Assessment of Water Supply System, Dedoplistskaro

Republic of Georgia

Technical Report Number 10

Integrated Natural Resources Management in the Republic of Georgia Program

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List of Acronyms and Abbreviations

1. ^{o}C - degrees Celsius
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. GNEWRC - Georgian National Energy and Water Regulatory Commission
11. GWP - Georgian Water and Power
12. INRMW - Integrated Natural Resources Management in Watersheds
13. km – kilometer
14. kW - kilowatt
15. LLC - Limited Liability Company
16. L – liter
17. L/d – liter per day
18. L/sec - liter per second
19. m - meter
20. m^3 - cubic meter
21. m^3/d – cubic meter per day
22. m^3/h - cubic meter per
23. mm - millimeter
24. m^2 - square meter
25. mg/l - milligram per liter
26. ml - milliliter
27. NGOs - Non-governmental Organizations
28. UNESCO - United Nations Educational, Scientific and Cultural Organization
29. UNESCO-IHE – UNESCO Institute 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).

Among various planned activities within the INRMW framework, 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 the support of UNESCO-IHE. In accordance with the program work plan, the work was divided into two stages. In the initial 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. In the subsequent stage, WSPs were to be developed for urban areas (Dedoplistskaro and Senaki) in the lower pilot watershed areas of Alazani-Iori and Rioni basins. Assessments of water supply systems serve as baseline studies for WSPs that include detailed description of centralized water supply systems, identification of existing and potential hazards, including hazardous events/situations/hazard sources, and assessment of their risks.

The current report is a detailed assessment of the water supply system for the city of Dedoplistskaro. It includes description of the system, identification of existing hazards to drinking water quality and their sources as well as 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, including management and monitoring measures. It also contains a description of the methodology used to gather data of the existing water supply system, identification of hazards, assessment of their risks and determination of control measures. The report will serve as the basis for developing WSP for the water supply system of the city of Dedoplistskaro 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 on health/dw q/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 as well as their sources, and/or hazardous events/situations posing threat 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 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, treatment facilities and methods employed
    - Water disinfection
    - Water distribution system
    - Storage (service reservoir and 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 and their sources, and/or related hazardous events/situations as well as 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 a 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, including key capacity development (support) and monitoring measures and re-assessment of risks in terms of likelihood of impact taking into consideration the effectiveness of each control measure[2]. Risks were prioritized in terms of their estimated impact on the capacity of the system to deliver potable 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 potable water are regulated by laws on Public Health, Water, and Mineral Resources, as well as by a number of regulations. According to the Water Law, in the allocation of water resources, the first priority is to be given to water 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 groundwater abstractions for drinking water supply (for further details, refer to the relevant sections on surface waters and mineral resources)[3]. The Law on Public Health segregates responsibilities among various ministries with regard to water safety. The list of laws and regulations governing potable water supply sector is given on page 7 below.

Potable water quality standards and rules for its quality monitoring are stipulated in the "Technical Regulation on Drinking Water" approved by the Decree #349/N, 17.07.2007 of the Minister of Health, Labor and Social Protection.[4] 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. However, it does not cover the quality of small scale water supply systems with a capacity of 10 m^3/day serving less than 50 people and natural mineral waters where mineralization exceeds 1,500 mg/l. The regulation defines requirements against common parameters of odor, 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 maintaining safe level of radioactivity in potable water (refer annex 4). The quality of water in a natural water body intended for drinking purposes should not exceed the ambient water quality standards stipulated by the Decree #297/N of the Minister of Labor, Health and Social Affairs on "the Approval of Ambient Environment Quality Standards," issued on 16.08.2001.[5]

According to the "Technical Regulation of Drinking Water", the regulations for state compliance ensuring monitoring and control of drinking water quality, including components to be inspected, 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 the testing of potable water quality, it may delegate its functions/outsource the assignment to an accredited independent laboratory. In instances where the required standards are not in conformity with the Technical Regulation, the supplier of drinking water is liable to carry out appropriate measures, including reporting to relevant authorities, identifying contaminating sources, restricting water supply and implementing corrective measures for the safety of the population[6].

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[3]Technical Report 1. Rapid National Assessment, February 2011, www.globalwaters.net content/upl oads/2012/12/Technical-Report-1-Repid-National-Assesemnet-of-Legal-Policy-and-Institutional-Settings.pdf

[3]https://matsne.gov.ge/index.php?option=com_ldm ssearch&vi ew=docView&id=52384&lang=ge;

[4]: i)http://www.momxmarebeli.ge/images/file_955911.pdf%3B;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/upl oads/2012/12/Technical-Report-1-Repid-National-Assesemnet-of-Legal-Policy-and-Institutional-Settings.pdf

[5]https://matsne.gov.ge/index.php?option=com_ldm ssearch&vi ew=docView&id=52384&lang=ge;

[6]For more details on water related issues please refer 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.

