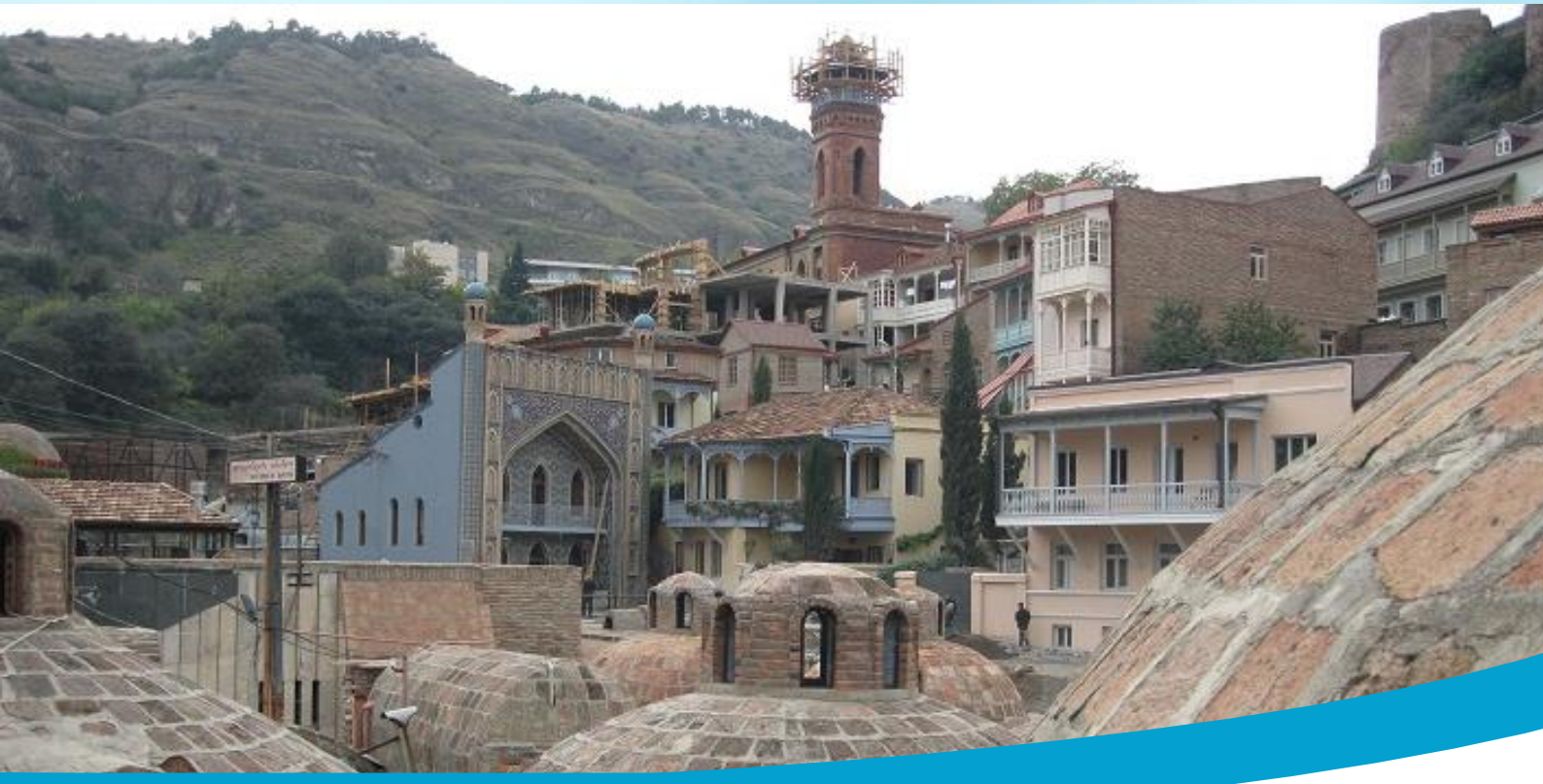
Assessment of Water Supply System, Oni
Republic of Georgia

Technical Report Number 9



Integrated Natural Resources Management in the Republic of Georgia Program

Technical Report Number 9

Assessment of Water Supply System, Oni

Republic of Georgia

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List of Acronyms and Abbreviations

1. ^{o}C – Temperature degree by Celsius scale
2. CENN – Caucasus Environmental NGO Network
3. Cfu - Colony forming unit
4. D – Diameter
5. E. coli – Escherichia Coli
6. EU – European Union
7. FIU-Florida International University
8. GIS – Geographic Information Systems
9. GLOWS – Global Waters for Sustainability
10. GWP – Georgian Water and Power
11. INRMW – Integrated Natural Resources Management in Watersheds
12. LLC – Limited Liability Company
13. IHE – International Hydrological Education
14. L – liter
15. L/d – liter per day
16. L/sc – liter per second
17. m – meter
18. m^3 – cubic meter
19. m3/h – qubic meter per hour
20. mm - millimeter
21. m^2 – square meter
22. mg/l – milligram per liter
23. ml - milliliter
24. NGOs – Non-governmental Organizations
25. UNESCO –United Nations Educational, Scientific and Cultural Organization
26. USAID – United States Agency for International Development
27. WHO – World Health Organization
28. WI – Winrock International
29. 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 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) of pilot watershed areas of Rioni and Alazani-Iori river basins. To accomplish this task, the 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, Ambrolauri) of upper pilot watershed areas of Alazani-Iori and Rioni Basins, followed by the second stage of developing WSPs for urban areas (Dedoplistskaro, Senaki) of lower pilot watershed areas. Assessments of water supply systems are baseline studies for WSPs that envisage detailed description of centralized water supply systems, and identification of existing and potential hazards, hazardous events/situations and/or hazard sources and assessment of their risks.

