Assessment of Water Supply System, Telavi
Republic of Georgia

Technical Report Number 7

Integrated Natural Resources Management in the Republic of Georgia Program

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Funding for this publication was provided by the people of the United States of America through the U.S. Agency for International Development (USAID) under Agreement No.CA # AID-114-LA-10-00004, as a component of the Integrated Natural Resources Management for the Republic of Georgia Program. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Agency for International Development of the United States Government or Florida International University.

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For bibliographic purposes, this document should be cited as:

GLOWS-FIU. 2011. Technical Report 7: **Assessment of Water Supply for the City of Telavi, Republic of Georgia.** Global Water Sustainability Program, Florida International University. 38 p.

ISBN:

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List of Acronyms and Abbreviations

1. a.s.l. – Above sea level
2. ^{o}C – Temperature degree by Celsius scale
3. CENN – Caucasus Environmental NGO Network
4. Cfu - Colony forming unit
5. D – Diameter
6. E. coli – Escherichia Coli
7. EU – European Union
8. FIU-Florida International University
9. GIS – Geographic Information Systems
10. GLOWS – Global Waters for Sustainability
11. GNEWRC - Georgian National Energy and Water Regulatory Commission
12. GWP – Georgian Water and Power
13. INRMW – Integrated Natural Resources Management in Watersheds
14. LLC – Limited Liability Company
15. L – liter
16. L - length
17. L/sc – Liter per second
18. m – meter
19. m^3 – cubic meter
20. m^3/sc – cubic meter per second
21. mm - millimeter
22. m^2 – square meter
23. m^2/d – square meter per day
24. mg/l – milligram per liter
25. ml - milliliter
26. NGOs – Non-governmental Organizations
27. ROFIU-GE – Representative Office of FIU in Georgia
28. UNESCO –United Nations Educational, Scientific and Cultural Organization
29. UNESCO-IHE – Instituted for Water Education
30. USAID – United States Agency for International Development
31. UWSCG – United Water Supply Company of Georgia
32. WHO – World Health Organization
33. WI – Winrock International
34. WSP – Water Safety Plan

1. Introduction

In September 2010, USAID-Caucasus launched a four-year program entitled: "Integrated Natural Resources Management in Watersheds of Georgia" (INRMW-Georgia), implemented within the framework of an umbrella program "Global Water for Sustainability" (GLOWS) by a consortium of international and national organizations under the leadership of Florida International University (FIU), in partnership with CARE International, Winrock International (WI), UNESCO-IHE, and the Caucasus Environmental NGO Network (CENN).

Within the INRMW framework, among various planned activities, it is envisaged to develop Water Safety Plans (WSPs) for six cities (Akhmeta, Telavi, Dedoplistskaro, Oni, Ambrolauri and Senaki) in the pilot watershed areas of the Rioni and Alazani-Iori river basins. To accomplish this task, a local WSP team was established with support of UNESCO-IHE. In accordance with the program work plan, the work was divided into two stages. During the first stage, WSPs were to be developed for four cities (Akhmeta, Telavi, Oni, and Ambrolauri) of the upper pilot watershed areas of the Alazani-Iori and Rioni Basins. During the second stage WSPs were to be developed for urban areas (Dedoplistskaro, Senaki) in the lower protions of pilot watershed areas. Assessments of water supply systems are baseline studies for WSPs that include a detailed description of centralized water supply systems, and identification of existing and potential hazards, hazardous events/situations/hazard sources and an assessment of their risks.

The present report is a detailed assessment of the water supply system for the city of Telavi. It includes a description of the system, identification of existing hazards to drinking water quality, their sources and related hazardous events/situations together with water safety risk assessments. In addition, the report includes a list of recommended control measures to avoid and/or mitigate risks, together with management and monitoring measures, a description of the methodology used to gather data of the existing water supply system, an identification of hazards, an assessment of their risks and a determination of control measures. The report will serve as a basis for developing the WSP for the water supply system of the city of Telavi in accordance with WHO guidelines.[1]

[1] World Health Organization (2005) Water Safety Plans: Managing Drinking Water Quality from Catchment to Consumer. WHO/SDE/WSH/05.06,http://www.who.int/water_sanitation_health/dwq/wsp170805.pdf

2. Methodology

Assessments of water supply systems in the targeted cities of pilot watershed areas are based on WHO guidelines that recommend investigation of existing systems from source to tap together with identification of hazards, their sources and/or hazardous events/situations imposing hazards to water safety, and assessment of their risks.

The analysis is based on information and data collected by the WSP team directly from the United Water Supply Company of Georgia as well as through site inspections of water supply systems from the catchment to the consumer and interviewing of local staff of the company based on sanitary observation questionnaires.

The WSP team visited each pilot city to collect information and elaborate flow diagrams which reflect all units of water supply systems from catchment to point of use. The following aspects were assessed:

- Land use in the catchment area;
- Abstraction method and location;
- Likely changes of water quality at the source;
- Detailed description of the water supply system;
    - Intake unit and treatment facilities and methods;
    - Water disinfection;
    - Water distribution system;
    - Storage (service reservoir, tankers);
    - Network;
- Water consumption and consumers;
- Drinking water quality monitoring procedures, databases and availability of trained staff.

In the next step the WSP team identified hazards, their sources and/or related hazardous events/situations and assessed risks. More specifically, the team identified all potential biological, physical and chemical hazards associated with each step/element of the drinking water supply system that can affect the drinking water safety followed by basic risk assessment of these hazards. The final step for the drinking water supply system assessments was the determination of control measures for each hazard and hazardous event/situation, together with key capacity development (support) and monitoring measures and re-assessment of risks in terms of likelihood and impact taking into consideration effectiveness of each control measure[2]. Risks were prioritized in terms of their likely impact on the capacity of the system to deliver safe water.

[2] The means by which risks may be controlled

3. Institutional and legal Framework for the Drinking Water Supply Sector

Currently, issues related to potable water are regulated by laws on Public Health, Water, and Mineral Resources, as well as by a number of regulations. In accordance with the water law, during the allocation of water resources, first priority is given to water allocation for drinking and bathing purposes. Furthermore, the law requires establishing water sanitary zones for water bodies used for drinking water purposes. Rules for sanitary zones are further defined by the order of the Minister of Health and Social Protection on Ambient Environmental Quality Standards (16 August 2001). The law on Mineral Resources of Georgia requires licensing of ground water abstractions for drinking water supply (for more details see relevant parts on surface waters and mineral resources). The law on Public Health divides responsibilities among various ministries with regard to water safety. The list of laws and regulations governing the potable water supply sector is given on the following page.

Drinking water quality standards and rules for drinking water quality monitoring are set out in the "Technical Regulation on Drinking Water" approved by the #349/N Decree, 17.07.2007 of the Minister of Health, Labor and Social Protection.[3] More specifically, the regulation defines rules of self-monitoring to be conducted by water suppliers. The "Technical Regulation on Drinking Water" is based on the Georgian Law on Public Health, WHO recommendations, EU directives, and regional characteristics including climate and relief conditions. The document regulates the quality of natural and treated tap water as well as the quality of bottled water. It does not cover the quality of small water supply systems with a capacity of 10m^3/day serving less than 50 persons as well as natural mineral waters, where the mineralization exceeds 1,500 mg/l. The regulation sets requirements against common parameters of smell, taste, color and turbidity as well as against organoleptic, microbiological, intra-microbiological, epidemiological, chemical composition, including inorganic and organic substances (common pesticides and individual organic pesticides) and radioactive safety of potable water (See annex 4). The quality of water in a natural water body intended for drinking water use should not exceed ambient water quality standards set out by the #297/N Decree of the Minister of Labor, Health and Social Affairs on "the Approval of Ambient Environment Quality Standards", issued on 16.08.2001.[4]

According to the "Technical Regulation of Drinking Water", rules for state compliance assurance monitoring and control of drinking water quality including components to be checked, frequency of sampling and analysis methods should be defined by the relevant law enforcement agency, currently by the Service of Food Safety, Plant Protection and Veterinary Service of the Ministry of Agriculture. In case the state laboratory of the Ministry of Agriculture does not have enough capacity to carry out drinking water quality testing, it may delegate its functions/outsource the assignment to an accredited independent laboratory. In cases where the required standards are not met under the Technical Regulation, the supplier of drinking water is liable to carry out appropriate measures, including reporting to relevant authorities, identification of pollution

[3]: i) http://www.momxmarebeli.ge/images/file_955911.pdf; ii) http://water.gov.ge/uploads/kanonmdebloba/standarti.pdf; iii) P. 105, Annex 4, Technical Report 1. Rapid National Assessment, February 2011, http://www.globalwaters.net/wp-content/uploads/2012/12/Technical-Report-1-Repid-National-Assesemnet-of-Legal-Policy-and-Institutional-Settings.pdf

[4] https://matsne.gov.ge/index.php?option=com_ldmssearch&view=docView&id=52384&lang=ge

sources, restriction of water supply and implementation of corrective measures for the safety of the population[5].