Listed below is the set of laws and regulations governing potable water supply sector:

- Water Law.[7]
- Law on Public Health.[8]
- Decree #297/N of the Minister of Labor, Health and Social Affairs, 16.08.2001 on "Approval of Ambient Environment Quality Standards."
- Decree #349/N of the Minister of Labor, Health and Social Affairs of Georgia, 17.07.07 on "Technical Regulation of Drinking Water."
- Decree #59 of the Minister of Environment, 07.05.1998 on the "Approval of the Provision on Water Protection Zone."[9]
- Law on Sanitary Protection Zones of Resorts and Resort Areas, 20.03.1998.
- Decree #16/N 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."
- Decree #15/N of the Minister of Health, Labor and Social Protection, 22.01.2004 on the "Approval of Sanitary Rules on Drinking Water Sampling."
- Decree #17/N of the Minister of Health, Labor and Social Protection, 22.01.2004 on the "Approval of Sanitary Rules on Water Treatment by UV Radiation."
- Decree #250/N 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."
- Ordinance #32 of the GNEWRC, 26.11.2008 on the "Approval of the Rules on Drinking Water Supply and Consumption."
- Ordinance #18 of the GNEWRC, 29.08.2008 on the "Approval of the Methodology for Setting out Water Use Tariffs."
- Ordinance #14 of the GNEWRC, 26.11.2008 on "Penalizing Illegal Users of Centralized Water Supply and Sanitation Systems."
- Ordinance #17 of the GNEWRC, 17.08.2010 on "Water Use Tariffs."
- Decree # 10 of the Government of Georgia, 30.01.2009, on "Approval of the Charter of 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.[10]

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

- The Ministry of Labor, Health and Social Protection establishes ambient water quality standards

[7] http://nfa.gov.ge/files/kan onebi/wylis_shesaxeb.pdf
[8] http://www.nsc.gov.g e/files/files/legislations/kanonebi/ sazogadoebrivi%20janmrteloba.pdf
[9] https://matsne.gov.ge/index.php?option=com_ldmssearch&view=docView&id=80770
[10] http://water.gov .ge/uploads/kanonmdebloba/debuleba5.pdf

in accordance with WHO guidelines.

- The Ministry of Agriculture executes state control of drinking water quality.
- The Ministry of Environmental Protection develops and coordinates the 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 of natural resources, together with environmental inspectorate will shift 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. With the exception to the population of Tbilisi, Mtskheta, Rustavi and Autonomous Republic of Adjara, provision of water supply to the remaining Georgian population 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; vii) Kutaisi. These branches have their laboratories which conduct monitoring activities for drinking water quality in the urban water supply system under their jurisdiction.
- The Georgian National Energy and Water Regulatory Commission (GNEWRC) establishes water supply and consumption rules, approves methodologies for setting up water usage tariffs, determines tariffs, and approves rules on penalizing illegal water users, including those illegally discharging wastewaters in sanitation systems
- Georgian Water and Power (GWP) is the leading company in the water supply sector of Georgia. The company provides water supply services to the population of Tbilisi and its adjoining areas, as well as to State organizations, industrial and commercial entities. The company also provides wastewater services to the capital city of Tbilisi. GWP serves around 400,000 customers throughout the city, of which approximately 2,000 are budget organizations, 15,000 are commercial entities and the remaining are residential consumers.

4. Description of Water Supply System from Catchment to Consumer

The water supply system of the city of Dedoplistskaro operates under the supervision of Kakheti Regional Office of the United Water Supply Company of Georgia. The Dedoplistskaro Service Centre consists of 29 employees, of which 15 are technical-engineering and operational staff. The Service Center is divided into the following units/divisions: i) technical division comprising two staff members; ii) operations team composed of eight staff members; iii) laboratory unit consisting of one staff member; iv) chemist, accident prevention/maintenance team is composed of four staff members.

The city is located in the farthest east part of Georgia and is 780-880 m above sea level.

Dedoplistkaro and few adjusent villages are supplied with drinking water from two systems: 1) „Mazovka“ (Annex 7. Pics. 2-7) (coordinates: E 46° 5'41.25", N 41°28'40.69";) – main system, operated continuously and recesiving water from intake points - N1 (E 46° 6'8.07", N 41°28'14.54"), N2 (location is unknown) and N3 („Obeliski“) (E 46° 4'56.21", N 41°28'5.58"); 2) „Stadium“ (coordinates: E 46° 6'45.94", N 41°27'44.45") (Annex 7. Pics. 8-10), receiving water from headwork, operated full-time only in summer (3-4 months).

The city receives water through mechanical pumps. Please refer Annex 1 for the location map of the Dedoplistskaro drinking water supply system.

