000

Advisory review of draft ESIA report submitted: 19 July 2002

Advisory review of final ESIA report submitted: 22 November 2002

Information on the project:

The Baku–Tbilisi–Ceyhan Main Export oil pipeline project is considered a major system for transporting up to one million barrels per day (50 million tonnes per year) crude oil from an expanded Sangachel terminal near Baku in Azerbaijan, through Georgia to a new marine terminal at Ceyhan in Turkey on the Mediterranean coast. Total length of the pipeline is 1760 km. The length in Georgia as proposed in the ESIA is 248 km.
In addition to the 248 km pipeline itself, permanent facilities in Georgia include: two pump stations, a pig launcher/receiver station along with two further pigging facilities integrated within the pump stations; one metering station, a number of valve stations, a cathodic protection system, an optical fibre communication system and a computer-based integrated control and safety system. The planning is that the construction will start in spring 2003, the pipeline will become operational in early 2005.
This advice focuses on that part of the BTC-project that crosses the territory of Georgia.

South Caucasus Pipeline

The South Caucasus pipeline (SCP) is considered to be a pipeline system to transport up to 7.3 billion cubic metres per year of gas from an expanded Sangachal terminal near Baku in Azerbaijan, through Georgia to the Georgian/Turkish border for onward distribution to Turkish domestic customers via the national gas network. In addition to the pipeline itself, permanent facilities in Georgia include: one pressure reduction and metering station, a number of block valve stations, a natural gas off-take site, a cathodic protection system, an optical fibre communication system and a computer-based integrated control and safety system. The total length of 690 km, 248 km follows the preferred route and runs parallel to the BTC pipeline between the Sangachal Terminal and the Georgian / Turkish border near Akhaltsikhe. The planning is that the pipeline will become operational in late 2005.
This advice focuses on that part of the SCP that crosses the territory of Georgia.
The Georgian Minister of environment has requested assistance from the Dutch Minister of environment, with a thorough implementation of EIA for the BTC and SCP projects. The Dutch Minister of environment requested the Commission for EIA to advice on EIA.

Composition of the working group of the Commission for EIA:

Mr. J.M. Marquenie
Mr. D. Steensma
Mr. B. Burgess
Mrs. I. Kurtskhalia – Local expert
Mr. D. de Zeeuw – Chairman
Mr. Y. Zhou

Local experts (resource persons):
Nodar Begalishvili - Risk Assessment and Analysis of Oil Spill Simulation Models
Nugzar Buachidze - Assessment of Land Baseline Contamination Study
Jemal Gabechava – Hydrogeology
Vakhtang Gvakharia - Land Baseline Contamination Study (Laboratory Analysis)
Shalva Jaoshvili - Hydrology, Sedimentology
Tengiz Lazarishvili – Hydrogeology
Temuri Mdinaradze - Geo-engineering; Hydro-engineering
Merab Tvalchrelidze - Geo-morphology;
Kote Zarandia – Soils
Andrei S. Kandaurov – Ecology and Zoology

Mr. Z Gurielidze acted as a resource person to the working group during the preparation of the guidelines.

Technical secretary:

Mr. A.J.Kolhoff – Technical Secretary

APPENDIX 3
Legislative framework

Legislation and protection of the sensitive areas

According to the degree of Georgian Cabinet of Ministers, auxiliary activities of formation of the protected territory systems were defined and on March 7th 1996, the Georgian Parliament declared the Law on Protected Territories (Protected Area System). Up till now, 22 areas are protected and united in 20 nature reserves (www.parliament.ge). This is an area of in total 307 246 ha (4.4% of the territory of the country). In addition so called protected forest categories protected under the Forest Code of Georgia amount to 1.113.130 ha (which is almost 15.9 percent of Georgia's territory). The reserves are defined to protect several relict and endemic species. Since the Borjomi area is one of the territories, the question is how this intention of protection is effectuated.

Since Dutch standards were agreed to be used as a reference in the qualification of the ESIAs, a brief explanation of the Dutch / European Union (EU) approach will be given below.

The European countries are united in the EU and most of the environmental legislation is based on formally agreed EU directives. Countries have the obligation to implement these directives in their national legislation as a minimum standard, but are free to adopt more stringent rules. The basis for the protection of natural values is laid down in three directives: Impact Assessment Directive (85/337/EEC and additional EC/97/11), the Bird Directive (79/409/EEC) and the Habitat Directive (92/43/EC). The latter is also enforcing an international and interconnected network of ecological sensitive areas (article 6 (4): NATURA2000). The EC Directives give protection to both species and habitats. The following is determined: "where the site concerned hosts a priority natural habitat type and/or species, the only consideration s that may be raised are those relating to human health and safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the (EC) Commission, to other imperative reasons of overriding public interest".

As a consequence, activities with a negative impact are not allowed in such areas unless it is proven that there is no alternative. This also applies to activities outside the designated areas, but with an impact on values under protection (extended regime). In addition, it was decided in recent jurisdiction that in such cases compensation is required of the natural values on a local scale and prior to the activity.

Both directives have been implemented in the Dutch nature conservancy legislation ("Natuurbeschermingswet" and "Flora en Fauna wet"). The extended regime also applies to the Dutch situation and was enforced based on protest to the Dutch Supreme Court in 1994 because of a potential negative impact on a national reserve due to an impact on the groundwater outside the reserve. The situation around Borjomi is very simular.

Several of the areas crossed by the pipeline transect and the species impacted would be qualified under the Bird and Habitat Directives in case Georgia would have been a member state.

In addition, it is worth mentioning that the Dutch Commission for Impact Assessment made a field visit to the Borjomi National Park buffer zone and based on its own observations, fully supports its recognition as an area of ecological importance. The rules are in line with the Dutch and European requirements, apart from the compensation principle.

Legislation on water protection

Groundwater resources in Georgia are protected under "the Law on Sanitary Protection Zones of Resorts and Resort Areas". This legislation forms the basic framework. It states clearly that any activity is prohibited if the available mineral resources are endangered. However, in cases of overriding interest, the government of Georgia is the dispensing authority, but only if the Government is fully compensated. In the case of the Borjomi groundwater reserves, this means the total value of the reserves and loss of income. According to the management the Borjomi mineral waters, the future of the 1500 employees is at stake.