The legal relations between the water supplier and the consumer are regulated by the "Rules on Drinking Water Supply and Consumption" adopted by the Georgian Energy and Water National Regulatory Commission, dated 26 November 2008.

Below is given the list of laws and regulations governing the drinking water supply sector:

- Water Law.[6]
- Law on Public Health. [7]
- #297/N Decree of the Minister of Labor, Health and Social Affairs, 16.08.2001 on "Approval of Ambient Environment Quality Standards".
- #349/N Decree of the Minister of Labor, Health and Social Affairs of Georgia, 17.07.07 on "Technical Regulation of Drinking Water".
- #59 Decree of the Minister of Environment, 07.05.1998 on the "Approval of the Provision on Water Protection Zone".[8]
- Law on Sanitary Protection Zones of Resorts and Resort Areas, 20.03.1998
- #16/N Decree of the Minister of Health, Labor and Social Protection, 22.01.2004 on the "Approval of the Guidelines for Hygienic Assessment of Materials, Chemicals, Equipment and Technologies Used in Centralized Water Supply Systems".
- #15/N Decree of the Minister of Health, Labor and Social Protection, 22.01.2004 on the "Approval of Sanitary Rules on Drinking Water Sampling".
- #17/N Decree of the Minister of Health, Labor and Social Protection, 22.01.2004 on the "Approval of Sanitary Rules on Water Treatment by UV Radiation.
- #250/N Decree of the Minister of Health, Labor and Social Protection, 15.09.2006 on the "Approval of Sanitary Rules on Chlorination of Centralized Urban and Rural Waters Supply Systems and Disinfection of Technical Facilities of these Systems".
- #32 Ordinance, 26.11.2008 of the GNEWRC on the "Approval of the Rules on Drinking Water Supply and Consumption".
- #18 Ordinance, 29.08.2008 of the GNEWRC on the "Approval of the Methodology on Setting Out Water Use Tarrifs".
- #14 Ordinance, 26.11.2008 of the GNEWRC on "Penalizing Illegal Users of Centralized Water Supply and Sanitation Systems".
- #17 Ordinance, 17.08.2010 of the GNEWRC on "Water Use Tariffs".
- # 10 Decree, 30.01.2009 of the Government of Georgia on "Approval of the Charter on the Ministry of Regional Development and Infrastructure".

[5] For more details on water related issues please see INRMW technical report 1. Rapid National Assessment at http://www.globalwaters.net/projects/current-projects/inrmw/
[6] http://nfa.gov.ge/files/kanonebi/wylis_shesaxeb.pdf
[7] http://www.nsc.gov.ge/files/files/legislations/kanonebi/sazogadoebrivi%20janmrteloba.pdf
[8] https://matsne.gov.ge/index.php?option=com_ldmssearch&view=docView&id=80770

- Regulations of the "United Water Supply Company of Georgia" LLC Approved by the Order No 02/01 dated 1st March 2010 Of The director of "United Water Supply Company of Georgia" LLC. [9]

The institutional framework for potable water supply management sector is as follows:

- The Ministry of Labor, Health and Social Protection sets out ambient water quality standards in accordance with WHO guidelines.
- The Ministry of Agriculture carries out state control of drinking water quality.
- The Ministry of Environmental Protection develops and coordinates implementation of state water resources management policies and protection of water bodies from pollution and exhaustion. Currently, as a result of the parliamentary elections of October, 2012, reorganization of the Ministry is ongoing. More specifically, the agency for natural resources, together with environmental inspectorate will be moved to the Ministry of Environmental Protection from the Ministry of Energy.
- The Ministry of Regional Development and Infrastructure is responsible for state planning and coordination of development of water supply systems throughout Georgia. Provision of water supply to the Georgian population, except for the populations of Tbilisi, Mtskheta, Rustavi and the Autonomous Republic of Ajara is carried out by the State Company "The United Water Supply Company of Georgia", LLC, owned by the Regional Development Ministry. It has regional branches and subordinated to these branches are service centers in all relevant regions, including regions targeted by the INRMW program. More specifically, the Company has seven regional branches: i) Kakheti, ii) Shida Kartli and Mtskheta-Mtianeti, iii) Kvemo Kartli, iv) Samktskhe-Javakheti, v) Samegrelo, Zemo Svanety and Guria, vi) Imereti, Racha-Lechkhumi and Kvemo Svaneti and, vii) Kutaisi. These branches have their laboratories, which conduct monitoring activities for drinking water quality in the urban water supply system under their responsibility.
- The Georgian National Energy and Water Regulatory Commission (GNEWRC) sets out water supply and consumption rules, approves methodologies for setting up water use tariffs, sets water use tariffs, and approves rules on penalizing illegal water users, including those illegally discharging wastewaters in sanitation systems
- Georgian Water and Power (GWP) is a leading company in the water supply market of Georgia. The company provides water supply services to the population of Tbilisi and its neighborhoods, as well as to State organizations, industrial and commercial objects. The company also delivers wastewater services to the capital. GWP serves about 400 000 customers throughout the city, out of which about 2000 are budget organizations, 15 000 are commercial objects and the rest are residential customers.

[9] http://water.gov.ge/uploads/kanonmdebloba/debuleba5.pdf

4. Description of Water Supply System from Catchment to Consumer

The water supply system of the city of Telavi operates under the Telavi Service Center of the Kakheti regional office of the LLC "United Water Supply Company of Georgia" (UWSCG). The Service Center of Telavi consists of 28 employees, of which 20 are technical-engineering and operational staff (including 6 employees from emergency group). Please see Annex 7, pic 1.

Telavi city is located in the east Georgia, on the foothills of the northeast slope of Gombori range and on the Alazani plain. It is situated at about 500-800 m above sea level.

Two systems of headworks' collectors are used for drinking water abstraction: 1. "Jvari Patiosani" (E45°27'40.344" N41°54'1.873"), where spring waters of "Tbiltsklebi" flow in, and 2. "Burus Nakalakari" (E45°21'2.169" N41°52'6.891") where the waters of following springs: "Burus", "Nakalakari", "Tikhiani Rike", Psitis Tsikhe" and "Mta" flow in. They originate on the "Tsiv-Gombori" ranges. Water from all intakes to the City flows through gravity system. Please see Annex 1.

4.1 Main Characteristics of the Water Source and its Catchments

Land use. Water intake facilities of the Telavi water supply system are located far from settlements and no agriculture or other anthropogenic activities take place on the catchments. These areas are predominately mountains and rocky mountains covered with forest.

Main characteristics of water intake sources. Sources of all above mentioned headworks' collectors are underground waters contained in aquiferous complex of Apsheron-Agchagil continental deposits, lithologically composed of conglomerates, sands, sandstones and clays,[10] except for the source "Burus", which represents a filtrate of the Turdo river.

In general, groundwater sources, used by Telavi water supply system belong to the pore, stratal, fractured and fractured-karst waters of the Alazani Artesian Basin located between the southern slopes of the Greater Caucasus and northern slopes of the Tsiv-Gombori range and comprising the entire Alazani Valley. The basin represents the complex of sub-mountainous and inter-mountainous confined aquifers. It is enclosed between impermeable strata of Quaternary alluvial-proluvial sediments and is very rich in fresh subsurface pore and stratal water.

Geologically, groundwaters – sources of the Telavi water supply system belong to the aquiferous complex of lagoon-continental deposits (continental molasse) of „Agchagil-Apsheron-Alazani Series". This represents upper part of the Alazani artesian basin, lithologically composed of sands, sandstones, clays, clayey shales and conglomerates of up to 2,000 m thickness. Three horizons, composed of sequencing impermeable and water content strata are outlined here, including „Telavi horizon", „Gurjaani horizon" and „Kvareli horizon". Of there, Telavi drinking water is abstracted from the first one. „Telavi horizon" has a hydraulic conductivity 100-200 m^2/d and its

[10] Annex 2. Maps of Geology and Groundwater Aquifers, Technical Report 12. Detailed Assessment of Natural Resources of Upper Alazani Pilot Watershed Area, March 2013. INRMW program. http://www.globalwaters.net/publications/

recharge areas a re located on the northern slope of the Tsiv-Gombori Range. Based on artesian borewell data, total resource is estimated at 5 m^3/sc.[11]

Abstraction method and location. The headwork collector of "Jvari Patiosani" is supplied from nearby existing underground drainage and from spring water captation of the "Tbilisklebi" water intake point. From the "Tbilitsklebi" source to the headworks' collector water flows through 80 mm diameter pipe, with total length 2.5 km The intake facility of "Jvari Patiosani" source is located at 1140 m above sea level and that of "Tbilitsklebi" source – at 1,250 m above seal level. The water intake collector "Jvari Patiosani" is located of 2 km from Telavi.