The present report is a detailed assessment of water supply system for the city of Oni. It includes a description of the system, identification of existing hazards to drinking water quality, their sources and related hazardous events/situations and/or sources for hazards 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, description of the methodology used to gather data of the existing water supply system, identification of hazards, assessment of their risks and determining control measures. The report will serve as a basis for developing the WSP for the water supply system of the city of Oni 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, www.who.int

2. Methodology

Assessments of water supply systems of targeted cities of pilot watershed areas of INRMW program 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 an 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 for collecting information and elaborated flow diagrams which reflect all units of water supply systems from catchment to point of use. The following aspects were assessed based on collected information:

- Land use in the catchment area;
- Abstraction method and location;
- Likely changes of water quality at the source;
- Detailed description of 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.

As a next step the WSP team has identified the hazards, their sources and/or related hazardous events/situations and assessed their risks. More specifically, the team identified all potential biological, physical and chemical hazards associated with each step/element of the drinking water supply that can affect the drinking water safety followed by 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 Frameworks for the Drinking Water Supply Sector

Currently, issues related to the potable water are regulated by the laws on Public Health, on Water and on 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 the water allocation for drinking and bathing purposes. Furthermore, the law requires the setting of 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 the 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, regional characteristics, including climate and relief conditions of the country. 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 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 for carrying 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 reasons, restriction of water supply and implementation of corrective measures for the safety of the population[5].

[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;

[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/

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 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 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 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 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 Desinfecntion 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 Tarrifs".
- # 10 Decree, 30.01.2009 of the Government of Georgia on "Approval of the Charter on the Ministry of Regional Development and Infrastructure".
- 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:

[6] nfa.gov.ge
[7] www.nsc.gov.ge
[8] https://matsne.gov.ge/index.php?option=com_ldmssearch&view=docView&id=80770
[9] water.gov.ge

- The Ministry of Labor, Health and Social Protection sets out ambient water quality standards in accordance with WHO guide values.
- 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 objects 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 it from the Ministry of Energy.
- The Ministry of Regional Development and Infrastructure is responsible for state planning a 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 regional branch, ii) Shida Kartli and Mtskheta-Mtianeti regional branch, iii) Kvemo Kartli regional branch, iv) Samktskhe-Javakheti regional branch, v) Samegrelo, Zemo Svanety and Guria regional branch, vi) Imereti, Racha-Lechkhumi and Kvemo Svaneti regional branch and, vii) Kutaisi branch. These branches have their laboratories, which conduct self-monitoring activities for drinking water quality in the urban water supply system under their responsibility.
- 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, 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. Georgian Water and Power serves about 400 000 customers throughout the city, out of which about 2000 are budget organizations, 15 000 commercial objects and the rest of them are residential customers.

4. Description of Water Supply System from Catchment to Consumer

The water supply system of the City of Oni is subordinated to the Imereti, Ratcha-Lechkhumi and Kvemo (Lower) Svaneti Regional Branch of the "United Water Supply Company of Georgia". The Service Center of Oni consists of 13 employees, of which 7 are technical-engineering and operational staffs. Please see Annex 7, pic 1.

The city is located in western Georgia, on the southern slopes of the Caucasus range, 800 m above sea level. Two headworks: "Kvedi" (E 43°32'20.84" N 42°32'52.19") and "Zhizhoreti" (E 43°28'7.676" N42°36'33.669"), are used for drinking water abstraction. These intakes are situated above the distribution network and the water flows by gravity from the source to the city.

4.1 Main Characteristics of the Water Source and its Catchments

Land use. "Kvedi" headworks is located in a remote area with no agriculture and other economic activities carried out close to it. This territory represents predominately forest covered and rocky mountains and is an upstream area of the watershed of the Kvedrula river, right tributary of the Jejora river (left tributary of the Rioni river). Please see pic 2. in annex 7.

"Zhizhoreti" headworks is located on the left bank of the Rioni river. It is surrounded by forest covered high mountains. No agriculture activity is carried out in surroundings of water source and its catchment but the area is easily accessible to animals. Please see pic. 6-7 in annex 7.

Main characteristics of water sources. For the headworks "Kvedi" water abstraction source is a spring of the karst groundwater contained in the aquifer of Paleocene and Upper Cretaceous carbonate rocks composed of marl and limestone.[10] The spring takes its origin from the forest area, then disappears in the caves near the village "Kvedi" and appears again at the headworks' territory. The catchment of the "Zhizhoreti" headworks is the Rioni river filtratate.

For the situation map and diagram of the system please see Annex 1 and 3.

Abstraction method and location. The catchment of "Kvedi" headworks is located at 1,045 m above sea level. Water is abstracted from the "Tskhra Tskaro" source by a spring water collector. The sanitary zone of the headworks is not fenced, the territory is guarded/supervised. The size of the 1st sanitation zone is 11,813 m^2, and is located 11.4 km from the city.

The catchment of the "Zhizhoreti" headworks is the Rioni river filtration drainage. The headworks is located at 845 m above sea level. It is not fenced or guarded/supervised. The size of the first sanitation zone is 16,891 m^2, and is located 2 km from the city. Please see pic. 8-9 in Annex 7.

Water Quality at Sources. Deterioration of the water quality at "Kvedi" headworks, is predominately caused by heavy rains, which wash limestone out of karst sediments and increase the turbidity of ground water. 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 the headworks due to absence of relevant technical facilities.