4.1 Main Characteristics of the Water Source and its Catchments

***Water sources*:** All four water sources represent groundwaters.

In most parts of Dedoplistskaro Municipality, groundwaters are by and large represented by sub-mountainous and inter-mountainous aquifers belonging to Iori-Shiraki basin of pore and stratal water, which is built with merged river debris cones. Fractured waters have very limited distribution and are found only in the “Shiraki Formation“. Alluvial and alluvial-prolluvial debris cone sediments of late Pliocene and Quaternary ages, frequently reaching 300-500 m and occasionally 1,000-1,500 m in thickness, are composed of boulders, cobble, gravel, sand, clay, loams and loose conglomerates. Groundwaters at the top of the cones form a single unconfined aquifer. In the center and periphery where clay or clayey matrix occurs, it divides the single aquifer into the unconfined aquifer and several confined ones. Thus, in every abovementioned pores and stratal water basins, unconfined and several confined aquifers are present. Confined aquifers occur several kilometers below the contact zone between the bedrock and coarse-fragmented talus, and their distribution is lower than that of the unconfined aquifer. Aquifer of the Quaternary alluvial-prolluvial sediments of 10-500 m thickness is widespread within the Iori tableland. In the Iori-Shiraki artesian basin, the aquifer thickness ranges within 37-72 m in the debris cones of the Iori River tributaries. The waters are mainly free-flowing, with flow rates of 1.5 to 8.5 L/sec. These are built with conglomerates cemented with clay and lime, and occasionally by sandstone and clay. The total thickness of the strata reaches as much as 3,000 m. Wellspring flow rates range within 0.10-5.7 L/sec. The aquifer of the recent alluvial sediments built from cobble with sandy, sand-salty matrix and inter-beds, sand lenses, sandy loam, loam and clay is found in floodplains as well as in the abovementioned floodplain river terraces. The aquifer thickness mostly ranges within 3-15 m, occasionally reaching 30-40 m. The filtration coefficient is 10-30 m/day, and occasionally 100-200 m/day. The aquifer has substantial water resources and its water has high drinking quality.[11]

The aquifer of marl carbonaceous (calcareous) flysch of late Jurassic period built with 1,500 m thick limestone, dolomite and marl is found on the territory of Dedoplistskaro City. The system 2 – Stadium, supplying Dedoplistskaro with drinking water during summer, receives water from the headwork situated in the city and abstracted water from the given aquifer. The headwork with three (N1, N2 and N3) intake points feeding system 1 – Mazovka is located in the village of Khornabuji and it abstracts water from the aquifer of lower Quaternary alluvial deposits composed of gravel, conglomerates, loams and sandy loams.[12] These sediments gather in river beds and terraces. Groundwaters associated with alluvium represent river filtrates. Sub-surface water circulates at a depth of 1-2 m and is recharged as low capacity springs.

Location of intakes and abstraction methods. As aforementioned, intakes of Mazovka system are located in the village of Khornabuji. The headworks collector is situated in the outskirts of the village and there is a livestock farm in its vicinity. N1 intake is located in an abandoned household plot (orchard), N2 intake is situated in the surroundings of the Mazovka headworks collector (the exact geographic location of the intake point is not yet established by the UWSCG), and N3 intake, named as "Obeliski", is in the outskirts of the village of Khornabuji. There is an artificial lake on the intake's territory, which is currently eutrophified and bogged (please refer Annex 7 for pictures).

The headworks of the Stadium system is represented by 1 intake point located on the territory of the city's stadium. Detailed characteristics of the Dedoplistskaro water supply system are given in Annex 2.

Water abstracted by the 3 intakes of the Mazovka system is collected in 300 m^3 concrete tank (pic. 2, Annex 7). The sanitary zone of the collector tank is fenced and supervised by an operator round the clock. There is also a pump station that propels water to feed the storage/regulating reservoir (pic. 1, Annex 7). In the N1 intake, water is abstracted from a 7 m deep closed brick well through groundwater capitation (pic. 5, Annex 7). The intake point is located at 780 m above sea level. The area of the 1st sanitary zone is 1,434 m^2, located 1 km from the water collector tank, and this area is under private ownership. However, in agreement with the owner, it is controlled by the Dedoplistskaro Service Center. The area is fenced but not guarded. The location of the N2 intake point is unknown. Consequently, complete information on the sanitary zone and technical condition of the headworks is now known. The N3 intake represents an underground drainage system of 150 mm in diameter and 700 m long steel pipes. The system has 14 closed concrete observation wells located 50 m apart from each other (pics. 6-7, Annex 7). The intake is situated at 780 m above sea level. Total area of the 1st sanitary protection zone is 68,678 m^2 and is located at a distance of 1.2 km from the collector tank. The area is fenced partially and not guarded.

Water intake of the "Stadium" system is characterized by a 22 m deep covered brick shaft well, and water is pumped out of it by the means of a deep well pump (pic. 9, Annex 7). The water abstraction point is located at 820 m above sea level. Total area of its1st sanitary zone is 565 m^2; it is fenced and controlled/supervised by the local service center, but not guarded.

Water quality issues at sources. Given that the majority of headworks are located in settled areas or in their vicinity, there is a risk of source water contamination (microbiological cause) by human activities. Moreover, the location of the N2 intake, the structure of the intake, and abstraction method are unknown. N3 intake is located near a lake that is bogged and it is necessary to conduct detailed studies

[11] ENVIRONMENTAL ASSESSMENT: INTEGRATED NATURAL RESOURCES MANAGEMENT IN WATERSHEDS OF GEORGIA (INRMW-GEORGIA). http://www.globalwaters.net/wp-content/uploads/2012/12/INRMWPEAfinal.pdf; Technical Report 2. Rapid Assessment of the Rioni and Alazani-Iori River Basins of Georgia. http://www.globalwaters.net/wp-content/uploads/2012/12/Technical-Report-2-Rioni-Alazani-Iori.pdf

[12] Map of the Groundwater Aquifers, Annex 2 to the Draft Technical Report 14. Detailed Assessment of Natural Resources of the Lower Alazani-Iori Pilot Watershed Area

of the impact of this water body on the water intake. Furthermore, there is a livestock farm near the water collector tank representing a potential source of bacteriological hazard.