The headworks' collector system of "Burus Nakalakari" is supplied from „Burus" abstraction source - filtrates of the Turdo River and through the catchment of "Nakalakari" source, which is also joined by ground waters of following sources: "Tikhovani Rike", "Phtis Tsikhe" and "Mta". "Burus" intake is located at 975 m, "Nakalakari" at 1,136 m, "Psitis Tsikhe" - at 1,220 m, "Tikhiani Rike" 1,350 m, "Mta - at 1,490 m above sea level. The headworks' collector system of "Burus Nakalakari" is located 16 km from Telavi. In addition water is abstracted from 4 wells, located neareby reservoirs. For more information please see chapter 4.2.2.

None of the headworks is fenced and there guarded/supervisor. Data on the 1st sanitary zones are not currently available.

General data on the Telavi water supply system is given in Annex 2.

Water quality at the headwork. Potential cause for deterioration of water quality (microbiological cause) might be unprotected headworks. Domestic and wild animals can access the unprotected water catchment area, which could result in the animal fecal matter entering the water supply system and affecting the quality of the source water

Currently the water quality is at headworks is satisfactory, there are some cases of deterioration of the water quality, predominately caused by heavy rains, which wash sediments out and increase the turbidity of ground water at "Jvari Patiosani" headworks. Another reason of deterioration of water quality during heavy rains is flooding and bogging of "Burus" abstraction point, caused by the shortage/inadequate river revetment structures along the Turdo river. During these events water quality does not meet national drinking water quality standards (physical parameters: color and turbidity). Technological treatment of the source water (clarification and filtration) is not provided at headworks due to the absence of relevant technical facilities.

4.2 Detailed Description of Intake System

4.2.1 Headwork sand Treatment Facilities

The flow diagram of the water supply system of Telavi is presented in Annex 3.

The headwork collector of "Jvari Patiosani" headworks is represented by 2 m X 2 m and 5 m deep closed concrete well. At this headworks, water is abstracted through 420 mm diameter and 350 m long pipe of the groundwater drainage system, with 18 observation wells (3-3.5 m deep each,

[11] Technical Report 12. Detailed Assessment of the Natural Resources of the Upper Alazani Pilot Watershed Area, March 2013. INRMW program. http://www.globalwaters.net/publications/

except for #18 well, which is 5 m deep); the last well is a collector gathering water from "Tbilistsklebi" spring water captation system. From the collector water flows directly to the steel main pipe. Water discharge rate at the "Jvari Patiosani" headworks' collector varies within 9.5-16 L/sc. Intake units of "Jvari Patiosani"spring were rehabilitated in 1983, while the "Tbliltsklebi" intake unit – in 2002. Technical condition of the intake units is not satisfactory at present. During the field assessment of the Telavi water supply system (January-February 2012) drainage systems of all intakes were obsolete and damaged and works for rehabilitation of drainage system of the „Jvari Patiosani" headworks was under procurement by the government. As a result of rehabilitation works it was expected to increase headworks capacity to 30-50 L/sc. There is no disinfection provided at the headwork collector.

The headworks' collector of "Burus Nakalakari" is closed concrete well, where water is streamed through 6 m deep active underground drainage network. Average capacity (discharge rate) of the "Burus Nakalakari" headworks amounts to 70 L/sc. (max. 140 L/sc). Spring water captation systems of the sources: "Mta", "Tikhiani Rike", "Psitis Tsikhe" were built in 2002 and those of "Burus" and "Nakalakari" – in 1966. The intake unit of the "Nakalakari" source was renovated in 1996. General condition of "Burus Nakalakari" headworks is unsatisfactory, with its drainage network being obsoleted and damaged and overall capacity of the headworks decreased. At "Burus" intake structure existing river revetment structure cannot ensure avoiding swamping of water abstraction points. Water is disinfected by liquid chlorine on a daily basis.

During field assessment (January-February, 2012) of the Telavi water supply system, new treatment plant for the Telavi water supply system was being constructed, including modern chlorination facility, with 125 L/sc. designed capacity to treat water from both catchments. More specifically, water from water mains of the both catchments/headworks will flow into receiving chamber/collector tank of the treatment plants connected to filtration facility.

The new treatment plant would include: water receiving/inlet chamber; 7-section horizontal settling reservoir; filtration facility with 6 fast filters and chlorination building with automatic chlorination system (where chlorination will be carried out with salt electrolysis of salt). Construction works would include arranging of the guard's booth and surrounding territory. The schedule of works envisaged completion of construction works and commissioning of the new plant by spring 2012. Please see pic. 3 and 4 Annex 7 for treatment plant construction activities.

4.2.2. Water Distribution Network

From the headworks collectors water is delivered to the City through two steel main pipes: "Jvari Patiosani" (D - 219/100 mm, L – 1.5 km) and "Burus Nakalakari" (D -220/426/630 mm; L - 20 km). During field assessment of the Telavi water supply system, 426 mm diameter and 11 km long section of steel water main (same as main pipe) on "Burus Nakalakari" was being replaced with PVC pipe. 220 mm diameter and 6.5 km long section of the same system constructed in 1982, is currently damaged in many places and corroded, with numerous leaking points. The remaining part of the pipe of the same system was gradually replaced during 2002-2006. Overall technical condition of the Jvari Patiosani water main is satisfactory, with very few damages and leaks.

The average pressure of the "Burus Nakalakari" main pipe is 11-12 Bars and that of "Jvari Patiosani" 10 Bars.

Five regulating reservoirs (see Annex 3, and 8 pic. 5,6) with 5,750 m^3 total volume serve the water supply system of Telavi city; N1 reservoir is square iron-concrete tank with 2000 m^3 capacity, located at 850 m above sea level. The reservoir was built in 1971. The N2 reservoir (please see Annex 7. pic. 5 and 6) is circular iron- concrete tank with 1000 m^3 capacity, located at 830 m above sea level and operational since 1966. The N3 reservoir is square iron-concrete with 2000 m^3 volume, located at 740 m above sea level and operational since 1985. The N4 reservoir is a circular iron-concrete tank with 350 m^3 capacity, located at 750 m a.s.l., built in 1948. The N5 reservoir (located at 750 m a.s.l.) is also circular, iron-concrete tank with 400 m^3 capacity, built in 1950. The physical condition of all reservoirs is unsatisfactory, except that of N2 reservoir. Because of damages reservoirs are not fully operational. They are connected to each other by 400 mm diameter pipes that ensure water supply balance. From the headworks water flows to the N1 2000 m^3 storage/regulating reservoir, from where it flows to N2 and N3 reservoirs and directly to the distribution network. For connections of the reservoirs please see in Annex 3. N1 and N3 reservoirs also receive waters from nearby two ground water artesian borewells with 12 and 10 L/sc. capacity respectively. During the field assessment of the Telavi water supply system, the UWSCG was planning to organize new wells (2) near N2 reservoir with 4-5 L/sc. capacity each. All above mentioned reservoirs are fenced and served by operators on the spot, although unprotected roofs and aeration pipes create risks for potential contamination. None of reservoirs has equipment for monitoring of water level and it is very difficult to regulate water supply and monitor water level.

The total length of the distribution network is 42 km, part of which was built during 1930-1950. The major portion was built in 1996. During the field assessment of the Telavi water supply system, 70% of the network were obsolete, damaged and leaking at many points. However, rehabilitation works were on the short agenda of the government to replace 15.5-km old section with plastic pipe. After renovation works, about 30% of the network would remain obsolete.

It should be noted that initially the network was developed spontaneously as a result of which it became very difficult to carry out the optimal operation of the network. Additional problem is pressure regulation in the network. Due to the geographic and relief peculiarities of the City, the districts are situated on different height and requires different pressure zones. But most of closing valves (which are related pressure) are damaged or do not operate and very difficult to ensure corresponding pressure. Average pressure in the system is 3-4 Bars.

4.2.3 Water Consumption and Consumers

The water supply system of Telavi serves up to 21,600 users, consisting of 92% of the total population of the City and part of the neighboring village Gulgula. Out of total customers, 6,694 are households and 461 organizations. During the field assessment of the Telavi water supply system consumers received water only 2-3 hours a day in every other day and the process of installation of water meters were initiated in the city. But, this situation would significantly improve as a result of rehabilitation works.

According to the resolution #17 (17 August 2010) of the Georgian National Energy and Water Supply Regulation Commission on Water Supply Tariffs, consumers with water meters pay 0.423 GEL per m^3 (including the price for sanitation service); the tariff for consumers without water

meters is set at 2.03 GEL per capita (including the price for water sanitation service). Organizations (legal entities) pay 3.65 GEL per 1 m³ of water (for the time being this rate includes the price for sanitation service).