[10] Annex 2, Technical report 12. Detailed Assessment of Natural Resources of Upper Rioni Pilot Watershed Area. www.globalwaters.net

Another potential cause for deterioration of water quality (microbiological cause) might be both unprotected headworks, "Zhizhoreti" headworks is also unguarded/supervised. Domestic and wild animals can easily 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.

The map of water supply system of the city of Oni is presented in Annex 1.

4.2 Description of Water Supply System

4.2.1 Water Abstraction and Treatment

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

Headworks "Kvedi" was built in 1948. The structure is obsolete and its current state is poor. Please see the photo gallery in annex 7, pictures 2-5. The water flow rate is 60-71 L/sc. The water collector of the Kvedi headworks is a well with the following specifications: 3.8 m deep 4.5 m x 5.5 m square. Water is collected through captation of the groundwater. There are old and damaged sedimentation and filtration facilities at headworks, which are out of operation and accordingly technological treatment of abstracted water is not provided. There is a small size building that is periodically used for chlorination. The water is chlorinated mostly in summer by chlorinated lime twice a month as a preventive measure.

"Zhizhoreti" headworks was built in 1985 and rehabilitated 2001, but in 2006 the structure was destroyed, the reason being the flooding of the Rioni river. Please see the photo gallery in annex 7, pictures 6-9. Total length of horizontal drainage network is 120 m and consists of 6 small size concrete wells (1.2 m X 1.5 m, with 2-3 m depth), from which two are collectors. The wells are close to the Rioni bank and 20-meter from each other. They are interconnected by ground water collection pipes and water is collected in two collector wells. The drainage network has recently been rehabilitated and 120 mm – 350 mm diameter asbestos-concrete pipes replaced with 250 mm diameter PVC pipes. However, 10 m long asbestos pipe still exists. At the abstraction point, average water flow rate is 14-20 L/sc. Drainage wells do not have roofs/covers. No technological treatment and disinfection takes place at the headworks.

4.2.2 Water Conveyance and Distribution

From "Zhizhoreti" headworks water flows to the distribution network through 220 mm diameter and 2.3 km long main pipe. In 2007, the 450 m fragment of this pipe was replaced by the same diameter steel and PVC pipes. The remaining part is old and dilapidated (e.g. corroded and leaking at many points).

From the water collector of the "Kvedi" headworks water flows (through the valve) to the steel water main with following specification: 300 mm diameter 0.3 km long section, 600 mm diameter 1.1 km long section and 250 mm diameter 8.0 km long section. Total length of the main pipe is 9.4 km. It is out of date (50 years old) and in unsatisfactory condition. The 2.0 km long fragment of the 8 km long and 250 mm diameter section of the water main is replaced with 270 mm diameter steel pipe.

The capacity of headworks supports the 24 h operation of the system, but in summer, with high numbers of tourists, and sometimes during the winter, water shortage particularly, in hilly areas of the city is observed. As the water supply system operates without a reservoir, accumulation of water particularly during high water demand hours is not carried out. Existing 2,000 m^3 capacity concrete

storage reservoir (located at 800 m above sea level) does not operate, it was damaged in 1991 by an earthquake. The reservoir is located below “Kvedi” headworks, near the city of Oni.

Total length of the distribution network is up to 21 km. The network was entirely rehabilitated in 2009-2010 and steel pipes were fully replaced with new PVC pipes. There is almost 250 m pressure gradient between catchment and distribution network that requires pressure reduction. Currently, the pressure regulating tank is damaged. Pressure in the network reaches 1.5 – 2 bars and is regulated through 7 valves/gears, which are not enough for providing water at high locations.

4.2.3 Water Consumption and Consumers

The water supply system of Oni city serves about 3,051 people. In total there are 1,202 customers, from which 1,134 are households and 68 organizations. This is about 95% of the total population of the city. In addition, it serves 20 more consumers in nearby settlement Tsmendauri. Remaining 5% of Oni population is supplied from the Gari village water supply system, which is not under the responsibility of the United Water Supply Company of Georgia.

Most of the city has round-the-clock water supply. 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 m^3 of water (for the time being this rate includes the price for sanitation service).

According to the Oni Service Center, the average daily amount of drinking water consumption per capita is 800 l (and even more from spring to early fall), which is estimated without individual water meters. This amount is high and may be attributed to the source water spring capacity,water losses in the system (10%) and non-essential and inefficient water uses. Daily water consumption for the city of Oni is extremely high in comparison with the established rate by European countries, which varies from 120 to 150 L/d per resident.

5. Risk Assessment

Identification of hazards, their sources and potential hazardous events/situations as well as risk assessment of the Oni 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)[11], 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 developed 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. *R*egular water quality monitoring of the Oni system currently focuses on the following basic set of parameters: *Microbial parameters – E. Coli and total Coliforms*; *Physical parameters* - taste, odor, color, turbidity, pH, temperature; chemical parameters residual chlorine, total hardness nitrites, ammonium chlorides, sulphates, iron.

The laboratory control of the drinking water is carried out by the Oni Service Center and the Imereti, Racha-Lekhumi and Kvemo Svaneti Regional Laboratory of the UWSCG; water quality monitoring points are set up by the central office of the UWSCG and is 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.

The Laboratory of the Oni Service Center has been recently abolished and water testing is conducted by Imereti, Racha Leckhumi and Lower Svaneti regional laboratory. It should be noted that the frequency of sampling and analysis of drinking water for microbial and chemical contamination is rather low for Oni water supply system that significantly limits availability to get a full picture of drinking water quality in the referred system.