Headworks of the “Stadium” system located in the city, which is fanced but not guarded 24 hours a day. Curently the water quality of the Stadium system is poor and there are on-going studies to determine the sources of water contamination. As a result, the operation of the headwork is temporarily suspended.

According to the service center laboratory, drinking water quality is currently satisfactory within Mazovka system, though during heavy rains, water turbidity increases in the collecting wells of the N3 (Obeliski) headworks.

4.2 Description of Water Supply System

4.2.1 Water Abstraction and Treatment

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

Mazovka system’s underground covered water collector tank (300 m^3) is located at 760 m above sea level. Water from intake points are fed here through gravity flow and the discharge rate of water depends on the capacity of springs varying from 17 to 20 L/sec depending on the type of season: N1 – 5 L/sec average capacity; N2 – 7-8 L/sec average capacity; N 3 – 5-8 L/sec average capacity. The Mazovka collection tank was fully rehabilitated in 2003 and N3 intake structure in 2009. Other intakes are very old and have never been rehabilitated. The N1 collector well was built in the beginning of the 20th century, but the age and the state of N2 well are unknown.

Water flows from N1 intake through a steel pipe 200 mm in diameter and 1 km in length, whereas from N2 intake point, water flows through a cast iron pipe 200 mm in diameter, the length of which is unknown, and from N3 intake point, water flows through a steel pipe 200 mm in diameter and 1.2 km in length. Water from all headworks is drained in one collection reservoir.

No technical treatment or disinfection is carried out at the headworks. There is an old chlorination facility in the territory of the water collector tank that does not function currently (pic.3, Annex 7). Water chlorination is carried out in the regulating reservoir of the distribution network. The details are described in chapter 4.2.2.

Headworks of the Stadium system has 8 L/sec average discharge rate, and the system is only used during summer. The headwork was rehabilitated in 2009. There are two underground collecting tanks (250 m^3 and 300 m^3) near the headworks that are currently out of order and malfunctioning. Mechanical and chemical (disinfection) treatments are not conducted for the water at the headworks. As aforementioned, the operations of the Stadium system are temporarily suspended currently.

4.2.2 Water Transportation and Distribution

Water flows from the Mazovka collector tank and Stadium headworks to two storage/regulating reservoirs of the city with the help of mechanical pumps (pic. 12, Annex 7). From here, the water is fed into the distribution system. The schematic of the system is illustrated in Annex 3.

The pump station of the Mazovka system (pic. 1, Annex 7) is located on the territory of the water collector tank and it has three sets of pumps – N1 and N2 pumps were made in China and installed in 2009, whereas N3 pump is an old Soviet-made machine. Newer pumps have the following specifications: Q=108 m^3/h (water extraction/pumping rate), H=202 m (submersion depth), N=90 kW (power capacity). These pumps are operated sequentially 16 and 24 hours a day during summer (4 months). The older pump has following specifications: Q=180 m^3/h, H=212 m, N=160 kW and it functions as a backup.

Additionally, the pump station in the Stadium system has a deep pump that abstracts water from the well shaft, and it has following specifications: Q=29 m^3/h, H=125 m, N=18 kW. The pump is mostly operated round the clock during summer and16 hours daily, if it is operated in other seasons.

Water from pump stations to the regulating reservoirs flows through 2 water mains. Water main of the Mazovka system comprises 300/250/200 mm diameter and 4.65 km long pipes that was partially rehabilitated in 2003. Water from Stadium headworks flows through plastic (PVC) 110 mm diameter and 1.31 km long water main that was replaced in 2010-2011. Average pressure in water mains is 12-13 bars.

Water mains transport water to N1 and N2 underground square shaped iron-reinforced concrete regulating reservoirs, from which water flows to the distribution network through gravity. Both reservoirs have the capacity of 6,000 m^3 each and are located at 902 m above sea level. Currently, only N2 reservoir functions, because N1 is nonfunctional and out of order (pic. 11, Annex 7). As a result, the villages of Khornabuji and Samreklo connected to Dedoplistskaro system have limited water supply, particularly during summer. Overall, the technical condition of the N2 reservoir is satisfactory and it poses no risk of water contamination. However, it does not have automated water discharge meter and observation window.

The area surrounding regulating reservoirs is fenced and supervised by operators round the clock. It also has a chlorination station, and disinfection is conducted continuously by chlorination with chlorine lime through a primitive duster (pics. 13-14, Annex 7). Analysis of the residual chlorine is carried out twice a day, and thrice a day during summer. Water is not supplied continuously to the reservoir and its minimum level of the water is 4.7 m.

The discharge rate of water of the regulating reservoir is 1,500-1,700 m^3/d. The city receives 1,100 m^3/d, the remaining water is supplied to the villages of Khornabuji and Samreklo through seven 50 mm and two 90 mm diameter pipes.