This law is effectuated by way of amendments, in this case the "Law regarding zones and resorts". The Borjomi area is protected under this law by a declaration entitled "Resort Borjomi sanitary protection zones: project. Volume III; graphical annex (Tbilisi, 2000). The protection zones are indicated on a map, but the motivation is unclear. According to this declaration, the pipeline transect crosses Protection area 3 and the northern part of the10 km zone also crosses the even more stringent Protection area 2. Following the law, activities can only be permitted if damage to the mineral resource can be excluded (chapter 5, paragraph 38). In case no viable alternatives exist, dispensation is required from government under the conditions of a financial deposit in the order of the value of the resource and if an impact can be excluded (paragraph 39a-b).

The EC Water management Directive was recently agreed and is presently in the process of being implemented. In the Netherlands, the right to clean drinking water has two approaches: the definition of drinking water criteria and the protection of groundwater infiltration and extraction areas, the so-called "Grondwaterbeschermingsgebieden". Until 1994, all potential polluting activities were simply forbidden in such areas. Since the revision of the Dutch EIA legislation, these areas are qualified as highly sensitive. The principle to be followed thereafter is that activities are not allowed unless all alternatives have been explored to be non existent. In many cases, the groundwater protection areas also have a high ecological value and are also protected nature reserves.

In this light, it is important to see how this compares with the national Georgian legislation and policy and how this is dealt with in the EIA.

With respect to groundwater protection, the legislation is comparable to the Dutch situation as well. Unfortunately, information on the protective regime is missing from the EIA. Because of the essential nature of the information, the Commission will herewith provide a summary of their findings and urges that this will be completed as soon as possible.

APPENDIX 4

Risk assessment – examples

Example 1: Criteria for the risk of groundwater contamination depend on the situation and should be developed circumstantial. In the case of, for example Borjomi, the groundwater has a significant social and economic value. The groundwater also supports the ecosystem and probably enters the river. In this situation it can be argued that the risk should be zero. In practical terms this means that the change, where groundwater deposits become contaminated in a significant way should be less then a factor once in the 2.500 -10.000 years. This is comparable to the accepted risk of a major dike break in the Netherlands and based on Dutch law, the so-called Deltawet. The difference in acceptance is based on economic criteria (highly developed industrial south or lesser developed Wadden Sea islands). The Commission is of the opinion that the situation with possible occurrence of once every 2.500 years is comparable with the situation in Borjomi.

Example 2: If landslides are a major cause of pipe breaks and if the frequency of significant (in terms of mass capable of breaking a pipeline) landslides in the area is higher then once every 2.500 years, additional measures will be needed in case the pipeline will be used for oil or chemicals. It is worth mentioning that, where gas is concerned, no extra measures will be needed, because gas will escape into the atmosphere (assuming a low level of condensate). It is also remarked that the boulders contain a thick layer of clay deposits and are expected to be impermeable for oil. Measures to reduce the risk of contaminating ground water deposits may be technical (extra valves, geo-textiles, increased wall thickness of the pipeline section) or operational (increased inspection), or conditional (if the free span of the pipeline is above a critical length, the line should be closed in; or oil should be removed within a certain time).

Appendix 5

Review of Studies on Vulnerability of the Borjomi Groundwater Resources on Oil Spill Pollution from BTC Pipeline in Georgia

Table of Contents

Annexes

1. Introduction

In Georgia, the Environmental and Social Impacts Assessment Study (ESIA) on the pipeline project was completed in September 2002. The draft ESIA report is made public for disclosure and consultation (ESIA, Georgia, draft for disclosure, 2002). The Georgia Glass and Mineral Water Company (GGMWC) raises serious concerns on the impacts on their Borjomi mineral groundwater resources from an oil spillage of the BTC pipeline. BP hired a consultant hydrogeologist to assess the vulnerability (Lloyd, 2002) and concluded that the Borjomi mineral groundwater is not vulnerable from an oil spillage of the BTC pipeline. However, reconnaissance study commissioned by GGMWC (EMTS and CSD Azur, 2002) concluded that there are risks of oil spill pollution of the mineral groundwater. Local hydrogeologists in Georgia (ASG, 2002) also voice various concerns.

In view of the above conflict conclusions on the impact on the Borjomi mineral groundwater resource, the Commission invites two hydrogeologists (Dr Dick Hemker, Free University of Amsterdam and Dr Yangxiao Zhou, UNESCO-IHE Institute for Water Education, Delft) to assess the different studies with the aim to get a clear view of the differences and similarities between these studies. The results of this comparative study will be used to facilitate the discussion with the different stakeholders in Georgia. Secondly, the results of the comparative study will be used as input in the final advisory review to be prepared by the Commission.

2. Objectives and approaches of the comparative study

Objectives of the comparative study are:

- to identify the differences and similarities of the conclusions
- to compare the impact analysis in the different conclusions

A two-step approach was followed.

In the first step a desk study was executed. The study concentrated on the review and analysis of the following reports:

- Lloyd, J.W., 2002, Review of Hydrogeology Pertinent to the River Borjomola Catachments and Gujaretis Tskali Catchments KP175 – KP 192
- EMTS and CSD Azur, 2002, Reconnaissance Mission Concerning the Risks of Pollution to the Borjomi Groundwater Sources related to the Construction of the BTC pipeline
- Scientific Commission of the President of Georgia at Academic Sciences of Georgia, 2002, Assessments and Recommendations in Relation with the Project of Environmental Impact Assessment Documents of TBC Crude Oil Pipeline Project and South Caucasian Pipeline project

The relevant chapters of the ESIA report were also consulted for background information.

In the second step Dr Zhou joined the working group of the Commission during the visit to Georgia in the period 5 -14 November 2002. The objectives of the visit are to appreciate actual hydrogeological conditions of the area, to ascertain views and opinions expressed by different parties and to verify some important assumptions. The main activities are:

- Meeting of Georgian Hydrogeologists (Annex I)
- Meeting of GGMWC Hydrogeologists

- Discussion of findings with BP hydrogeologist through E-conferencing
- Collection of data of GGMWC production wells (Annex II)
- Field visit of production sites, river valley and Daba spring

The results of the comparative review are presented in Section 3 to 5. Findings of the visit are described in Section 6. Finally in Section 7 conclusions are draw and recommendations are given.