According to the Telavi Service Center of Georgian United Water Company, during the field assessment of the Telavi water supply the average maximum amount of drinking water consumption for households was 800 l per day (especially from late spring to early autumn), which was estimated without individual water meters. This amount was high and might be attributed to the 2-3-hour working regime of 5 storage/regulating reservoirs (with a total capacity of 5,750 m^3), capacity of water supply springs and water losses in the network, which is approximately 30% according to the Service Center. Daily water consumption in the city of Telavi is extremely high in comparison with the established rate by European countries, which varies from 120 to 150 l/day per resident. However, after planned rehabilitation works as well as completion of metering of individual consumers, the company envisaged significant improvement in water use efficiency.

5. Risk Assessment

Identification of hazards, their sources and potential hazardous events/situations as well as risk assessment of the Telavii water supply system were conducted through field observation/inspection of the system using a special sanitary inspection questionnaire. This approach is based on WHO WSP guidelines (2005)[12], which recommend the identification of hazards and hazardous events by using sanitary observation questionnaires. This questionnaire should be elaborated for sanitary inspection of key points of the water supply system (headworks, water treatment plant, and main and distribution network, etc.) and water abstraction methods (e.g. drilled wells, pit wells, spring water collectors, etc.).

Stemming from the fact that almost all key components of water supply systems have the same problems and pose the same risks to water safety, sanitary inspection questionnaires were elaborated for entire water supply systems and not for particular elements. Furthermore, a risk prioritization matrix using hazard likelihood and impact criteria was developed and the risks were prioritized based on this matrix.

5.1 Compliance of Drinking Water Quality with National Standards

Monitoring parameters, sampling points and frequencies are defined by the Georgian Technical Regulation on Drinking Water, 2007. Please see Annex 4. Regular water quality monitoring of the Telavi system currently focuses on the following basic set of parameters: *Microbial parameters – E. coli and total coliforms*; *Physical parameters* - taste, odor, color, turbidity, temperature; *Chemical parameters* – residual chlorine, pH, total hardness, nitrites, ammonium chlorides, sulfates, and iron.

The laboratory control of water is carried out by the Service Centers of UWSCG; water quality monitoring points are set up by the central office of UWSCG and are in compliance with the Georgian Technical Regulation on Drinking Water, 2007. For all water supply systems, control points should include:

i) Water intake (surface water filtrate).
ii) Water intake (ground water).
iii) Release points (treated water).
iv) Distribution network.

Water quality monitoring is carried out by the laboratory of the Telavi Service Center of UWSCG The technical capacity of the laboratory is satisfactory and it is relatively well-equipped in comparison with laboratories of other pilot cities. The laboratory was recently granted by portative equipment for microbiological analyses of water. Please see Annex 7. pic.7 and 8. Samples from the different points of the distribution network are taken once a day and from the headworks once a month and, analyzed for parameters listed above. The laboratory of the Telavi service center also serves other cities of Kakheti region, regarding the microbiological testing of water. Monitoring results are reported in registration books.

[12] World Health Organization (2005) Water Safety Plans: Managing Drinking-water Quality from Catchment to Consumer. WHO/SDE/WSH/05.06, http://www.who.int/water_sanitation_health/dwq/wsp170805.pdf

Assessment of drinking water quality for the Telavi water supply system is based on 2011 water quality monitoring data (see annex 5). According to these data, 304 samples were collected, from which 247 were collected from the distribution network, 45 from released (treated) water and 11 from the ground water sources and 1 sample taken from a surface water source [13]. Table 1 reflects Drinking water quality compliance with the national standards in 2011.

Table 1. Drinking water quality compliance with the National Standards for the Telavi Drinking Water Suppy System, 2011[14]

Monitoring Point	Number of samples	Compliance and non-compliance with the National Standards %[15]			
		Compliance		Noncompliance	
		Numb. of samples	%	Numb. of samples	%
Surface water source (raw water)	1	1	100	0	0
Ground water source at headwork	11	10	91	1	9
Released treated water	45	44	98	1	2
Distribution network	247	240	97	7	3
In total	304	295	98	7	2

The figures in the tables showed water quality compliance with the National Standard within 91% - 100% range for all control points. More specifically, 1 sample taken from a surface water source met the standard (100%); 10 samples out of 11 samples taken from a ground water source at headwork met the standards (91 %) 44 out of 45 samples taken from releasing treated water met the standards (98%); 240 out of 247 samples taken from distribution network met the standards (97%).

The deviation was detected in 7 samples taken from distribution network: in February – 2; In March – 1; In May – 2; In October – 1 and; In December – 1. Apart from deviations in the distribution network, non-compliances were detected for 1 ground water sample out of 2 samples taken at ground water intake and for 1 sample out of 6 samples taken from treated water. Deviations were revealed in February, March, May and December (see annex 5). This might be caused by the damaged distribution system, inadequate chlorination process and/or water interruptions.

In order to identify issues related to particular parameters, additional information was requested from the service center laboratory staff. Based on this information it was learned that non-compliance of water quality with the national standards was generally due to microbiological contamination – non-compliant concentrations of total coliform bacteria and E.coli. Physical parameters in general met the national standards, except in some cases, when water transparency was not in compliance with the standards. According to chemical parameters, water quality met national standards. However, concentration of residual chlorine was sometimes lower than the national standard (0.3 – 0.5 mg/l). It is unknown if chlorination was not conducted in these instances or if it was conducted insufficiently.

Concerning contagious diseases for the City of Telavi, statistics for 2011 shows 1 case of acute viral hepatitis B, 2 cases of bacterial intestinal disease, escherichiosis and 11 cases of brucellosis, 40 Diarrhea. However, there is no evidence that these cases resulted from water contamination. For detailed information please refer the annex 6.

[13] From this monitoring data it is difficult to judge which parameters are not in compliance with the national standards
[14] Source: UWSCG
[15] Rounded off to the nearest whole number

5.2 Hazard Identification

For identification of hazards, their sources and potential hazardous events/situations and assessment of risks, visual observation of the water supply system was conducted by the WSP team jointly with the representatives of the local Service Center of United Water Supply Company of Georgia. In addition, a sanitary inspection questionnaire was developed, handed out and filled in by the technical personnel of the Telavi Water Supply Service Center. It consisted of 10 questions with "Yes" or "No" answers. The sum of the "Yes" answers gave the scale/level of the risk divided into following classes: 9 -10 = Very High, 6-8 = High, 3 -5 = Medium, 2-0 = Very Low/no risk.

Stemming from the fact that the situation in all headworks is the same (with little differences), sanitary inspection questionnaires were elaborated for entire water supply systems and not for particular elements.

As defined in the WHO WSP Guidelines (2005):

- *A hazard is any biological, chemical, physical or radiological agent that has the potential to cause harm.*
- *A hazardous event is an incident or situation that can lead to the presence of a hazard (what can happen and how).*

Presented below is the completed questionnaire for the Telavi water supply system. The answers for all headworks were identical.

Table 2 . Questionnaire for sanitary observation for 2012

#	Question	Yes	No
1	Is the area around the catchment not protected?	X	
2	Do animals have access to the area around the catchment?	X	
3	Are there any solid or liquid collecting sites within 30 m of the catchment?		X
4	Is there any source of pollution within 10 m radius of the catchment (e.g. animal breeding, cultivation, roads, industry etc.)?	X	
5	Are coagulation and sedimentation tanks absent?	X	
6	Is the main pipeline corroded or damaged?	X	
7	Is water treatment plant absent?	X	
8	Is the chlorine tank improperly covered?	X	
9	Has there been a discontinuity in water supply in last 10 days?	X	
10	Does the community report any pipe breaks in the last week?	X	
In total		9	1

As it is shown from the aggregate responses to the questions on Telavi Water Supply the Sanitary Inspection Questionnaire, 9 positive responses out of 10 questions were received indicating that the System belongs to **very high** risk category systems.

Thus, through sanitary observation of Telavi Water Supply System the WSP team has identified following hazards:

1. Absence of the sanitary protection zone around headworks, leaving the headworks easily accessible to wild animals and livestock
2. Absence of any preliminary water treatment (sedimentation/coagulation reservoir, chlorination) at intake
3. Presence of large corroded and damaged sections in pressure pipes
4. Application of out of date technologies for chlorination, e.g. Disinfection with chlorine in chlorine tanks connected to the distribution network
5. Frequent interruptions in water supply
6. Frequent accidents in distribution systems

All above listed hazardous events/situations/hazard sources may lead to any of three hazards: i) deterioration of physical properties of the drinking water, ii) microbial contamination of the drinking water and; iii) chemical contamination of the drinking water. These hazards may cause the spread of water borne diseases, in particular during heavy rains, floods, increased air temperatures and droughts. Chemical contamination and deterioration of organoleptic (physical) properties (e.g. odor, taste, color, transparency) of drinking water are also possible even if serious sources of chemical contamination are not located in the surrounding areas of the headworks.

5.3. Hazard Prioritization

In accordance with WHO WSP guidelines (2005), hazards revealed for the whole water supply scheme were prioritized by application of a risk assessment matrix. Risks were quantified according to categories of hazards (e.g. microbial, chemical, etc.) for various hazardous events/situations/sources of hazards, as suggested in the WHO WSP guidelines.