Assessment of drinking water quality for the Oni water supply system is based on 2011 water quality monitoring data (see annex 5). According to these data, 19 samples were collected, from which 7 samples were taken from Zhizhoreti intake, 7 samples – from Kvedi intake and 5 samples – from the

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

distribution network[12]. 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 Oni Drinking Water Suppy System[13], 2011

Monitoring Point	umber of samples	Compliance with the National Standards %			
		Compliance		Noncompliance	
		Numb. of samples	%[14]	Numb. of samples	%
ıizhoreti" headworks (raw water)	7	6	86	1	14
vedi" headworks released (treated) water	7	4	57	3	43
table water in distribution system	5	2	40	3	60
total	19	12	63	7	37

The figures in the table show that 86% of samples from "Zhizhoreti" source and 57% of samples from "Kvedi" headworks meet the National Standards. 5 samples were collected from the distribution network and among them, 3 (60%) samples did not meet hygienic requirement. As the distribution network is entirely rehabilitated, this might be caused by damaged fragments of the main pipe, inadequate chlorination process and/or water interruptions.

All samples recorded as "non-compliance" were taken in the months of April-July. This period is characterized by snow melting, heavy rains, high temperatures and water interruptions. On average, 12 samples (63%) out of 19 samples taken from various key points of Oni Water Supply System met the National Standards.

In order to identify issues related to particular parameters, additional information was requested from the service center. 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 April to July, 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 Oni, statistics for 2011 shows 150 cases of diarrhea. However, there is no evidence that these cases had resulted from water contamination. For detailed information please refer the annex 6.

5.2 Identification of Hazards, their Sources and Potential Hazardous Events/ Situations

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 Oni 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.

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

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).*

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

Table 2. Questionnaire for sanitary observation

#	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 waste collecting sites within 30 m of the catchment?		X
4	Is there any source of pollution within a 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 arranged?	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		8	2

As shown by the aggregated responses to the questions on Oni Water Supply Sanitary Inspection Questionnaire, 8 positive responses out of 10 questions were received, indicating that the system belongs to the ***high risk category*** systems.

Thus, the WSP team has identified the following hazardous events/situations/sources for water contamination:

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 stage (sedimentation/coagulation reservoir, chlorination) at intakes.
3. Improper design and outdated technologies for chlorination.
4. Frequent interruptions in water supply.
5. Damaged main pipes.

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. Bacteriological 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 though no serious source of chemical contamination was found in the water catchment.

5.3 Prioritization of Hazards

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.

The risk of hazards was assessed by two factors: likelihood and potential 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.

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

Table 3. Hazard prioritizing matrix for Oni water supply system

Deviations from 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	37[15]	0
11-30	0	0	0	0
1-10	0	0	0	0
Risk level	low	medium	high	very high
Priority action level	none	low	**high**	urgent

Despite the fact that 12 (63%) water samples out of 19 meet the national standards and just 7 (37 %) are deviated from the standard, the system falls within according to the results (score 8) of filled sanitary questionnaires the entire system, including distribution network is assessed at *high risk*; respectively, the water supply points scored as "yes" in the sanitary inspection form represent the potential sources/factors of hazards for microbiological of drinking water.

Thus, on the basis of the sanitary questionnaire and hazard prioritizing matrix for Oni water supply system biological and physical contamination risk factors were identified that have a negative impact on the quality of drinking water and represent a hazard for exposure to waterborne diseases. In more details, on the basis of visual inspection and the results of the sanitary observation questionnaire, the following components of water supply system were identified that might cause contamination of potable water:

- Water disinfection;
- Headworks;
- Main Pipes.

Apart from above, the quality of the water testing laboratory and water quality monitoring can be considered as factors that may indirectly impact the water quality. As it was described in the above

[15] The figure reflects (in totals) deviation from standards identified at all monitoring points

paragraphs of this chapter, Oni Service center does not have laboratory and water quality testing is conducted by regional laboratory located in Tskaltubo. Given the distance between Oni and the latter, it is difficult to conduct every day monitoring of water quality and thereby, sampling and analysis frequency is low (e.g. 19 samples in 2011). This is judged to be insufficient given that the headworks structures are damaged, water intake facilities are not fenced or guarded, no technological treatment or disinfection is provided and water abstracted at the headworks goes directly to the main pipe of water supply system and, chlorination is carried out manually by primitive methods that do not guarantee optimum concentration of the chlorine in water. 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 – level of risk

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
	1	2	3	4	5
A (almost certain)	H	H	E	E	E
B (likely)	M	H	H	E	E
C (moderate)	L	M	H	E	E
D (unlikely)	L	L	M	H	E
E (rare)	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 Oni water supply system