Total length of the distribution system is 48 km. In recent years, old pipes were almost entirely replaced by PVC pipes. In 2007-2008, around 35% of the network was renovated, roughly 45% in 2009 and around 20% in 2010-2011. Pressure in the network is regulated by pressure valves (pic. 15, Annex 7) adjusted to 7-8 bars, which is not enough and it is necessary to lower the pressure down to 2-3 bars. Accordingly, there is a need to install an additional pressure valve. There are 89 closing valves. As said by the technical manager of the Dedoplistskaro Service Center, water losses in the system are insignificant to affect normal operations of the network.

4.2.3 Water Use and Consumers

The water supply system of Dedoplistskaro City serves 2,593 customers (approximately 7,800 people), of which 2,500 are households and 93 are organizations. The network coverage is 87% for the city. In addition, the system serves 365 households and 37 organizations in the villages of Samreklo and Khornabuji. The city has round the clock water supply except during summer when water is supplied only 12 hours a day.

According to 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 cubic meter of water (including the price for water sanitation service). Whereas, 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 cubic meter of water (for the time being, this rate includes the price for water sanitation service). All customers of the Dedoplistskaro Service Center have water meters installed.

The estimate of the average amount of drinking water consumption for households is 144 L/d per capita (especially from late spring to early autumn).[13] If we take into consideration that this is only an estimate, the real consumption might be 10-15% higher than the estimated figure and may amount to 160 L/d per capita. In Europe, daily average consumption rate is 120-150 L/d without wastage. Therefore, the Dedoplistskaro consumption norm is close to the European standard, which might be attributed to the recent rehabilitation of the networks and installation of water meter for all customers.

[13] Calculation is made in the following manner: Daily supply of water is 1,123,200 m^3, which is 13 L/sec. If we divide this amount among 7,800 individuals, we will receive - 144 l per day per capita consumption.

5. Risk Assessment

Identification of hazards, their sources and potential hazardous events/situations as well as risk assessment of the Dedoplistskaro 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)[14] that recommend the identification of hazards and hazardous events by using sanitary observation questionnaires. This questionnaire should be elaborated for sanitary inspection at key points of the water supply system (headworks, water treatment plant, main and distribution network, etc.) and water abstraction methods (e.g. drilled wells, pit wells, spring water collectors, etc.).

Given 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 the water supply systems in its entirety and not confined to 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 periodicities are defined by the Georgian Technical Regulation on Drinking Water, 2007 (please refer Annex 4). Regular water quality monitoring of the Dedoplistskaro water supply system currently focuses on the following basic set of parameters: *Microbial parameters – E. coli and total Coliforms*; *Physical parameters* - taste, odor, color, turbidity and 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, the water quality monitoring points are established 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 (groundwater);
iii) Release points (treated water);
iv) Distribution network.

The water quality testing laboratory of the Dedoplistskaro Service Center has two rooms allocated in its office. One room is a dedicated lab and the other storage. However, the lab is poorly equipped, and the existing equipments are outdated and insufficient. There is a shortage of auxiliary materials, and chemicals are stored in used bottles of mineral water. Distilled water is delivered from Telavi. Chemicals are heated on electric stoves. Organoleptic and chemical parameters are sampled and tested every day in the lab. Bacteriological parameters are tested in the Telavi Central Laboratory. As a result, bacteriological analysis is not carried out regularly.

Assessment of drinking water quality for the Dedoplistskaro water supply system is based on 2011 water quality monitoring data (refer annex 5). According to this data, 310 samples were collected, of which 289 samples were collected from the distribution network, 7 from released (treated) water and

[14] 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

14 from the groundwater sources[15]. Table 1 illustrates drinking water quality compliance with the national standards in 2011.

Table 1. Drinking Water Quality Compliance with the National Standards for Dedoplistskaro Drinking Water Supply System, 2011[16]

Monitoring Point	Number of Samples	Compliance with the National Standards %			
		Compliance		Noncompliance	
		Number of samples	%[17]	Number of samples	%
Groundwater source (raw water)	14	14	100	0	0
Released (treated) potable water	7	6	86	1	14
Potable water in distribution system	289	267	92	22	8
Total	310	287	93	23	7

The table demonstrates that although most components of the water supply system were in compliance with the national standards, there were instances of noncompliances in 2011 (287 samples or 93% complied and 23 samples or 7% did not comply with national drinking water quality standards). The figures in the table indicate that 86% of samples from released (treated) potable water, 92% of samples from distribution networks and 100% of samples from groundwater sources (raw water) met the national standards. Monthly distribution of nonconformities are as follows: February – 1 out of 4 samples (25%); March – 3 out of 13 samples (23%); April – 4 out of 52 samples (8%); July - 2 out of 20 samples (10%); August – 2 out of 37 samples (5%); September - 2 out of 43 samples (5%); October – 4 out of 33 samples (12%); November – 4 out of 29 samples (14%); December – 4 samples out of 53 samples (8%). As observed, with the exception of January, May and June, noncompliances were recorded in all other months. The deterioration of drinking water quality may be attributed to snowmelt and storm waters reaching the headworks during heavy rains, as well as due to the absence of mechanical and chemical water treatment at the headworks.