3. Summary of similarities and differences of conclusions

BP consultant (Lloyd, 2002) carried out an intensive review of hydrogeology of the area concerned and analysed vulnerability of different hydrogeological systems to possible oil spill pollution. Conclusions are based on the hydrogeological hypothesis, some measured data, field observations of hydrogeological phenomena, and discussions with some Georgian hydrogeologists.

GGMWC consultant (EMTS and CSD Azur, 2002) carried out a reconnaissance mission. It reviewed the ESIA report and hold discussions with parties concerned (GGMWC, BP, and Georgia hydrogeologists). Their conclusions are based mainly on local knowledge of Georgian hydrogeologists, questioning of hypothesis made by BP consultant and similar experiences in France.

Scientific Commission of the President of Georgia at Academy of Sciences of Georgia reviewed the ESIA report and report made by BP consultant. The following experts raised concerns of impacts on groundwater:
Mr Vakhtang Gvakharia, head of department, Georgia Academy of Ecological Sciences
Mr Tegiz Lazarishvili, Hydrogeologist, Georgian Department of Geology
Mr Jemal Gabechava, Hydrogeologist, Director, Zenith Gamma Consulting

Conclusions of these three parties are presented in Table 1.

Table 1 Conclusions of impacts of an oil spill of BTC pipeline in the Borjomi-Bakuriani area

Impacts of an oil spill on	BP consultant	GGMWC consultant	Experts at ASG
Water courses beyond KP192	Not analysed	Vulnerable	Vulnerable
Gujaretis Tskali River	Not vulnerable	No clear statement	No clear statement
Borjomula River	Vulnerable	Vulnerable	Vulnerable
Mtkvari River	No clear statement	Vulnerable	Vulnerable
River valley alluvium	Vulnerable	Vulnerable	Vulnerable
Groundwater in Volcano-clastic formation	Vulnerable, but contaminant travel times would be sufficiently slow to permit effective remediation	Vulnerable, difficult for effective remediation in fractured aquifer	No clear statement
Mineral groundwater in Cretaceous limestone	Not vulnerable, mineral groundwater is under artesian condition and discharges to rivers	Vulnerable, polluted river water may mix mineral groundwater	Vulnerable, polluted river water may mix mineral groundwater

Groundwater in Quaternary lava	Not vulnerable, groundwater discharges to rivers and springs	Vulnerable, polluted river water may enter to Lava	Vulnerable, polluted river water may enter to Lava

In conclusions:

- All parties agree on potential impacts of oil spill on Borjomula River and river valley alluvium. Drink water supply using these river water and/or groundwater in river alluvium is vulnerable to oil spill pollution.
- Parties disagree on potential impacts of oil spill on Borjomi mineral groundwater. BP consultant concluded no vulnerability, GGMWC consultant stated polluted river water may mix deep mineral groundwater through cracks and faults and there is not enough hydrogeological information to determine its sensitivity. Georgian hydrogeologists stated that Cretaceous limestone is very near to surface at confluence of Borjomula and Mtkvari rivers and is sensitive to pollution, especially when GGWMC production wells switch to pumping.
- Parties also disagree on potential impacts of oil spill on Quaternary lava feeding Sadgeri and Daba springs. BP consultant concluded no vulnerability; GGMWC consultant stated that Daba spring is more vulnerable on oil spill pollution. Georgian hydrogeologists raised concerns on potential impacts and recommended further study.
- GGMWC consultant concerns that the Mtkvari River could be possibly polluted from the oil spill beyond KP192. BP consultant didn't analyse this possibility.

4. Comparison of impact analysis on the Borjomi mineral groundwater

The Borjomi mineral groundwater is exploited from artesian wells intercepting groundwater from the Cretaceous limestone formation. The preferred BTC pipeline crosses the south of the area where this formation is buried underneath the Volcano-clastic and Flysch formations. In the confluence area of Borjomula and Mtkvari rivers, the Cretaceous limestone is only a few meters beneath Flysch. Therefore, there is no direct pathway of pollution from oil spill. The possible indirect pathways are:

- Spill into surface water courses and arrive at the confluence area of Borjomula and Mtkvari rivers and subsequently entry into mineral groundwater through cracks and faults
- Spill into Volcano-clastic formation and subsequently entry into mineral water source through faults and cracks

Impact analysis by three parties is summarised in Table 2.

Analysis of possible pathway of the confluence area of the Borjomula and Mtkvari Rivers:

- BP consultant considers the Mtkvari River as the regional groundwater drainage base so that groundwater discharges (upward flow) into the rivers. Therefore, polluted river water can't entry into Borjomi mineral groundwater. Regional distribution of the Cretaceous limestone formation, Spring waters in the vicinity of Borjomi and measured groundwater heads in the GGMWC wells were used to support this hypothesis.
- GGMWC consultant argues that the density difference between the shallow cold water and the deep hot water may cause the downward flow. In this case, the polluted shallow water could flow downward mixing with the mineral groundwater.
- Georgian hydrogeologists raise concerns that when GGMWC artesian wells switch to pumping, groundwater level may drop below the river level so that polluted Borjomula and Mtkvari river water may entry into mineral groundwater since

Cretaceous limestone is very near to surface at the confluence area of the Borjomula and Mtkvari rivers.

Analysis of possible pathway of the Volcano-clastic and Flysch formation:

- BP consultant assumes that mineral groundwater in the Cretaceous limestone formation leaks upward into Volcano-clastic formation in Tsikisjvari and Bakuriani area. On the other hand, contaminant travel times would be sufficiently slow to permit effective remediation.
- GGMWC consultant argues that the Bakuriani area also is a possible recharge area of Cretaceous limestone aquifer. The transport of pollutant in fractured rocks is very complex so that it is difficult for a remedy measure.
- Georgian hydrogeologists raise questions that the function of geological faults is not analysed.