Drinking water supply system component	Hazardous event/situation/hazard source	Hazard	Likelihood	Impact/ severity	Qualitative risk
Water treatment	Inadequate Disinfection *insufficient amount of residual chlorine in water system*	Microbial pathogens	**D** *Chlorination of Kvedi source water is carried out by the primitive method (chlorine lime) twice a week in summer time, which is not effective for proper concentration of chlorine*	4	H *(High risk, management attention needed)*
Water treatment	Inadequate Disinfection *High amount of residual chlorine in water system*	Chemical	D *Chlorination of Kvedi source water is carried out by the primitive method (chlorine lime) twice a week in summer time, which is not effective for proper concentration of chlorine*	4	H *(High risk, management attention needed)*
Water treatment	Absence of disinfection *Possibility of water contamination at any stage of water supply*	Microbial pathogens	B *There is no chlorination of Zhizhoreti source water. Though, out of total (7) samples taken from this sources only 1 was non-compliant with water quality standards, we can't consider these data as solid evidence for good water quality due to the low number of samples taken from this headworks. Therefore, the probability of source water contamination is assessed at high*	4	H *(High risk, management attention needed)*
Water treatment	Increased water turbidity and changed color during heavy (seasonal) rains *(particularly at "Kvedi" intake facility)*	Physical	C *Water sources represent ground waters (karst-origin waters) which is easily impacted by heavy rains. Besides, technological treatment of water is not carried out*	3	H *(High risk, management attention needed)*
Headworks and water abstraction points	Humans, domestic and wild animals can access the water catchment area, which could result in the animal faecal matter entering in the water supply	Microbial pathogens	C *The headworks are unfenced and located in forest covered area and might be easily accessible to wild animals and birds. The "Zhizhoreti" headworks is unguarded/not supervised. . Source water quality data do not indicate at frequent cases of contamination, though number of samples taken during entire years is low. Stemming from above, the likelihood of source water bacteriological contamination is ranked at moderate*	4	E *(Extreme risk, immediate action required)*
Headworks and water abstraction points	Increased water turbidity and changed color during heavy (seasonal) rains *(particularly at "Kvedi" intake facility)*	Physical	C *Water sources represent ground waters (karst-origin waters) which is easily impacted by heavy rains. Besides, headworks are in poor condition and technological treatment of water is not carried out*	3	H *(High risk, management attention needed)*
Headworks and water	People may access the water catchment area and	*Chemical*	*E The headworks are unfenced and*	*5*	*H (High risk,*

abstraction points	purposefully or unintentionally discharge chemicals into the wells *leading to chemical pollution of the source water;* Significant source of chemical pollution may exist in the catchment *and may pollute source water*		*located in forest covered area, herewith "Zhizhoreti" headworks is unguarded/supervised. There no single case of the source water chemical contamination recorded; No serious source of chemical pollution was detected in the catchment; Therefore, the likelihood of source water chemical pollution is very low*		*management attention needed)*
Headworks and water abstraction points	Damaged headworkss structures may result *in easy access of organic and chemical pollutants into source water*	Microbial chemical	*C* *Headworkss structures are partially obsolete and/or damaged and collector wells uncovered; In 2011 14% of Zhizhoreti source water and 43% of Kvedi source water didn't comply with national drinking water quality standards. The figure is pretty high for Kvedi headwork. However, water quality data are not sufficient enough to judge about the trend of the source water contamination. Stemming from the fact that headworks are located in remote unpopulated areas with no/low human activities there, but taking into account water quality data and the poor condition of headworks, likelihood for source water contamination is ranked at moderate*	4	E *(Extreme risk, immediate action required)*
Main pipes and distribution network	Damaged main pipes and insufficient pressure, water interruption can result in backflow from customer systems into the network.	Microbial pathogens	B *in some points main pipes are damaged, the water pressure regulating valves is not sufficient . The system works without regulating reservoir*	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 Oni Service Center, visual inspection of the system and analysis of existing drinking water quality data. 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 Oni the following control measures should be carried out:[16]

1.***Source and source protection***

- Fencing of water intake facility sanitary zone (where it is possible) and 24-hour guarding/supervising at all headworks to avoid the potential hazard of surface spring water contamination in case of anthropogenic involvement at the intake point/territory.
- Full-scale rehabilitation of all intake facilties.
- Installation of roofs of drainage wells at "Zhizhoreti" headworks.
- Interruption of water supply during high turbidity
- Renewal of the water technological treatment process, including renovation of the sedimentation tank/basin, filter at Kvedi headworks.

2.***Water treatment***

- Carrying out chlorination in compliance with corresponding norms (.e.g. increase in chlorination frequency with chlorinated lime).
- Rehabilitation/renovation of chlorination station at Kvedi headworks.

- Adding chlorination stage at "Zhizhoreti" headworks.
- Interruption of water supply during high turbidity
- Renewal of the water technological treatment process, including renovation of the sedimentation tank / basin, filter at Kvedi headworks.

3.***Main pipes and distribution network***

- Replacement/renewal of the damaged part of D - 300/600/250 mm diameter and 300/1100/600m-length main steel pipeline, connecting "Kvedi" water source to the City.
- Replacement/renewal of obsolete and damaged part of D - 220 mm 1500 m long main steel pipeline.
- Rehabilitation of the pressure regulating station at the city entrance.
- Rehabilitation and renewal of operations of existing 2,000 m^3 (or installation new one) concrete reservoir in order to optimize the corresponding pressure in the network and ensure proper water supply for the entire city, particularly in the summer period.
- Installation of water meters to help use water more efficiently.

[16] Recently, the government of Georgia, through Municipal Development Fund (MDF) has received a grant from USAID to improve the quality and quantity of drinking water provided to the residents of Oni. Please see chapter 6.2.

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

- Re-establishment of the local water testing laboratory.
- Equipping of the laboratory with modern equipment and conduct training for laboratory staff.
- Development of accurate and detailed database on laboratory testing results (particularly microbe contamination parameters).
- Development of a plan as to how to inform the population about the deterioration of the water quality and what protection measures should be taken from their side (boiling etc.) to avoid water borne diseases.
- Regular trainings should be conducted for service personnel to introduce new approaches to improve potable water quality and water safety plans.

Summary information on identified hazards, hazardous events and control measures for Oni water supply system is given in table 7 below.