By WHO WSP definition, risk is the likelihood (probablity) of identified hazards causing harm in exposed populations in a specified timeframe, including the magnitude of that harm and/or the consequences.

The risk of hazards was assessed by two factors: likelihood and impacts (results of water quality self-monitoring of the water supply system). The likelihood was expressed by anticipated occurrences of hazards identified through the sanitary observation of the system. Hazards threatening the water supply system were prioritized using the matrix in Table 3. The priority matrix is based on risk scores of the sanitary inspection questionnaire and water quality monitoring data received from UWSCG.

Table 3. Hazard Prioritizing matrix for Telavi water supply system for 2011

Deviations drinking water quality standards, %	**Sanitary inspection score (SIS)**			
	0 – 2	3 – 5	6 – 8	9 - 10
71-100	0	0	0	0
31 – 70	0	0	0	0
11-30	0	0	0	0
1-10	0	0	0	2%[16]
Risk level	low	medium	high	very high
Priority action level	none	low	high	urgent

[16] The figure reflects (in total) deviation from standards was identified at all monitoring points

Despite the fact that 295 (98%) water samples out of 304 meet the national standards and just 7 (2%) deviated from the standard, according to the results (score 9) of the sanitary questionnaires, the entire system, including the distribution network, is assessed at very *high risk*. The water supply points scored as "yes" on the sanitary inspection form represent the potential sources/factors of hazards for microbiological contamination of drinking water.

Thus, on the basis of on-the-ground situation existed by February 2012, the sanitary questionnaire and hazard prioritizing matrix for the Telavi water supply system, biological, chemical and physical contamination risk factors were identified that have a negative impact on the quality of drinking water and cause a hazard of exposure to water borne diseases or chemical contamination. In more detail, on the basis of visual inspection and the results of the sanitary observation questionnaire, the following components/steps of water supply system were identified as the most probable causes of contamination of potable water:

- Headworks;
- Water treatment;
- Reservoirs;
- Main pipes and distribution network.

Apart from above, technical conditions and capacities of water testing laboratory and the quality of the water testing can be considered as factors that may indirectly impact the water quality. As it was described in the above paragraphs of this chapter, water testing equipment of the laboratory of the Telavi Service Center is in good working condition and is operated and maintained by qualified chemists and operators. However, most part of the equipment is old and accuracy/precision is thus more difficult to maintain. Furthermore, monitoring at headworks is carried out only once per month. This is judged to be insufficient given that the majority of headwork structures are damaged, water intake facilities are not fenced or guarded. Regardless, the water quality testing component/step was not included in the identification of hazards and hazardous events/situations, because it is not a source for water contamination and represents the means for tracking the progress towards achieving operational limits/targets (in our case, national drinking water quality standards). Meanwhile, we have included measures related to the improvement of water quality testing as recommendations for inclusion the WSP.

To calculate a priority score (based on WHO guidelines) for each identified hazard we used semi-quantitative risk assessment and a prioritization matrix. The objective of this matrix is to rank hazardous events and identify the most significant hazards. Risk ratings, calculated based on the likelihood and severity of impact, were made based on matrices of tables 4 and 5.

Table 4. Definitions for likelihood and consequence/impact categories that could be used in hazard prioritization.

Rank	Level of likelihood/impact	Description of a level of likelihood/impact
Likelihood		
A	Very high likelihood	Very frequent (e.g. to happen continuously or at least once a day)
B	High likelihood	Frequent (e.g. to happen at least once a week)
C	Moderate likelihood	Moderately frequent (e.g. to happen at least once a month)
D	Low likelihood	Rare (e.g. to happen at least once a year)
E	Very low likelihood/Unlikely	Very rare (e.g. to happen at least once every 5 years)
Impact/consequence		

5	Catastrophic: Public health impact	Mortality expected from consuming water
4	Major: Regulatory impact	Morbidity expected from consuming water
3	Moderate: Aesthetic impact	Major aesthetic impact possibly resulting from the use of alternative but unsafe water sources
2	Minor: Compliance impact	Minor aesthetic impact causing dissatisfaction but not likely to lead to use of alternative less safe sources
1	Insignificant: No impact or not detectable	No detectable impact

Table 5: Qualitative risk analysis matrix – risk categories

Consequences					
Likelihood	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**
	1	2	3	4	5
A	H	H	E	E	E
B	M	H	H	E	E
C	L	M	H	E	E
D	L	L	M	H	E
E	L	L	M	H	H

Note: The number of categories should reflect the need of the assessment.

E – Extreme risk, immediate action required; H – High risk, management attention needed; M – Moderate risk, management responsibility must be specified; L – Low risk, manage by routine procedures.

Based on the above matrices each identified hazardous event/situation/hazard source was ranked against the level of hazard risk. The results are given in Table 6.

Table 6. Evaluation of hazard levels for Telavi water supply system[17]

Drinking water supply system component	Hazardous events	Hazard	Likelihood	Severity	Qualitative risk
Water disinfection	*Inadequate Disinfection insufficient amount of residual chlorine in water system*	*Microbial pathogens*	D *Water is chlorinated with liquid chlorine that guarantees more effective water disinfection*	4	H *(High risk, management attention needed)*
Water disinfection	*Inadequate Disinfection High amount of residual chlorine in water system*	*Chemical*	*E Water is chlorinated with liquid chlorine that guarantees more effective water disinfection*	*4*	*H (High risk, management attention needed)*
Water disinfection	Absence of disinfection *Possibility of water contamination at any stage of water supply*	Microbial pathogens	A *There is no chlorination of source water from "Jvari Patiosani" headwork collector*	4	E *(Extreme risk, immediate action required)*

[17] Based on 2011 water quality data and on-the-ground situation of February 2012

Headworks and water abstraction points	*Domestic and wild animals can access the water catchment area, which could result in the animal faecal matter entering the water supply*	*Microbial pathogens*	*C The headworks are located in places that are accessible by humans and animals is High*	*4*	*E (Extreme risk, immediate action required)*
Headworks and water abstraction points	People may access the water catchment area and purposefully or unintentionally discharge chemicals into the wells *leading to chemical pollution of the source water*	*Chemical*	*D Headworks is not fenced and guarded; But, there no single case of the source water chemical contamination recorded; Therefore, the likelihood of source water chemical pollution is not very low*	*5*	*H (High risk, management attention needed)*
Headworks and water abstraction points	Damaged headworks structures may result *in easy access of organic and chemical pollutants into source water*	Microbial, physical chemical	*C Water abstraction points and Headworks collector structures are damaged to different extents because no fundamental maintenance/rehabilitation has been carried out. Regardless of the fact that in 2011 only 9% of samples from headworks didn't comply with national drinking water standards, these data are not sufficient enough to judge about the frequency of source water contamination due to insufficient number of samples taken and possible measurement errors of the laboratory. Stemming from above likelihood of source water contamination is high.*	4	*E (Extreme risk, immediate action required)*
Headworks and water abstraction points	*Increased water turbidity during heavy (seasonal) rains*	Physical	D *At "Burus" abstraction point water filtrate drainage is very close to river bed and during high waters intake is swamping due to lack of embankments At "Jvari Patiosani" abstraction point water sources represent ground waters (karst-origin waters), which is easily impacted by heavy rains*	3	M *(Moderate risk, management responsibility must be specified)*

Reservoirs	*Domestic and wild animals can access the reservoirs, which could result in faecal matter entering the treated water*	*Microbial Physical*	D *All reservoirs are fenced and full-time operators work there, but poor condition creates risks for potential contamination*	3	*M – Moderate risk, management responsibility must be specifies;*
Main pipes and distribution network	*Damaged pipes and insufficient pressure, water interruption can result in backflow from customer systems into the network*	*Microbial pathogens*	*B At some points pipes are damaged, there is frequent water interruptions and contamination by backflow is likely*	*4*	*E (Extreme risk, immediate action required)*

6. Determination and validation of control measures

6.1 Determination of Control Measures

WSP control measures were determined based on information and data collected by the WSP team through interviewing of the staff of Telavi Service Center, visual inspection of the system and analysis of existing drinking water quality data[18]. At the assessment stage, control measures are suggested as recommendations to be included in the WSP as planned actions. In addition to measures to control risks, necessary monitoring and other management measures are suggested to be included in the WSP.

To mitigate hazards and ensure safe drinking water for the population of Telavi the following control measures are recommended to be carried out:

1. Source and Source Protection

- Fencing of water intake facility sanitary zone (where it is possible) and 24 hours guarding/supervising should be ensured at all headworks to avoid potential hazards of surface spring water contamination in case of anthropogenic involvement at the intake point/territory.
- Rehabilitation of both headworks' collectors should be carried out.
- Rehabilitation of intake facilities – renovation of abstraction facilities[19] and increase of their capacity.[20]
- Arranging of river revetment structures at "Burus" intake point.