Table 2 Comparison of impact analysis on the Borjomi mineral groundwater

Possible pathways		**BP consultant**	**GGMWC consultant**	**Experts at ASG**
Confluence area of the Borjomula and Mtkvari Rivers	Conclusion	No pathway	Pathway	Pathway
	Arguments	Cretaceous groundwater discharges (upward flow) to Mtkvari River at Borjomi, no possibility of polluted river water flows downward mixing with mineral water	Downward flow of shallow water or river water to mix with deep mineral water since 1, shallow cold water with higher density could flow downward to deep hotter water with lower density 2, groundwater head in wells could be lower than Borjomula river level	When GGMWC artesian wells switch to pumping, groundwater level may drop so that polluted Mtkvari river may entry into mineral water
	Evidences	1, Spring waters at Borjomi: high Temperature, high TDS and abnormal CO_2 indicating deep groundwater discharge 2, GGMWC flowing wells have artesian condition, the deeper the well, the higher groundwater head, indicating upward groundwater flow 3, Groundwater heads in Cretaceous limestone are higher than Mtkvari river level	1, states no sufficient information to be sure that there is no deep mixing zone of deep mineral water with surface or shallow water 2, questions artesian conditions of the Cretaceous limestone aquifer 3, When Well No 41 is not restricted, water level in Well No 1 decreases	1, When Well No 41 is not restricted, water level in Well No 1 decreases 2, Outcrops of Cretaceous limestone are found at Mtkvari river gorge
Volcano-clastic and Flysch formation	Conclusion	No pathway	Pathway	Possible

	Arguments	Cretaceous groundwater leaks upward into Volcano-clastic formation. The contaminant travel times would be sufficiently slow to permit effective remediation.	Oil spill could reach the deep mineral water through cracks near the leak location. The transport of pollutant in fractured rocks is complex, difficult for effective remediation.	Hydrogeological roles of faults are not analysed.
	Evidences	Higher heads of thermal springs in Tsikisjvari and in boreholes at Bakuriani	Bakuriani area could be the recharge area of the deep mineral water	Geological map

5. Comparison of impact analysis on the Daba spring water

The Daba spring water discharges from the Quaternary lava unconfined system. The possible pathways are:

- Spill into lava formation and subsequently entry into spring water source through faults and cracks
- Spill into surface water courses (Gujaretis Tskali River and Borjomula River) and subsequently entry into spring water source

Impact analysis by three parties is summarised in Table 3.

Table 3 Comparison of impact analysis on the Daba spring water

Possible pathways		**BP consultant**	**GGMWC consultant**	**Experts at ASG**
Direct pollution of oil spill	Conclusion	No pathway	No clear statement	Pathway
	Arguments	Daba spring is in the Gujaretis Tskali River catachment and the BTC pipeline doesn't cross this catchment	-	Recharge area of Quaternary lava is located in the north of the pipeline. Groundwater flows towards Borjomi and discharges to Sadgeri spring and Daba spring
	Evidences	Topographical map	-	Geological map
Gujaretis Tskali River	Conclusion	No pathway	No clear statement	No clear statement
	Arguments	BTC pipeline doesn't cross the catchment of Gujaretis Tskali River	-	-
	Evidences	Topographical map	-	-

Borjomula River	Conclusion	No pathway	Pathway	Pathway
	Arguments	A groundwater divide exists forcing groundwater in Quaternary lava discharges to Borjomula River and Gujaretis Tskali River. Daba spring is in the Gujaretis Tskali River catachment, so Borjomula River can't flow to Daba spring	1, In the upper area where rivers cross the lava, polluted river water transports through cracks of lava to Daba spring 2, In the lower river valley where river level is higher than the old valley basement	1, Groundwater is concentrated in paleogorge stream 2, groundwater table in paleogorge stream may be lower than river level near village Sakochavi
	Evidences	Topographical map Estimate of groundwater recharge	Geophysical survey	Geology and Geophysical survey

In summary:

- BP consultant argues that the Daba spring is located in the Gujaretis Tskali River catachment and the BTC pipeline doesn't cross this catchment. A groundwater divide exists between the two river catchments, forcing groundwater in Quaternary lava discharges to Borjomula River and Gujaretis Tskali River. Therefore, Borjomula River water can't flow cross the water divide to Daba spring.
- GGMWC consultant argues that water level in rivers could be higher than Daba spring so that polluted river water can flow through cracks into Daba spring.
- Georgian hydrogeologists are critical to the simple hypothesis model used by BP consultant, which is based on assumptions of homogeneous and isotropic media and sufficient groundwater recharge. They argue that Quaternary lava is heterogeneous and anisotropic. Groundwater recharge may not be sufficient to maintain a water divide. Furthermore, geophysical survey reviewed that groundwater may be concentrated in paleogorge stream where water table may be lower than the river level. Therefore, polluted Borjomula river water may entry into groundwater and poses risks of springs.

6. Findings of visits to Georgia

Meeting of Georgian hydrogeologists

The detailed minutes of meeting are included in Annex I. Georgian hydrogeologists are not convinced by the report of BP consultant that there is no risk of oil spill pollution to groundwater in Quaternary lava and mineral groundwater in Cretaceous limestone. They believe there are high risks of pollution of lava groundwater and possible risk of pollution of mineral groundwater. They recommended that in the first place the pipeline should not cross the Borjomi area and should follow an alternative route south of the Borjomi area. In case of the pipeline crossing the Borjomi area, the engineering design should guarantee the zero risk of oil spill.

Meeting of GGMWC

Both the vice president of GGMWC and managing director of Borjomi mineral water stressed that the fact of the oil pipeline crossing the Borjomi area itself will pose problems of brand image, consumer confidence and promotion for exports of Borjomi mineral water. Irrespective to risks of potential pollution, any accident of oil spill in Borjomi area will be disastrous to consumer confidence, resulting in market claps which will be the end of Borjomi mineral water company.