Table 7. Identified Hazards and control measures for Oni water supply system[17]

#	Drinking water supply system component	Hazardous event/situation/hazard source	Hazard	Risk level	Control measures
1	**Water treatment**	Inadequate disinfection *Insufficient of residual chlorine in water system*	*Microbial pathogens*	H *(High risk, management attention needed*	***Short term strategy:*** • Carry out chlorination in compliance with corresponding norms (.e.g. increase chlorination frequency with chlorinated lime) ***Long term strategy:*** • Modernize chlorination procedure and technology
		Inadequate disinfection *high amount of residual chlorine in water system*	*Chemical*	H *(High risk, management attention needed)*	
		Absence of disinfection *Possibility of water contamination at any stage of water supply*	*Microbial pathogens, Chemical*	H *(High risk, management attention needed)*	***Short term strategy:*** • Add chlorination stage at "Zhizhoreti" headworks ***Long term strategy:*** • Modernize chlorination procedure and technology
		Increased water turbidity and changed color during heavy (seasonal) rains *(particularly at "Kvedi" intake facility)*	*Physical*	H *(High risk, management attention needed)*	***Short term strategy:*** • Interrupt water supply during high turbidity ***Long term strategy:*** • Renew water technological treatment process, including renovation of the sedimentation tank / basin, filter at Kvedi 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 system*	*Microbial pathogens*	E *(Extreme risk, immediate action required)*	***Short term strategy:*** • Install roofs with locks on the drainage wells of the "Zhizhoreti" headworks • Provide 24-hour guarding/supervising at "Zhizhoreti" headworks

[17] This table was drawn before USAID granting funds to the GoG for rehabilitation of Oni headworks

					• Fence sanitary zone of the (where it is possible) water intake facilities • Rehabilitate Kvedi headworks ***Long term strategy:*** • Fully r 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*	H (High risk, management attention needed)	***Short term strategy*** • Provide 24-hour guarding/supervising at "Zhizhoreti" headworks • Fence water intake facility sanitary zone (where it is possible) ***Long term strategy:*** • Rehabilitate and modernize damaged water intake units
		People may access the water catchment area and purposefully or unintentionally discharge chemicals into the wells *leading to chemical pollution of the source water;* Significant source of chemical pollution may exist in the catchment *and may pollute source water*	*Chemical*	H *(High risk, management attention needed)*	***Short term strategy:*** • Provide 24-hour guarding/supervising at "Zhizhoreti" headworks • Fence water intake facility sanitary zone (where it is possible)
		Increased water turbidity and changed color during heavy (seasonal) rains (especially at the Kvedi intake facility)	*Physical*	H *(High risk, management attention needed)*	***Short term strategy:*** • Interrupt water supply during high turbidity ***Long term strategy:*** • Arrange water technological treatment modules (sedimentation and clarification tanks) at Kvedi headworks
4	**Main pipes and distribution network**	Damaged pipes and insufficient pressure and water interruption can *result in backflow from customer systems into the network*	*Microbial pathogens*	E *(Extreme risk, immediate action required)*	***Short term strategy:*** • Ensure corresponding water pressure in the pipes by rehabilitaitng existing and installing additional valves ***Long term strategy:*** • Rehabilitate existing regulating 2000 m^3 reservoir or installation new one • Assess hotspot and carry out full rehabilitation of the main pipes and network • Install water meters

6.2 Risk Reassessment and Validation of Control Measures

After detailed description and identification of hazards for Oni water supply system, the next steps consist of risk reassessment and validation with technical personnel and the head of the Oni service center. For this purpose under the INRMW program a meeting was organized with a management team of the Oni 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 Oni 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 approved and judged acceptable for the Oni Water Supply Service Center with certain comments, particularly:

- Increasing of frequency of water quality monitoring, including residual chlorineWash out valves should be installed in the respective points in the distribution network, which would help to periodically wash out sediments from the distribution network;
- Earthquakes should be taken into consideration during the rehabilitation of the water supply units as one of the potential hazards for damage of the water supply system.

For effective implementation of the presented control measures the following monitoring and supporting programs should be implemented such as:

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

While drafting this report, the management of the UWSCG informed the WSP team that the government of Georgia, through Municipal Development Fund (MDF) received a grant from USAID to improve the quality and quantity of drinking water provided to the residents of Oni. The proposed works include construction of a new treatment plant with (a design capacity of 15 l/sec) sand filter; vertical filters with back flushing pumps (Q=72 L/sc, H=18 m, N=25 kW – 2 sets); chlorination units (liquid chlorine, 100 m^3/h– 2 sets) for disinfection; and construction of storage reservoir (1,000 m^3). The mechnical treatment and chlorination facilities will treat and disinfect raw water from the headworks "Kvedi". Construction works are currently under procurement process. They will start in May-June and will be finished within 6 months.[18] According to this new inormation the WSP team has made corrections in recommended control measures taking into consideration planned works. A consolidated list of hazards, related hazardous events/hazard sources and suggested control measures, monitoring and supporting programs which include above mentioned remarks of the local service center and information on construction works, is presented in Table 8 below.

Table 8 . Hazardous Events, Hazards, Control and Monitoring Measures and Supporting Programs Identified for Oni Water Supply System

Drinking water supply system component	Hazardous event/situation/hazard source	Hazard	Risk level	Control and monitoring measures		Supporting programs
				Developed by water safety team	Developed by water safety team	
Water treatment	Inadequate disinfection *Insufficient of residual chlorine in water system*	Microbial pathogens	H *(High risk, management attention needed)*	***Short term strategy:*** • Carry out chlorination in compliance with corresponding norms	• Increase frequency of water quality monitoring including monitoring of	• Strengthen technical capacity of service center

[18] http://mdf.ge/. Tender documentation, including project drawings and bill of quantity is available only as hard copies at charge of 300 GEL. Therefore, WSP team was unable to obtain this information