Regardless the fact that overall compliance to national standards was high, the true picture might be different and noncompliances may be more frequent due to poor water testing capacities of the service center.

In order to identify issues related to specific parameters, additional information was requested from the staff of the service center laboratory. Based on this information, it was learned that noncompliance of water quality with the national standards was mainly due to microbiological contamination, specifically, the concentrations of total Coliformic bacteria and E.coli were not in compliance with the national standard. In general, physical parameters met the national standards with the exception of turbidity. Although, according to chemical parameters, water quality met national standards, the concentration of residual chlorine was sometimes lower than the national standard (0.3 – 0.5 mg/l). It is unknown if chlorination was ever carried out in these instances or if it was conducted inadequately.

With regards to contagious diseases for the city of Dedoplistskaro, statistics for 2011 show one case of acute viral hepatitis B, two cases of acute hepatitis C, 37 cases of food poisoning and 32 cases of diarrhea. In addition, one case of chronic hepatitis C was also recorded. However, there is no evidence that these cases resulted from water contamination. For detailed information please refer Annex 6.

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

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

For the purpose of identifying hazards, their sources and potential hazardous events/situations and assessment of risks, a joint visual observation of the water supply system was conducted by the WSP Team along with the representatives of the local Service Center of United Water Supply Company of Georgia. In addition, a sanitary inspection questionnaire was developed, distributed and filled up by the technical personnel of the Dedoplistskaro 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 categories: 9 -10 = very high, 6-8 = high, 3 -5 = medium, 2-0 = very low/no risk.

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 minor differences), sanitary inspection questionnaires were elaborated for the water supply systems in its entirety and not confined to specific elements.

Presented below is the filled up questionnaire for Dedoplistskaro water supply system. The answers for all headworks were identical.

Table 2. Filled up Questionnaire for Sanitary Observation

#	Question	Yes	No
1	Is the area around the catchment unprotected?	X	
2	Do animals have access to the surrounding areas of the catchment?	X	
3	Are there any solid or liquid waste collecting sites within 30 m of the catchment?		X
4	Are there any sources 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 past 10 days?	X	
10	Did the community report of any pipe breakage in the past week?	X	
In total		9	1

As demonstrated by the aggregate responses to the questions on the Inspection Questionnaire, 9 positive responses out of 10 questions, it can be concluded that the system belongs to the ***very/extremely high risk category.***

Consequently, the WSP Team has identified the following hazardous events/situations/sources of water contamination:

1. Unprotected sanitary protection zone around the headworks, which makes these structures easily accessible to wild animals and livestock.
2. Proximity of livestock farm to the water collection tank.
3. Damaged water abstraction and collection facilities in the headworks.

4. Absence of any preliminary water treatment at different stages (sedimentation/coagulation reservoir, chlorination) at intakes.
5. Presence of corrosion and damaged sections in main pipes.
6. Improper design and outdated technologies for chlorination.
7. Frequent interruptions in water supply.
8. Frequent accidents in distribution systems.

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

5.3 Prioritization of Hazards

In accordance with WHO WSP guidelines (2005), hazards revealed for the entire water supply scheme were prioritized by the 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 (probability) 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 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.

Table 3. Hazard Prioritizing Matrix for Dedoplistskaro Water Supply System

Deviations from Drinking Water Quality Standards in Percentage (%)	**Sanitary Inspection Score (SIS)**			
	0 – 2	3 – 5	6 – 8	9 – 10
71-100	0	0	0	0
31 – 70	0	0		0
11-30	0	0	0	0
1-10	0	0	0	7[18]
Risk level	low	medium	high	very high
Priority action level	none	low	high	urgent

Despite the fact that 287 (93%) out of 310 water samples met the national standards and merely 23 (7%) deviated from the standard, according to the results (score of 9) of the sanitary questionnaires, the entire system, including the distribution network is assessed at ***very high risk.*** The water supply checked as "yes" on the sanitary inspection form represent the potential sources/factors of hazards for microbiological contamination of drinking water.

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

Therefore, on the basis of the sanitary questionnaire and hazard prioritizing matrix for Dedoplistskaro water supply system, biological, chemical and physical contamination risk factors that have a negative impact on the quality of drinking water and cause a hazard of exposure to water borne diseases or chemical contamination, were identified. In more detail, on the basis of visual inspection and the results of the sanitary observation questionnaire, the following components/stages of water supply system were identified as the most probable causes of contaminating potable water:

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

Apart from the aforementioned, technical conditions and capacities of water testing laboratory and the quality of water testing can be considered as factors that may indirectly impact water quality. As described in the previous paragraphs of this chapter, water testing equipment of the laboratory of Dedoplistskaro Service Center is in poor working condition, and is being operated and maintained by just one chemist. The equipment is old, which makes it all the more difficult to maintain accuracy/precision. Furthermore, monitoring of biological components is carried out rarely by the Telavi Central Laboratory on a monthly basis, which can be concluded as insufficient given that the majority of headwork structures are damaged, water intake facilities are not fenced or guarded and technical treatment or disinfection are not carried out regularly. In any case, 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 improving water quality testing as recommendations to be incorporated in the WSP.