Field visit of Borjomi mineral water production site

There are in total 9 mineral water production wells located in the Mtkvari River valley (Annex II). All production wells are artesian flowing and are not pumped. The total combined capacity is around 540 m^3/day. The central wells (No. 1, 21, 21e and 41) are shallow (raging from 18 to 200 m) and wells in Likani (No. 59 and 54) and Vashlovani (No.25, 37 and 38) are very deep (ranging from 700 to 1500 m).

Central wells are located on the axis of the anticline. Well No. 21 is located in the middle of Borjomula river. It is only 18 m deep and it reaches the Cretaceous limestone 5 m from the riverbed consisting of Flysch. The Total Dissolved Solids (TDS) is around 5.8 g/l and temperature is only 16 ^{0}C Groundwater head is 1.2 m above the river level. Close to well No 21 is the Well No. 1 locating at right bank of the Borjomula river. It was originally a mineral water spring and in 1958 a well (194 m deep) was drilled at spring outlet to increase the production. The TDS is around 5.7 g/l and temperature is 31 ^{0}C. Groundwater head is 3 m above the ground. Well 41 is 140 m deep and very productive (130 m^3/day). The TDS is around 5.6 g/l and temperature is 37 ^{0}C.

Wells in Likani and Vashlovani are deep and probably located in synclines. The TDS is around 6 g/l and temperature is varies from 31 to 41 ^{0}C.

The Cretaceous limestone is highly heterogeneous and anisotropic. Groundwater flow is mainly controlled by geological structures (anticline, synclines and faults). Around 100 exploration wells were drilled in the area. Only 9 wells yield sufficient water becoming production wells, another 11 with low yield are used as observation wells, majority (80) wells were found dry.

It is very interesting to notice that mineral groundwater is of type Na-HCO_3 and combined Na and HCO_3 concentrations account for 90% of TDS. Both Cl and Ca concentrations are very low.

The TDS doesn't clearly decrease with the decrease of well depth and is fairly constant in time, indicating possibly no mixing of deep mineral groundwater with shallow fresh water. Isotope analysis in 1983 found almost no tritium in Well 1, 25, and 54 while water in Lomi mountain (recharge area) contains 60 TU, indicating also no mixing.

The temperature decreases with decrease of well depth indicating that the deep hot groundwater is cooling down when flowing upward to the surface. Therefore, the measured temperature of water from wells doesn't represent actual temperature of groundwater in the aquifer.

It is very important to maintain the current way of production with artesian flowing. When production wells switch to pumping in order to increase production rate, groundwater heads will decrease. Lowering groundwater heads than river level will definitely increase risks of river water infiltrating into mineral groundwater, especially for Well No. 21.

7. Conclusions and recommendations

The following important water resources are present in the Borjomi area:

- Surface water rivers (Guraretis Tskali River, Borjomula River and Mtkvari River);
- Groundwater in the river valley alluvium which are used for drinking water supply by local villages;
- Groundwater springs (Sadgeri and Daba) discharged from the Quaternary lava are used both by Borjomi for drinking water supply and by the GGMWC for the bottled water;
- Groundwater in the Cretaceous limestone formation is used by the GGWMC for the bottled mineral water;
- Groundwater in the Volcano-clastic formation (the use of the water is not clear).

Taking into considerations of views and arguments from all parties and preliminary analysis of collected data, conclusions are draw and recommendations are given as following:

- Surface water rivers (Borjomula River and Mtkvari River) are vulnerable to pollution; even with the clean-up measure, dissolved hydrocarbons could be transported into Borjomula river and eventually arrive at Mtkvari River, which will have impacts on riparian ecosystems.

Recommendation
An emergence clean-up plan should be stand-by.

- *Groundwater in the river valley alluvium is vulnerable to the pollution once the river is polluted; even with the clean-up measure, dissolved hydrocarbons will be transported into groundwater.*

Recommendation
Alternative water sources should be found for drinking water supply to local communities.

· *There are no sufficient hydrogeological information to assess the vulnerability of groundwater springs (Sadgeri and Daba) discharged from the Quaternary lava. All parties hypothesised groundwater flow system and few data were used.*

Recommendation
Further hydrogeological investigation is required to make better assessment;

· *Under the present production method with artesian flowing, Borjomi mineral groundwater in the Cretaceous limestone is not vulnerable to pollution. A potential risk exists when production wells switch to pumping.*

Recommendation
It is strongly recommended the present artesian flowing production method is maintained.

- *Groundwater in the Volcano-clastic formation is vulnerable to pollution of oil spill. The transport of oil in fractured networks is very complex and it is very difficult to implement effective remedy measures.*

Recommendation
The installation of a detection monitoring network is very important to monitoring the spreading of oil in groundwater.

Annex I

Minutes of meetings with Georgian Experts Group I: Geology, Geohazards and Hydrogeology (minutes are not approved)

13 November 2002: 15:00 – 18:00 hours
Place: Georgian Ministry of Environment
Georgian experts:

- Mr Guram Buachidze, Hydrogeologist, Institute of Hydrogeology and Engineering Geology
- Mr Tegiz Lazarishvili, Hydrogeologist, Georgian Department of Geology
- Mr Jemal Gabechava, Hydrogeologist, Director, Zenith Gamma Consulting
- Mr Temeuri Mdinaradze, Geological Engineer, Georgian Water Project Design Institute
- Mr Merab Tralchrelidze, Geomorphology, Geological Institute

Main issues of concerns by Georgian experts

1 Kumysi Lake area

This is a saltwater lake. Geological deposits in the surrounding area are lake deposits with high content of salt. In geological history, salt in the deposits has being flushed by groundwater discharging into the Kumysi Lake. This process has caused surface collapses with depression hole of diameter of around 4-5 m. This geohazard may pose risk of oil pipeline. Special engineering measure is required to safeguard the pipeline. However, BP considers no risk.

2 Bendani mountain area

Groundwater in Quaternary lava is wide present, is used by local people for drinking water and has potential for drinking water supply to Tbilisi. The risk of oil spill pollution of this groundwater resource is not assessed in the ESIA report.

3 Tsalka reservoir

This is a large fresh water reservoir with good quality. The water is used for local drinking water supply and may also for Tbilisi in Future. The oil pipeline crosses the north bank of the reservoir posing high risk of oil spill pollution to the reservoir. To reduce the risk, the pipeline should keep distance of at least 2 km north of the reservoir.