	Inadequate disinfection *high amount of residual chlorine in water system*	Chemical	H *(High risk, management attention needed)*	***Long term strategy:*** • Modernize chlorination procedure and technology at "Kvedi" headworks	residual chlorine • Move modernization of chlorination procedure for "kbedi" headworks to the **short-term** strategy given it is planned to install chlorination devices through USAID grant support	laboratories • Training laboratory staff on water monitoring • implementation • Results of laboratory testing (particularly microbe contamination parameters) require more detailed description and quantitative reflection
	Absence of disinfection *Possibility of water contamination at any stage of water supply*	Microbial pathogens, Chemical	H *(High risk, management attention needed)*	***Short term strategy:*** • Add chlorination stage at "Zhizhoreti" headworks ***Long term strategy:*** • Modernize chlorination procedure and technology		
	Increased water turbidity and changed color during heavy (seasonal) rains *(particularly at "Kvedi" intake facility)*	Physical	H *(High risk, management attention needed)*	***Short term strategy:*** • Interrupt water supply during high turbidity ***Long term strategy:*** • Renew water technological treatment process, including renovation of the sedimentation tank / basin, filter at Kvedi headworks	• Move renovation of technological treatment (for "kvedi" headwork) to the **short-term** strategy	• Identify real water supply-demand and water losses (development of real water balance) • Set up hydraulic model of water supply system • Develop action plan for public information and recommendation in case of drinking water pollution and emergency situation • Elaborate long term development plan for water supply system • Periodically update water safety palns and service training of staff
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 system*	Microbial pathogens	E *(Extreme risk, immediate action required)*	***Short term strategy:*** • Install roofs with locks on the drainage wells of the "Zhizhoreti" headworks • Provide 24-hour guarding/supervising at "Zhizhoreti" headworks • Fence sanitary zone of the (where it is possible) water intake facilities • Rehabilitate Kvedi headworks ***Long term strategy:*** • Fully rehabilitate and modernize damaged water intake units	• Increase frequency of water quality monitoring including monitoring of residual chlorine • Take into consideration earthquake hazards during rehabilitation/construction of any units • Move modernization of chlorination procedure for "kbedi" headworks to **the short-term** strategy given it is planned to install chlorination devices through USAID grant support	
	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*** • Provide 24-hour guarding/supervising at "Zhizhoreti" headworks • Fence water intake facility sanitary zone (where it is possible) ***Long term strategy:*** • Rehabilitate and modernize damaged water intake units		
	People may access the water catchment area and purposefully or unintentionally discharge chemicals into the wells *leading to* significant *chemical pollution of the source*	*Chemical*	H *(High risk, management attention needed)*	***Short term strategy:*** • Provide 24-hour guarding/supervising at "Zhizhoreti" headworks • Fence water intake facility sanitary zone (where it is possible)		

	Increased water turbidity and changed color during heavy (seasonal) rains (especially at the Kvedi intake facility)	Physical	H *(High risk, management attention needed)*	***Short term strategy:*** • Interrupt water supply during high turbidity ***Long term strategy:*** • Arrange water technological treatment modules (sedimentation and clarification tanks) at headworks(where it is possible)	
Main pipes and distributio n network	Damaged pipes and insufficient pressure and water interruption can *result in backflow from customer systems into the network*	Microbial pathogens	E *(Extreme risk, immediate action required)*	***Short term strategy:*** • Ensure corresponding water pressure in the pipes by rehabilitating existing and installing additional valves ***Long term strategy:*** • Rehabilitate existing regulating 2000 m^3 reservoir or build new one • Assess hotspot and carry out full rehabilitation of the main pipes and network • Install water meters	• Increase frequency of water quality monitoring including monitoring of residual chlorine • Take into consideration earthquake hazards during rehabilitation/ construction of any units • Install washout valves at respective points of the distribution network. This measure will be implemented during 2013 through USAID grant support • Move construction of a new reservoir to the short-term strategy, given it is planned to construct 1,000m3 storage reservoir under USAID grant support