2. Water treatment

- Timely completion of construction works for a new treatment plant and assurance of its proper operations./

3. Reservoirs

- Rehabilitation/Installation of reservoir roofs and ventilation equipment and keep it always close.
- Modernization of reservoirs with technical equipment (water level meter, window for observation , etc.).

4. Water Mains and Distribution System

- Replacement of 250 mm diameter and 6.5 km long section of the "Burus Nakalaqari" main steel pipe. [21]
- About 4000m^3 volume reservoir should be constructed to ensure a significant improvement of water supply in the city (at least up to 50%).

[18] Control measures are based on hazards and risks indetified during field assessment of the Telavi water supply system and do not take into consideration situation after rehabilitation/renovation work.
[19] Rehabilitation of «Jvari Patiosani"intake facility was under procurement during field assessment of Telavi water supply system
[20] During elaboration of this report this control measure was completed, please see chapter 6.2
[21] During field assessment of the Telavi water supply system construction works were ongoing for his section of the water main

- Rehabilitation/renovation of water distribution system of the city is necessary in order to eradicate water leakages (up to 30%).[22]
- Installation of water meters for all customers.
- Detailed inventory of the water supply system and development of GIS-based comprehensive database to include data on technical characteristics of the system, drawings, maps, etc.

Regarding water quality monitoring, the following measures are recommended to be carried out:

- Equipping the water testing laboratory with modern equipment and conducting training for laboratory staff.
- Elaboration of an accurate and detailed database of laboratory testing results (particularly microbe contamination parameters).
- Development of a plan for how to inform the population about incidents of water contamination and what protection measures should be taken from their side (boiling, etc.) to avoid waterborne diseases.
- Regular trainings for service personnel to introduce new approaches to improve potable water quality monitoring and water safety plans.

Summary information on identified hazards, hazardous events and control measures for Telvi water supply systems is given in Table 7.

Table 7. Identified Hazards and control measures for the Telavi water supply system

#	Drinking water supply system component	Hazardous event/situation/hazard source	Hazard	Risk level	Control measures
1	Water disinfection	*Inadequate Disinfection insufficient or high amount of residual chlorine in water system*	Microbial pathogens chemical	H *(High risk, management attention needed)*	***Short term strategy:*** • Carry out chlorination in compliance with the corresponding norms • Modernize chlorination procedure and technology*
		Absence of disinfection *Possibility of water contamination at any stage of water supply*	Microbial pathogens	E *(Extreme risk, immediate action required)*	***Short term strategy:*** • Ensure chlorination of water from "Jvari Patiosani" headworks *
2	*Headworks and water abstraction points*	*Domestic and wild animals can access the water catchment area, which could result in the animal faecal matter entering the water supply*	*Microbial pathogens*	*E (Extreme risk, immediate action required)*	***Short term strategy:*** • Appoint guard for supervision of water intakes • Fence water intake facility sanitary zone ***Long term strategy:*** • Rehabilitate and modernize damaged water intake units*

[22] During field assessment of the Telavi water supply system, the government was planning to renovate about 15 km long section of the distribution network.

		People may access the water catchment area and purposefully or unintentionally discharge chemicals into the wells leading to chemical pollution of the source water	*Chemical*	*H (High risk, management attention needed)*	***Short term strategy:*** • Appoint guard for supervision of water intakes • Fence water intake facility sanitary zone ***Long term strategy:*** • Rehabilitate and modernize damaged water intake units*
		Damaged headworks structures may result in easy access of organic and chemical pollutants into source water	*Microbial, physical chemical*	*E (Extreme risk, immediate action required)*	***Short term strategy:*** • Appoint guard for supervision of water intakes • Fence water intake facility sanitary zone ***Long time strategy:*** • Rehabilitate and modernize damaged water intake*
		Increased water turbidity during heavy (seasonal) rains	*Physical*	M *(Moderate risk, management responsibility must be specified)*	***Short term strategy:*** • Interrupt water supply during high turbidity * ***Long time strategy:*** • Arrange technological treatment modules (sedimentation , coagulation and filtration) * • Arrange river revetment structures
3	*Reservoirs*	*Domestic and wild animals can access the reservoirs, which could result in faecal matter entering the treated water*	*Microbial Physical*	*M (Moderate risk, management responsibility must be specifies)*	***Short term activities:*** • Rehabilitate/Install reservoir roofs and ventilation equipment and keep it always close ***Long term strategy:*** • Modernize reservoirs with technical equipment (water level meter, window for observation)
4	*Main pipes and distribution network*	*Damaged pipes and insufficient pressure, water interruption can result in backflow from customer systems into the network.*	*Microbial pathogens*	*E (Extreme risk, immediate action required)*	***Short term strategy:*** • Rehabilitate main pipes • Rehabilite/renovate water distribution system* • Rehabilitate damaged valves ***Long term strategy:*** • Install water meters * • Construct about 4000m^3 volume reservoir to ensure significant improvement of water supply in the city (at least 50%)

** In the process of risk re-assessment and validation this control measure was identified as not relevant, because this activity was already completed durig elaboration of the repot, please see chapter 6.2.*

6.2 Risk Reassessment and Validation of Control Measures

After detailed description and identification of hazards for the Telavi water supply system, the next steps consist of risk reassessment and validation with technical personnel and the head of the Telavi service center. For this purpose under the INRMW program a meeting was organized with the management team of Telavi water supply service center. In this meeting consultants from UNESCO-IHE and a team working on water safety plans participated. The team presented actual

and potential hazards to the Telavi water supply system, risks which can provoke deterioration of drinking water quality and also control measures related to these risks (Table 7).
In general, hazards, their sources, related hazardous events and control measures presented by the working group were adjusted according to information of the Telavi service center of UWSCG. The majority of construction works undertaken or planned by the company was completed, in particular:

- The new treatment plant was already under operation;
- The headworks of "Jvari patiosani" was already renovated - water abstraction structure was replaced and accordingly capacity of headwork increased from 10-16 L/sc.to 30-50 L/sc;
- Nearby reservoir N2 water abstraction wells with capacity 4-5 L/sc. were arranged;
- 15 km of the distribution network in the city center was replaced with PVC pipes;
- Water meters were installed for 50% of customers;
- 2-3-hour water supply regime was replaced with 24 hour supply in the city center (20% of customers); 50 % of customers have 12-15 hour supply and the remaining part – less than 12 hour supply has 30% of customers.

Proceeding from above, presented hazards, risks and control measures were re-assessed and hazared levels was replaced. Please see below the table 8 with reassessed hazards:

Table 8. Corrected Hazards and Risks Taking into Consideration Renovation Works

Drinking water supply system component	Hazardous events	Hazard	Likelihood	Severity	Qualitative risk
Water disinfection	*Inadequate Disinfection insufficient amount of residual chlorine in water system*	*Microbial pathogens*	E *Recently manual liquid chlorination was replaced with automatic salt electrolysis chlorination method which ensures effective chlorination of water from two headwork collectors*	4	H *(High risk, management attention needed)*
Water disinfection	*Inadequate Disinfection High amount of residual chlorine in water system*	*Chemical*	*E Recently manual liquid chlorination was replaced with automatic salt electrolysis chlorination method which ensures effective chlorination of water from two headwork collectors*	*4*	*H (High risk, management attention needed)*
Headworks and water abstraction points	*Domestic and wild animals can access the water catchment area, which could result in the animal faecal matter entering the water supply*	*Microbial pathogens*	*D The headworks are located in places that are accessible by humans and animals , but currently raw water from headworks is fully treated the likelihood of contamination of potable water is moderate*	*4*	*H (High risk, management attention needed)*
Headworks and water abstraction	People may access the water	*Chemical*	*D Headworks is not fenced*	*5*	*H (High risk,*

points	catchment area and purposefully or unintentionally discharge chemicals into the wells *leading to chemical pollution of the source water*		*and guarded; But, there no single case of the source wate chemical contamination recorded; Therefore, the likelihood of water chemical pollution is not very low*		*management attention needed)*
Headworks and water abstraction points	Damaged headworks structures may result *in easy access of organic and chemical pollutants into source water*	Microbial, physical chemical	*D Headworks of "Jvari Patiosani" is already renovated. Water abstraction points and Headworks collector structures at "Burus Nakalakry" are damaged to different extents because no fundamental maintenance/rehabilitation has been carried out. However, The headworks are located in places that are accessible by humans and animals , but proceeding from the fact that raw water from headworks now is fully treated the likelihood of water contamination is not high*	4	H (High risk, management attention needed)
Headworks and water abstraction points	*Increased water turbidity during heavy (seasonal) rains*	Physical	E *Water filtrate drainage is very close to river bed and lack of embankments lead to flooding of intake facility during high waters; Proceeding from the fact that raw water from headworks now is fully treated the likelihood of water contamination is low*	2	*L – Low risk, manage by routine procedures.*
Reservoirs	*Domestic and wild animals can access the reservoirs, which could result in faecal matter entering the treated water*	*Microbial Physical*	D *All reservoirs are fenced and full-time operators work there, but poor condition creates risks for potential contamination*	3	*M – Moderate risk, management responsibility must be specifies;*
Main pipes and distribution network	*Damaged pipes and insufficient pressure, water interruption can result in backflow from customer systems into the network.*	*Microbial pathogens*	*C At some points pipes are damaged , there is frequent water interruptions and contamination by backflow is likely*	*4*	*E (Extreme risk, immediate action required)*

Other hazards and control measures approved and judged acceptable for the Telavi Water Supply Service Center with certain comments, are as follows:

- Increase of frequency of monitoring at intakes and in the networks;
- Periodical treatment of reservoir bottoms
- Washing/flushing valves should be installed in the distribution network, which will help to clean the system from residual material.