4 Borjomi area

The oil pipeline cross the Borjomi nature reserve. According to the existing Georgian Law, the oil pipeline is not allowed to cross this protected area. Furthermore, oil spill poses high risks of pollution of Borjomula river, Quaternary lava aquifer and possibly Borjomi mineral groundwater. Borjomi mineral water has important social and economical values.

Experts disagree with conclusions of Prof. Lloyd that there are no risks of oil spill pollution of Daba Spring and deep mineral groundwater. They argue that hypothesis model of Quaternary lava aquifer is too simple and doesn't consider geological structures causing heterogeneity and anisotropy of lava flow and paleo river valley alluvium. Geophysical survey at village Sakochavi indicating possibility that Borjomula river can infiltrate to paleo river alluvium which flows possibly to Daba spring.

They showed a east-west hydrogeological cross-section along the axis of the anticline through the Borjomi mineral groundwater production wells. The cretaceous limestone is

very near to surface near observation well 128. From the contour maps of groundwater heads and TDS of Borjomi production wells they believe there is possible mixing of deep mineral water with shallow water.

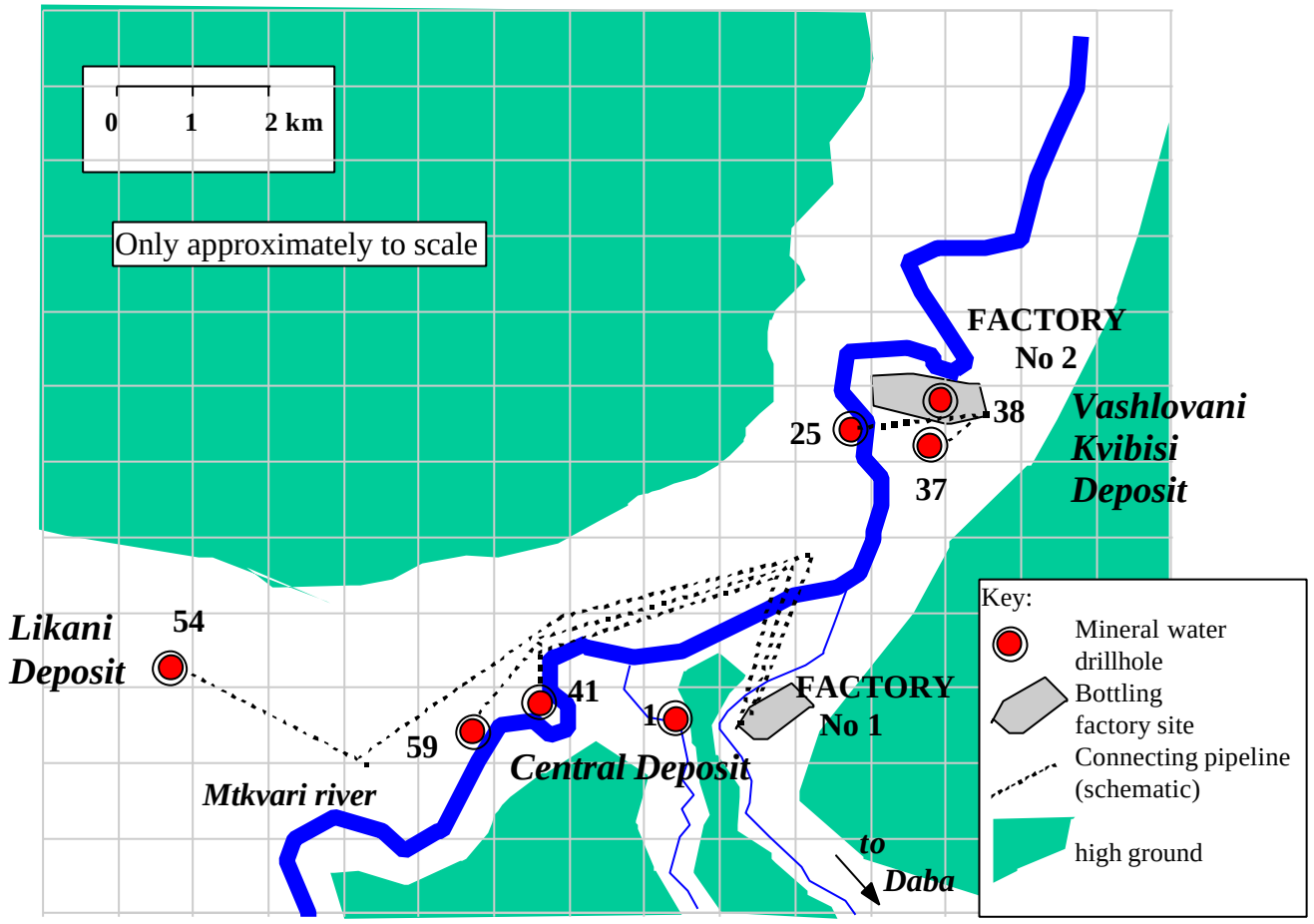
All experts suggest that in the first place the pipeline should not pass through the Borjomi area. In their opinion, an alternative route south of the Borjomi area is a better route. BP didn't choose this route due to security reason. Georgian experts found security is not a problem in the area. They have been working there many years and never had security problem.