Annexes

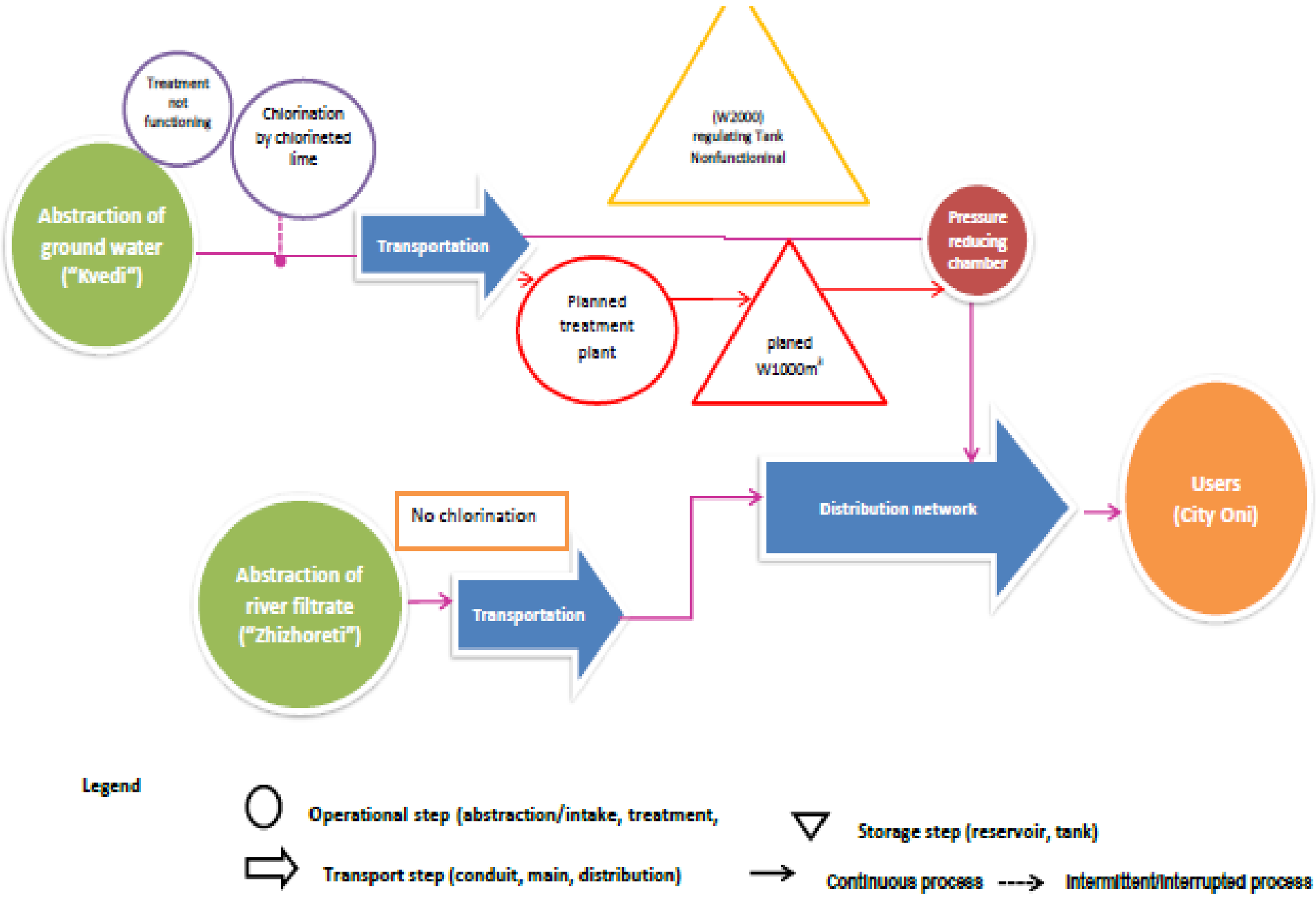
Annex 1. Map of Water Supply System of the City of Oni

Annex 2. Basic Data on Oni Water Supply System

Number of consumers served by the company	Number of households and organizations served	Consumers with water meters	Water source name, type and discharge	Number and volume of water collector/storage/regulating reservoirs	Water treatment method	Total metric length of the system
1202	1134 households and 68 organizations	0	Kvedi - Ground waters, intake capacity - 71 L/Sc Zhizoreti – Rioni filtrate 14-20 L/Sc	1, 2,000 m^3, curretly non-functional	Chlorination by chlorine lime; soon will be changed by automated chlorination by liquid chlorine	Main pipe - 11.7 km network - 21 km

Annex 3. Oni

Annex 3. Oni Water Supply System Flow Diagram



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
Smell	Numbers	2
Taste	Numbers	2
Coloration	Degree	15
Turbidity	Turbidity unit (by formazin or Mg/l by kaolin)	3.52
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. Number of Completed Analysis by Months during 2011
Imereti Racha - Lechkhumi Regional Branch Office, Oni Service Center

NAMES OF INDEPENDENT WATER SUPPLY SYSMENS: 1. Kveda 2. Zhizhoreti;													Period of Time
Number of Portable Water Quality Inspections at Control Units													
TOTAL INSPECTIONS	At surface water headworks (raw water)			At ground water headworks (raw water)			Released (treated) potable water			Potable water in distribution dystem			
		inter alia			inter alia			inter alia			inter alia		
	TOTAL	With normal range	Divergence from a norm (+)	TOTAL	With normal range	Divergence from a norm (+)	TOTAL	With normal range	Divergence from a norm (+)	TOTAL	With normal range	Divergence from a norm (+)	
19	**7**	**6**	**1**				**7**	**4**	**3**	**5**	**2**	**3**	**TOTAL**
2	1	1	_				1	1	_				
2	1	1	_				1	1	_				**January**
2	1	1	_				1	1	_				**February**
2										2	1	1	**March**
2	1	1	_				**1**	**_**	**1**				**April**
2										2	1	1	**May**
3	1	_	1				**1**	**_**	**1**	1	_	1	**June**
													July
2	**1**	**1**	**_**				**1**	**_**	**1**				**August**
													September
													October
2	**1**	**1**	**_**				**1**	**1**	**_**				**November**
													December

Annex 6. 2011 Registered Cases of Contagious Diseases for the City of Oni
Source: Statistical Yearbook, medical statistics, 2011

#	Cases of Contagious Diseases, 2011	
	Oni	
1	Viral hepatitis A	0
2	Acute viral hepatitis B	0
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	0
8.1	including: escherichiosis	0
9	Yersiniosis	0
10	Amebiasis	0
11	Diarrhea	150
12	Brucellosis	0
13	Malaria	0

Annex 7. Photo gallery

Pic. Oni service center

Pic. 2. “Kvedi” headworks, water collector

Pic. 3. Facility for the chlorination stage at the headworks “Kvedi”

Pic. 4. Destroyed water technological treatment modules at the headworks “Kvedi”

Pic. 5 Settler tank at the headworks “Kvedi”

Pic. 6. Gabion at “Zhizhoreti” headworks

Pic. 7. “Zhizhoreti” headworks

Pic. 8. Drainage well at the headworks of “Zhizhoreti”

Pic. 9. Drainage well at the headworks of “Zhizhoreti”

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