For effective implementation of the control measures, the following supporting programmes should be implemented:

- Laboratory capacity building for improving water quality monitoring;
- Defining the actual water demand and losses (elaboration of water balance);
- Developing a hydraulic model;
- Elaboration of long term development plans for the water supply system.

A consolidated list of hazards, related hazardous events/hazard sources and suggested control measures, monitoring and supporting programs which include above mentioned remarks, is presented in table 9 below.

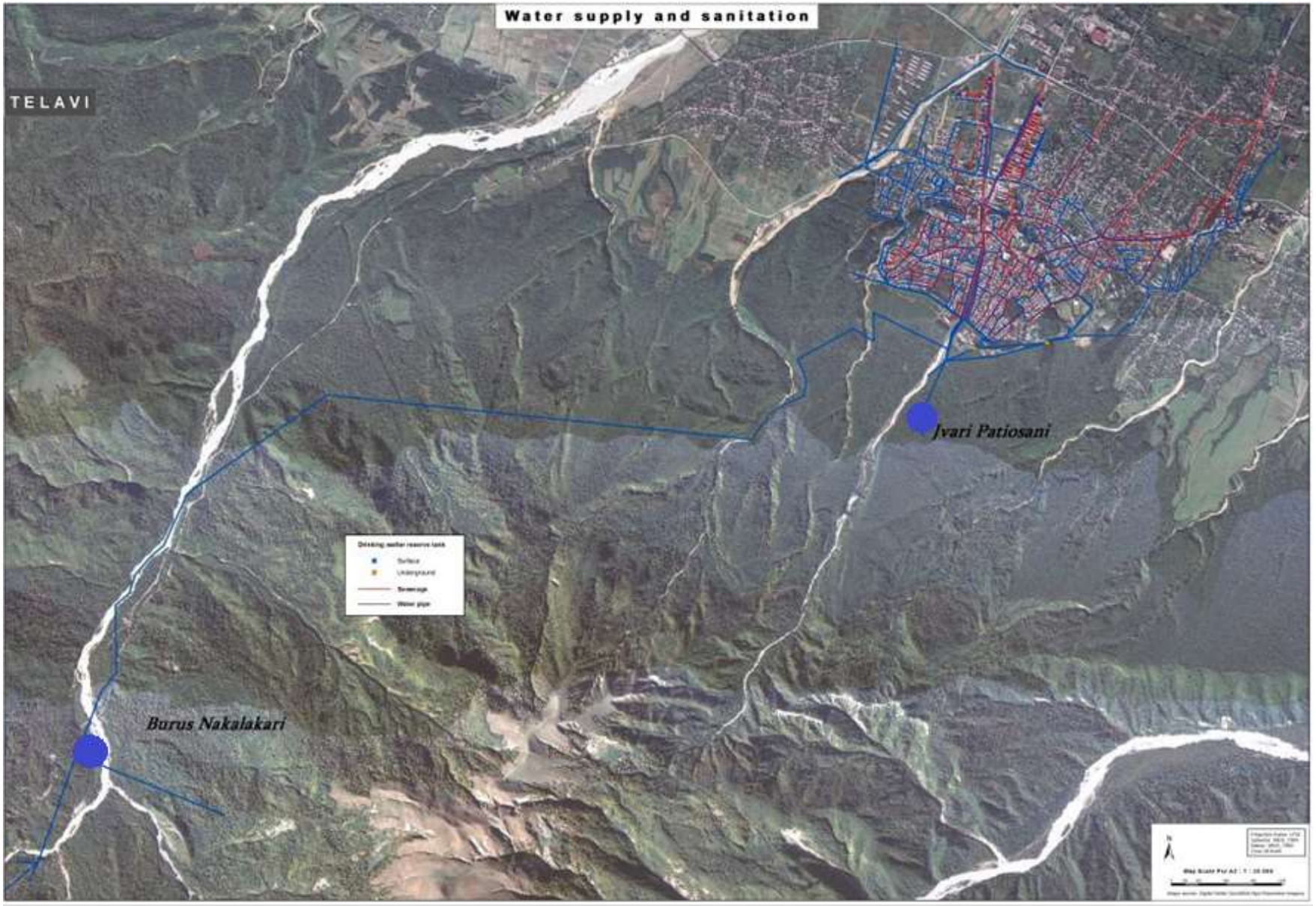
Table 9 . Hazardous Events, Hazards, Control and Monitoring Measures and Supporting Programs Identified for Telavi Water Supply System

#	Drinking water supply system component	Hazardous event/situation/hazard source	Hazard	Risk level	Control measures		Supporting programs
					Control and monitoring measures	Additional measures after validation workshop	
1	*Water disinfection*	*Inadequate disinfection Insufficient or high amount of residual chlorine in water system*	*Microbial pathogens chemical*	*H (High risk, management attention needed)*	***Short term strategy:*** • Carry out chlorination in compliance with corresponding norms • Ensure proper operation of new treatment plant	-	• *Strengthening of the technical capacity of service centre laboratories* • *Training of laboratory staff on water monitoring implementation* • *Results of laboratory testing (particularly microbial contamination parameters) require more detailed description and quantitative reflection* • *Identification real water supply-*
2	*Headworks and water abstraction points*	*Domestic and wild animals can access the water catchment area, which could result in the animal faecal matter entering the water supply*	*Microbial pathogens*	*H (High risk, management attention needed)*	**Short term strategy** • Appoint guard for supervision of water intakes • Fence water intake facility sanitary zone **Long term strategy** • Rehabilitate and modernize damaged water intake units at "Burus Nakalakari"	• Increase frequency of monitoring of water quality	
		People may access the water catchment area and purposefully or unintentionally discharge chemicals into the wells leading to chemical pollution of the source water	*Chemical*	*H (High risk, management attention needed)*	**Short term strategy** • Appoint guard for supervision of water intakes • Fence water intake facility sanitary zone **Long term strategy** • Rehabilitate and modernize damaged	• Increase frequency of monitoring of water quality	

					water intake units at "Burus Nakalakari" Headwork collector		*demand and water losses (development of real water balance);* • *Setting up of hydraulic model of water supply system* • *Development of action plan for public information and recommendation in case of drinking water pollution and emergency situation* • *Elaboration of long term development plan for water supply system* • *Periodical update of water safety plan and service training of staff*
		Damaged headworks structures may result in easy access of organic and chemical pollutants into source water	*Microbial, physical chemical*	*H (High risk, management attention needed)*	***Short term strategy*** • Appoint guard for supervision of water intakes • Fence water intake facility sanitary zone ***Long term strategy*** • Rehabilitate and modernize damaged water intake at "Burus Nakalakari" Headwork collector	• Increase frequency of monitoring of water quality	
		Increased water turbidity during heavy (seasonal) rains	*Physical*	*L (Low risk, manage by routine procedure)*	***Short term strategy:*** • Arrange river revetment structures at "Burus Nakalakari" Headwork collector		
3	*Reservoirs*	*Domestic and wild animals can access the reservoirs, which could result in faecal matter entering the treated water*	*Microbial Physical*	*M (Moderate risk, management responsibility must be specifies)*	***Short term activities:*** • Rehabilitate/Install reservoir roofs and ventilation equipment and keep it always close ***Long term strategy:*** • Modernize reservoirs with technical equipment (water level meter, window for observation)	• Periodically clean reservoir's bottoms	
4	*Main pipes and distribution network*	*Damaged pipes and insufficient pressure, water interruption can result in backflow from customer systems into the network.*	*Microbial pathogens*	*E (Extreme risk, immediate action required)*	***Short term strategy:*** • Rehabilitate main pipes • Rehabilitate/ renovate remaining part of water distribution system • Rehabilitate damaged valves • Install water meters ***Long term strategy:*** • Construct about 4000 m^3 reservoir to ensure a significant	• Washing valves should be installed at the respective points in the distribution network, which would help to periodically wash out residual material from the distribution network; • Increase frequency of water monitoring in the network	