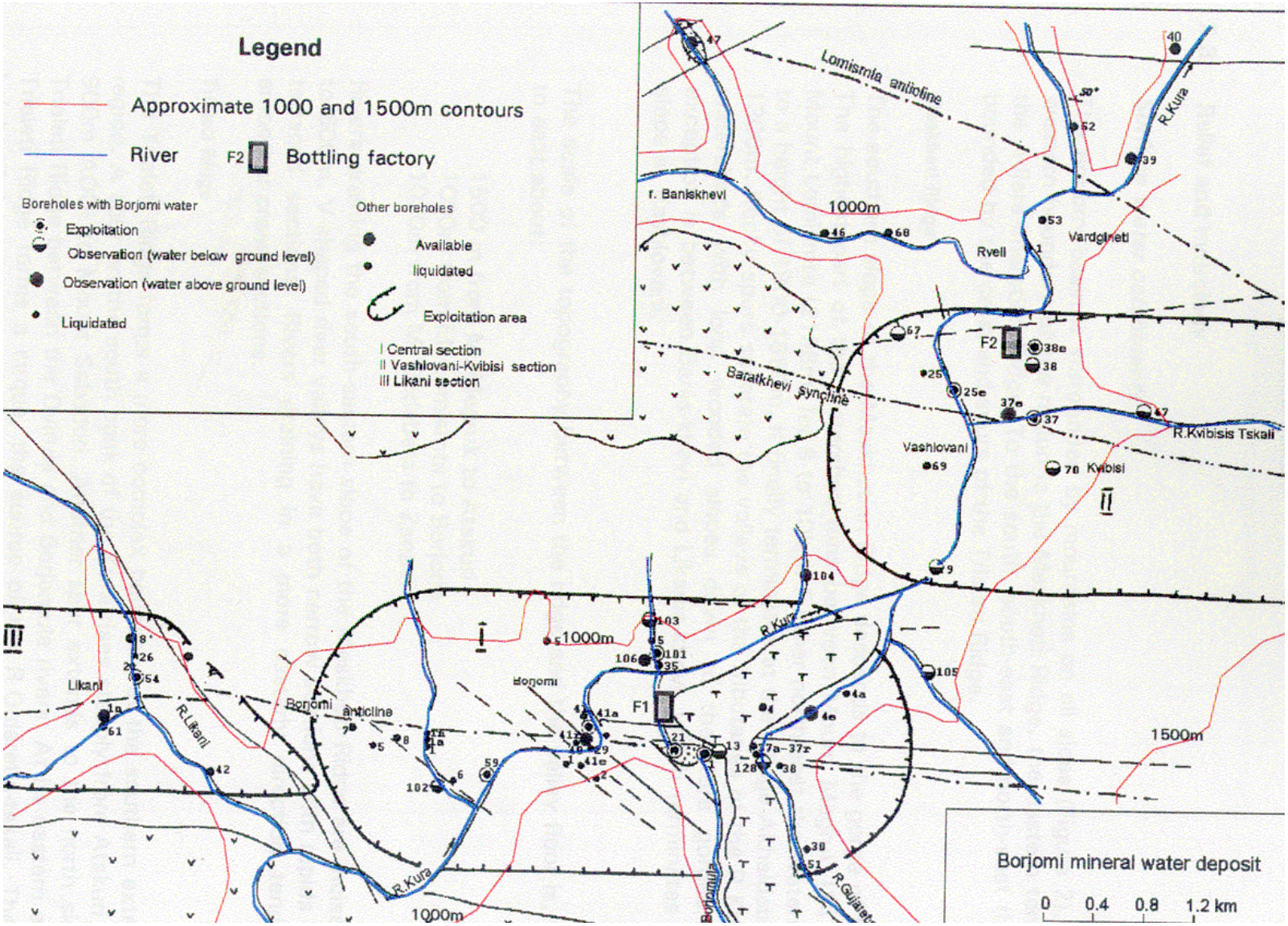
If the preferred route is chosen, the engineering design should guarantee the zero risk of oil spill.

5 Kodiana area (KP 189 to 192)

The area is prone to landslides. Several old landslides are found along three kilometer long ROW. Mr Mdinaradze visited the site together with BP experts. BP has investigated one landslide by drilling borehole of 4 m deep. The experts think the sliding mass may be more than 20 m thick. The drilled borehole is too shallow. BP has not yet provided the engineering solution.

Annex II
Data on Borjomi mineral water production wells




Legend
Approximate 1000 and 1500m contours
River
F2
Bottling factory
Boreholes with Borjomi water
Exploitation
Observation (water below ground level)
Observation (water above ground level)
Liquidated
Other boreholes
Available
liquidated
Exploitation area
I Central section
II Vashlovani-Kvibisi section
III Likani section
Lomismta anticline
r. Banikhevi
1000m
Rveli
Vardgineti
R.Kura
Baratkhevi syncline
F2
Vashlovani
Kvibisi
R.Kvibisis Tskali
II
III
Likani
R.Likanis
Borjomi
anticline
F1
1500m
R.Kura
Borjomula
R.Gularetis
Borjomi mineral water deposit
0 0.4 0.8 1.2 km

Georgian Glass Mineral Water Company

Total production wells	9
Daily production	539 m3/day
Observation wells	11

Well information					Groundwater head			
Well No	Location	Production layer	Production method	Production rate m3/day	Surface elevation m	Depth of well m	Elevation of observation m	Measured presure Pa
54	likani	Cretaceous limestone	Flowing	77	910	1400	911	0
59	likani	Cretaceous limestone	Flowing	29	793	700	794	1.1
41	Central	Cretaceous limestone	Flowing	130	789	140	791	2.2
1	Central	Cretaceous limestone	Flowing	20	807	194	807.9	0.3
21	Central	Cretaceous limestone	Flowing	6	798	18	799.2	0
21e	Central	Cretaceous limestone	Flowing	1	792	104	792.3	0
25	vashlovani	Cretaceous limestone	Flowing	110	770	1500	771.4	0.4
38	vashlovani	Cretaceous limestone	Flowing	108	789	1500	789.8	0
37	vashlovani	Cretaceous limestone	Flowing	62	797	1342	798.2	0

Well information		Groundwater chemistry (13/03/2002)					
Well No	Location	TDS g/l	Cl mg/l	Na mg/l	Ca mg/l	HCO3 mg/l	Temperature C
54	likani	5.429	267	1085	135	3770	37
59	likani	6.438	526	1465	93	4221	34
41	Central	5.579	377	1305	80	3697	37
1	Central	5.66	400	1290	91	3770	31
21	Central	5.838	275	1442	140	3904	16
21e	Central	6.496	345	1567	150	4319	15
25	vashlovani	6.749	414	1723	30	4502	41
38	vashlovani	5.199	306	1265	25	3526	35
37	vashlovani	6.801	467	1683	34	4526	31