To determine 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 to 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 the Level of Likelihood/Impact
		Likelihood
A	Very high likelihood.	Very frequent (e.g. to occur continuously or once a day).
B	High likelihood.	Frequent (e.g. to occur once a week)
C	Moderate likelihood.	Moderately frequent (e.g. to occur once a month).
D	Low likelihood.	Rare (e.g. to happen once a year).
E	Very low likelihood/unlikely.	Very rare (e.g. to occur 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 the use of alternative less safe sources.
1	Insignificant: No impact or not detectable.	No detectable impact.

Table5: Qualitative Risk Analysis Matrix – Risk Categories

	Consequences				
Likelihood	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 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, managements' responsibility must be specified; L–Low risk, manageable 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 Dedoplistskaro Water Supply System

Drinking water supply system component	Hazardous event/situation/hazard source	Hazard	Likelihood	Impact/severity	Qualitative risk
Water treatment and disinfection	Inadequate disinfection: Insufficient amount of residual chlorine in water system.	Microbial pathogens.	D Chlorination is carried out through primitive method (chlorine lime), which is not effective for proper concentration of chlorine.	4	H (High risk, management attention needed)
	Inadequate disinfection: High amount of residual chlorine in water system.	Chemical.	D Chlorination is carried out by primitive method (chlorine lime), which is not effective for proper concentration of chlorine.	4	H (High risk, management attention needed)
	Increased water turbidity and changed color during heavy (seasonal) rains	Physical	C Water turbidity increases at intake point N3 and in collection reservoir during heavy rains and flashfloods	3	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 fecal matter entering into the water supply system.	Microbial pathogens.	C All headworks (except #2 abstraction point of Mazowka headworks) are fenced but not guarded/ supervised 24 hours a day. However the headworks are located at places that are easily accessible and the likelihood of contamination is high; The location of the N2 intake point is unknown and it may represent the source of water contamination.	4	E (Extreme risk, immediate action required)
Headworks and water abstraction points	People can access the water catchment area and intentionally or unintentionally discharge chemicals into the wells.	Chemical.	E All headworks (except #2 abstraction point of Mazovka headworks) are fenced but not guarded/supervised 24	*5*	H (High risk, management attention needed)

			hours a day. The headworks are located at places that are easily accessible; Though, there is no single case of the source water chemical contamination recorded; Therefore, the likelihood of source water chemical pollution is low.		
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* At Mazovka headworks system N1 water abstraction stricture is very old and damaged, state of N2 abstraction point is unknown. In 2011 only 14% of samples of released treated water and 8 % from distribution network didn't comply with national drinking water standards, these data is not sufficient enough to judge about the frequency of source water contamination due to insufficient number of samples taken from all intakes and possible measurement errors of the laboratory. However, stemming from the fact that headworks are located in easily accessible areas with human activities there, the likelihood of source water contamination will be relatively high.	4	E (Extreme risk, immediate action required)
Reservoirs	Domestic and wild animals can access the reservoirs	Microbial pathogens and physical.	E The territory of reservoirs is fenced and protected, reservoirs are in a satisfactory condition, and bird and other animal fecal matter are unlikely to enter the reservoir.	4	H (High risk, management attention needed)
Main pipes and distribution network	Damaged pipes and insufficient pressure, and water interruption can result in backflow from consumer systems into the network.	Microbial pathogens	D Only some portions of the pipes are damaged; backflow prevention devices are not installed in all service connections; Water supply interruptions are frequent causing backflow from the consumer to the network.	4	H (High risk, management attention needed)

6.0 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 the staff of Dedoplistskaro Service Center, visual inspection of the system and analyzing the data of the existing drinking water quality. At the assessment stage, control measures are suggested as recommendations to be included as planned actions in the WSP. In addition to measures controlling risks, necessary monitoring and other management measures are suggested to be included in the WSP.

For the purpose of mitigating hazards and ensuring safe drinking water for the population of Dedoplistskaro, the following control measures should be carried out:

1. ***Source and Source Protection***

- Fencing of N3 intake point – Obeliski and provision of round the clock guard/supervisor to avoid potential hazard of surface contamination of source water in the event of anthropogenic involvement at the intake point/territory;
- Protection of artificial lake at Mazovka water collecting reservoir;
- Identification of the exact location of N2 intake point, its fencing and provision of round the clock guard/supervisor;
- Provision of round the clock guard/supervisor for the N1 intake point;
- Study of pollution source at Stadium Headworks and development of a plan to control the risks.
- Rehabilitation and modernization of damaged water intake units
- Construction/installation of water technological treatment modules (sedimentation and clarification tanks) at headworks (where it is possible).

2. ***Water Treatment***

- Rehabilitation/renovation of all intake points and collection reservoirs that envisages installation of technological modules for appropriate treatment of water (clarification and filtration);
- Upgrade of the chlorination facility located on the territory of regulating reservoir.

3. ***Reservoirs***

- Rehabilitation of 6,000 m^3 (currently non- functioning) regulating reservoir;
- Repair/rehabilitation of reservoir covers and vents; assuring that reservoirs are always covered;
- Modernization of reservoirs with technical equipment (water level meter, window for observation and etc.).