Annexes

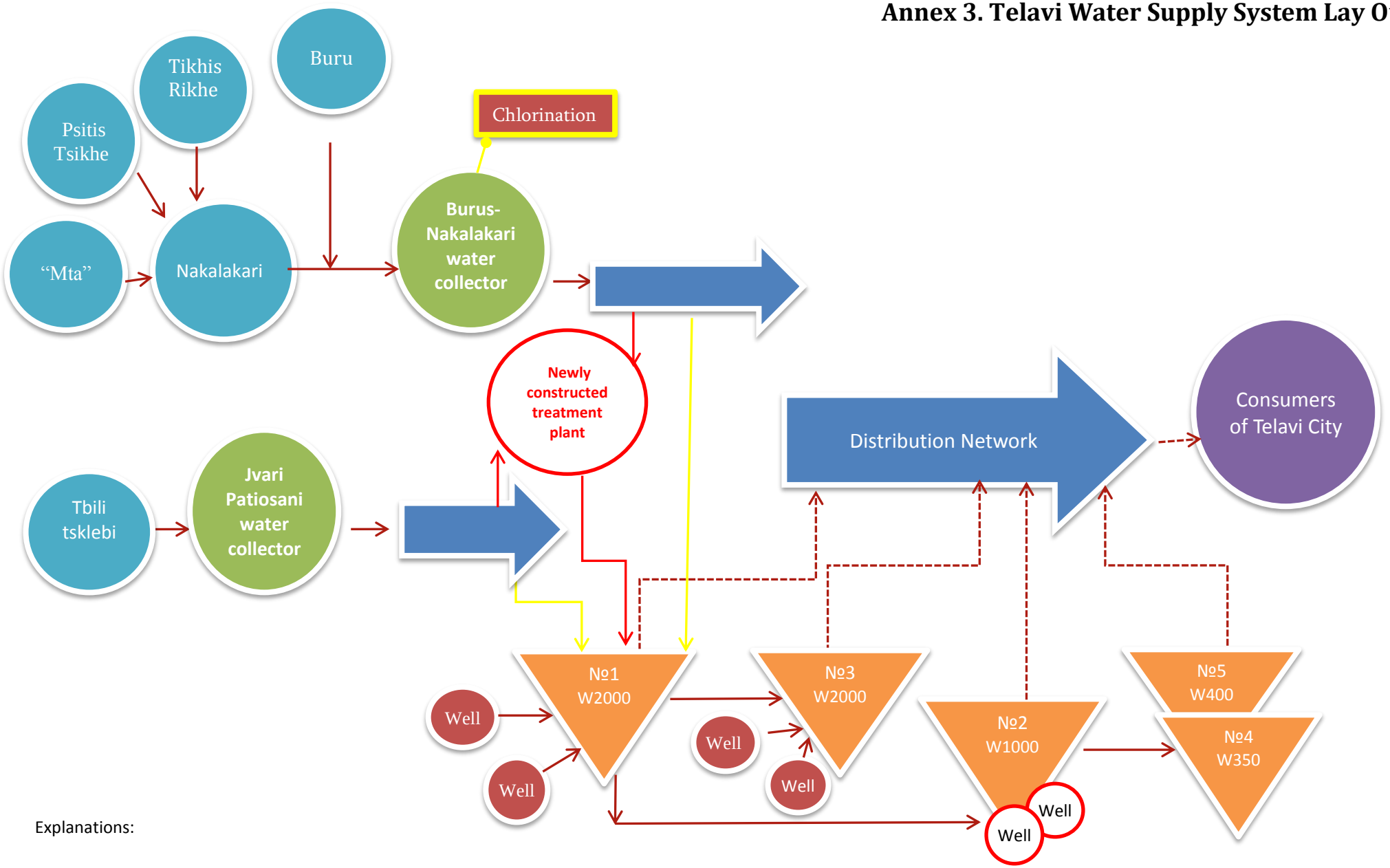
Annex 1. Map of water supply system of the town Telavi



Annex 2. Basic Data on Telavi Water Supply System

Number of consumers served by the company	Number of households served	Consumers with water meters	Water source name, type and discharge	Number and volume of water collector reservoirs	Water treatment method	Total length of the main and distribution system
16354	6694	461	"Burus Nakalakari" Drainage and Catchment -70 L/sc. "Jvari Patiosani" - Drainage and catchment -60L/sc. N 1, 2, 3, 4 wells discharge total capacity 20 L/sc.	2000 m^3 - 2 pieces 1000 m^3 - 1 piece 350 m^3 - 1 piece 450 m^3 -1 piece	Settling filtration Chlorination	Total Length - 63.4 km.

Annex 3. Telavi Water Supply System Lay Out



Explanations:

Operation stage (water abstraction, purification, consumption)

Accumulation stage (reservoirs and tanks

Transportation stage

Uninterrupted process

interrupted proses

Red lines - newly completed works

Yellw lines - nonfunctional stage and process

Annex 4. Sanitary Requirements for Drinking Water Quality (Defined by the Technical Regulation of Drinking Water. Decree #349/N Ministry of Labor, Health and Social Affairs of Georgia 17.07.07)

Index	Measuring unit	Standard not more than
Smell	Numbers	2
Taste	Numbers	2
Coloration	Degree	15
Turbidity	Turbidity unit (by formazin or Mg/l by kaolin)	3,5 2
Sulphate (SO42-)	mg/l	250
Chloride (Cl-)	mg/l	250
Oil products, total	mg/l	0.1
Surfactant substance anion active	mg/l	0.5
Rigidity	mg-eq/l	7-10
Calcium (Ca)	mg/l	140
Magnesium (Mg)	mg/l	85
Sodium (Na)	mg/l	200
Zinc (Zn 2+)	mg/l	3.0
Iron (Fe, total)	mg/l	0.3
Mezophilic aerobes and facultative anaerobes	Colony forming unit/ml 37 0C 22 0C	 20 100
Total coliformic bacteria	Amount of bacteria in 300 ml	not allowed
E.coli	Amount of bacteria in 300 ml	not allowed
Pathogenic microorganisms, including Salmonella	In 100 ml	not allowed
Coliform	Negative colony forming unit in 100 ml	not allowed
Pseudomonas aerugiosa (only for pre-aliquoted)	in 250 ml	not allowed

Annex 5. Numberof Completed Analysis by Month During 2011 Year
Kakheti Regional Branch Office, Telavi Service Center

NAMES OF INDEPENDENT WATER SUPPLY SYSMENS: 1.Burus Nakalakari 2. Jvari Patiosani													Month
Number of Portable Water Quality Inspections at Control Units													
TOTAL INSPECTIONS	Headwork At Surface Water Headworks (raw water)			At Ground Water Headworks (raw water)			Released (treated) Potable Water			Potable Water in Distribution System			
	TOTAL	inter alia		TOTAL	inter alia		TOTAL	inter alia		TOTAL	inter alia		
		With normal range	Divergence from a norm (+)		With normal range	Divergence from a norm (+)		With normal range	Divergence from a norm (+)		With normal range	Divergence from a norm (+)	
304	1	1	0	11	10	1	45	44	1	247	240	7	TOTAL
20				1	1	0	1	1	0	18	18	0	January
19							1	1	0	18	16	2	February
26							2	2	0	24	23	1	March
26				3	3	0	2	2	0	21	21	0	April
24							4	4	0	20	18	2	May
24							3	3	0	21	21	0	June
27	1	1	0				5	5	0	21	21	0	July
32							5	5	0	27	27	0	August
27							5	5	0	22	22	0	September
28				2	1	1	7	6	1	19	18	1	October
24				2	2	0	5	5	0	17	17	0	November
27				3	3	0	5	5	0	19	18	1	December
304	1	1	0	11	10	1	45	44	1	247	240	7	TOTAL

Annex 6. 2011 Registered Cases of Contagious Diseases for the City of Akhmeta

Source: Statistical Yearbook, medical statistics, 2011

Cases of Contagious Diseases, 2011		
Telavi		
#	Types of Diseases	Number of registered cases
1	Viral hepatitis A	0
2	Acute viral hepatitis B	1
3	Chronic viral hepatitis B	0
4	Typhus	0
5	Para typhus A, B, C	0
6	Salmonellosis	0
7	shigellosis (shigella infection)	0
8	Other bacterial intestinal diseases	2
8.1	including: escherichiosis	2
9	Yersiniosis	1
10	Amebiasis	1
11	Diarrhea	40
12	Brucellosis	11
13	Malaria	0

Annex 7. Photo gallery

Picture 1. Service Senter of Telavi

Picture 2.Constructing new drinking water treatment plant

Picture 3. Constructing horizontal settler

Picture 4. #1 Reservoir

Picture 5. #2 Reservoir

Picture 6. Territory of #2 Reservoir

Picture 7. Laboratory of Telavi service center

Picture 8. Portative water testing equipment

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