Isotope data	1983		
Location	Deutium	Oxygen 18	Tritium
Well 1	-112	-17.7	2 +/- 2
Well 25	-118	-12.6	0 +/- 2
Well 54	-106	-20.2	5 +/- 2
Sadgari spring	-98	-10.9	27 +/- 2
Lomi mountain	-99	-11	60 +/- 2

Appendix 6

4 Programme of the visit to Georgia 6-14 November 2002

Wednesday 6 November	11.00 hours	Expert meeting on ecology: 1. Themur Kokosadze; biologist - Ministry of environment 2. Alexander Bukhnikashvili; biologist - Ministry of environment 3. Ramaz Gokhelashvili; biologist - Georgian Center for the Conservation of Wildlife
	15.00 hours	Expert meeting on geology / geo-hydrology: 1. Themur Mdinaradze; geologist - USAID 2. Merab Tvalchrelidze; geologist - USAID 3. Gemal Gabechava; geologist - USAID 4. Thengiz Lazarashvili; geologist - USAID 5. Nino Basilashvili; Department of ecological expertise 6. Levan Bagdavadze; Borjomi Mineral Waters Company - Vice-President 7. Guram Buachidze; geologist – GIOC 8. Dimitri Oniani; geologist - Ministry of environment 9. Patty Miller; IFC
	18.00 hours	Expert meeting on social issues: 1. Guram Thevzadze; sociologist – Academy of Science 2. Rezo Jorbenadze; psychologist - Tbilisi State University 3. Leo Chikava; Director of Institute of Demography 4. Nana Sumbadze; psychologist, Institute for policy studies 5. George Khutsishvili; Director of International Center on Conflict and Negotiation 6. Iago Kachkachishvili; sociologist - Tbilisi State University 7. Maya Batiashvili; Manager GIOC
	20.00 hours	Visit to the Minister of Environment
Thursday 7 November	09.00 hours	Expert meeting on soil and water: 1. Vakhtang Gvakharia; Zenith Gamma Consulting 2. Kothe Zarandia; Land department - soil protection division 3. Nodar Begalishvili; Director of Institute of Hydrometeorology 4. Nugzar Buachidze; Institute of Hydrometeorology

		5. Jeffrey Jeter; EBRD
	13.00 hours	Meeting with panel of experts of the Minister of Environment
	14.00 hours	Meeting at National security council: 1. Tedo Japaridze;– National security advisor 2. Giorgi Chanturia; President of GIOC 3. Nini Chkobadze; Minister of Environment
	15.00 hours	Meeting at USA Embassy; Nicholas Dean – first secretary
Friday **8 November**	10.oo hours	NGO meeting: 1. Nino Gujaradze; CEE Bankwatch Network - national co-ordinator 2. Keti Dgebuardze; ECA NGO working group on the WB executive secretary 3. Kety Gujaridze; Association Green Alternative - social monitoring project co-ordinator 4. Manana Kochladze; CEE Bankwatch Network - regional co-ordinator for the Caucasus 5. Nana Jainashia; CENN Caucasus Environmental NGO Network 6. Nino Tevadze; CENN - country co-ordinator 7. Jeff Jeter; EBRD 8. Patty Miller; IFC 9. Nino Nadiradze; PA Consulting 10. Metgar Tchelidze; GIOC 11. Archil Magalashvili; GIOC 12. Zurab Shurgaia; GIOC 13. Maia Batiashvili; GIOC 14. Zaza Mebanidze; GIOC 15. Nino Basilashvili; Ministry of Environment 16. Khatuna Gogaladze; Ministry of Environment 17. Givi Kalandadze; Ministry of Environment
	11.00 hours	Experts of the Academy of Science meeting at GIOC 1. Giorgi Chanturia; President of GIOC 2. Claudio Belingieri; Head Environmental advisor team 3. Ruud Platenburg; Member EA-team 4. Erekle Gamkrelidze, Academy of Science 5. Shota Adamia, Academy of Science 6. Guram Buachidze, GIOC 7. Gia Nakhutsrishvili, Academy of Science 8. Theimuraz Gocnbhitashvili, Academy of Science 9. Nana Sumbadze, Institute for policy studies 10. Iago Kachkachishvili, Tbilisi State University 11. Guram Thevzadze, Acad. of Science
	14.00 hours	Meeting with Environmental Advisor team at GIOC

	15.00 hours	Meeting with Nicholas Dean – first Secretary of the USA Embassy
	16.30 hours	Meeting with Environmental advisor team and Minister of Environment
	18.00 hours	Meeting with BP
	20.00 hours	Meeting with Green Alternative
Saturday 9 November	09.30 hours	Meeting with Environmental advisor team and Minister of Environment
	16.30 hours	Meeting GIOC
Sunday 10 November		Field visit to Central corridor (Akhalkalaki district) and Karakia corridor
Monday 11 November		Drafting of the advice
	17.00 hours	Meeting with BP geo-hydrologists
Tuesday 12 November	12.00 hours	Meeting with PA consulting
	14.00 hours	Meeting with Mr Molenaar – Netherlands Ambassador
	20.00 hours	Dinner with Country representative of the World Bank and Mr Molenaar
Wednesday 13 November	09.30 hours	Meeting with deputy State Minister Mamuk Nikolaishvili
	12.00 hours	Meeting at the Academy of Science: 1. Alexouder Tavkhelidze 2. Givi Sanadze 3. Leo Chikava 4. Guram Buachidze 5. Gurem Tevzadze 6. Guram Gamkrelidze 7. George Nakhutsrishvili 8. Mr. Mirtskhvlava 9. Nino Chkhobadze
	14.00 hours	Meeting with BP staff
	17.00 hours	Meeting at the ABRD 1. Nicolas Hadjinski 2. Mariam Mekvine-Tukhutsesi
	18.00 hours	Meeting with chairman and members of the Parliament: 1. Nino Burjanadze (chairman) 2. Rosa Lortkiperidze 3. Givi Shugarov

		4. Nino Chkhobadze 5. George Vashakmadze
	19.30 hours	Visit Newspaper “24 hours”
Thursday 14 November	07.30 hours	Meeting with Nicholas Dean first Secretary of USA Embassy
	10.40 hours	Departure from Tbilisi