4. ***Distribution System***

- Adding of bore wells at the headworks;
- Repair of damaged valves;
- Installation of pressure regulation valves at points with high pressure;
- Assessment of hotspots and carrying out of full rehabilitation of the main pipes and network;
- Installation of additional pressure reductors in the system.

Concerning water quality monitoring, reporting and communications, the following measures are recommended to be carried out:

- Equipping the water testing laboratory with modern equipment and conducting training for laboratory staff;
- Elaborating an accurate and detailed database of laboratory testing results (particularly microbe contamination parameters);
- Developing a plan on 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;
- Conducting regular trainings for service personnel to introduce new approaches of improving potable water quality monitoring and water safety plans;
- Detailed inventory of the water supply system and development of GIS-based comprehensive database, including data on technical characteristics of the system, drawings, maps, etc.

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

Table 7. Identified Hazards and Control Measures for Dedoplistskaro Water Supply System

#	Drinking water supply system component	Hazardous event/situation/hazard source	Hazard	Risk level	Control measures
1	Water treatment and 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.*** ***Long-term strategy:*** • ***Modernize chlorination***
		Increased water turbidity and changed color during heavy (seasonal) rains (especially at the N3 intake).	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***
2	Headworks and water abstraction points	Domestic and wild animals can access the water catchment area, which could result in the animal fecal matter entering into the water supply system.	Microbial pathogens.	E (Extreme risk, immediate action required)	***Short- term strategy:*** • ***Fence N3 intake point – Obeliski and provide round the clock guard/supervisor;*** • ***Identify the exact location of the N2 intake point, fence it and provide round the clock guard/supervisor;*** • ***Provide round the clock guard/supervisor at the N1 intake point.*** ***Long-term strategy:*** • ***Rehabilitate and modernize damaged***

		People can access the water catchment area and intentionally or unintentionally discharge chemicals into the wells.	Chemical.	H (High risk, management attention needed)	***Short- term strategy:*** • ***Fence N3 intake point – Obeliski and provide round the clock guard/supervisor;*** • ***Identify the exact location of the N2 intake point, fence it and provide round the clock guard/supervisor;***
		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:*** • ***Fence N3 (the Mazovka headworks) intake point – Obeliski and provide round the clock guard/supervisor;*** • ***Identify the exact location of the N2 intake point of the Mazovka headworks, fence it and provide round the clock guard/supervisor;*** • ***Provide round the clock guard/supervisor at the N1 intake point of the Mazovka headworks;*** • ***Study water pollution sources at Stadium headworks and suspend operations of the system until these sources are not identified and researched.*** ***Long-term strategy:***
3	**Reservoirs**	Domestic and wild animals can access the Reservoirs.	Microbial pathogens and physical.	H (High risk, management attention needed)	***Short-term strategy:*** • ***Repair reservoir covers and ventilation windows.*** ***Long-term strategy:*** • ***Modernize reservoirs with technical equipments (water level meter, window for observation, etc.).***
4	**Main pipes and distribution network**	Damaged pipes and insufficient pressure, and water interruption can result in backflow from consumer systems in the network.	Microbial pathogens.	E (Extreme risk, immediate action required)	***Short-term strategy:*** • ***Add bore wells at the headworks;*** • ***Repair damaged valves;*** • ***Install pressure regulation valves at points with high pressure.*** ***Long-term strategy:*** • ***Assess hotspots and carry out full rehabilitation of the main pipes and network;***

6.2 Risk Reassessment and Validation of Control Measures

Following detailed description and identification of hazards for Dedoplitskaro water supply system, the subsequent steps consisted of risk reassessment and validation with technical personnel and the Head of the Dedoplitskaro Service Center. For this purpose, under the INRMW program, a meeting was organized with the management team of Dedoplistskaro Water Supply Service Center. This meeting was attended by consultants from UNESCO-IHE and a team working on water safety plans. The Team presented actual and potential hazards to the Dedoplistskaro water supply system, risks which can provoke deterioration of drinking water quality, and also control measures related to these risks (refer Table 4).

In general, hazards, their sources, related hazardous events and control measures presented by the working group were approved and deemed acceptable for the Dedoplistskaro Water Supply Service Center with certain comments, particularly:

- Increase in the frequency of water quality monitoring, particularly residual chlorine and bacteriological components;
- Improvement of the sanitary condition of the bogged artificial lake located at N3 intake point;
- Priority to be given to installation of the settling tank/basin, which would help prevent the threat of turbid water entering the system and reaching consumers;
- For timely protection against turbid waters, automatic shutters should be installed on reservoirs;
- Expansion of capacities of existing headworks through adding new intakes.

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

- Capacity building of laboratory for improving water quality monitoring;
- Defining the actual water demand and losses (elaboration of water balance). The service center possess leak detection devices;
- Developing a hydraulic model;
- Elaboration of long term development plans for water supply and sanitation systems.

A consolidated list of hazards, related hazardous events/hazard sources and suggested control measures, monitoring and supporting programs which include the abovementioned remarks is presented in the table 8 bellow.

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

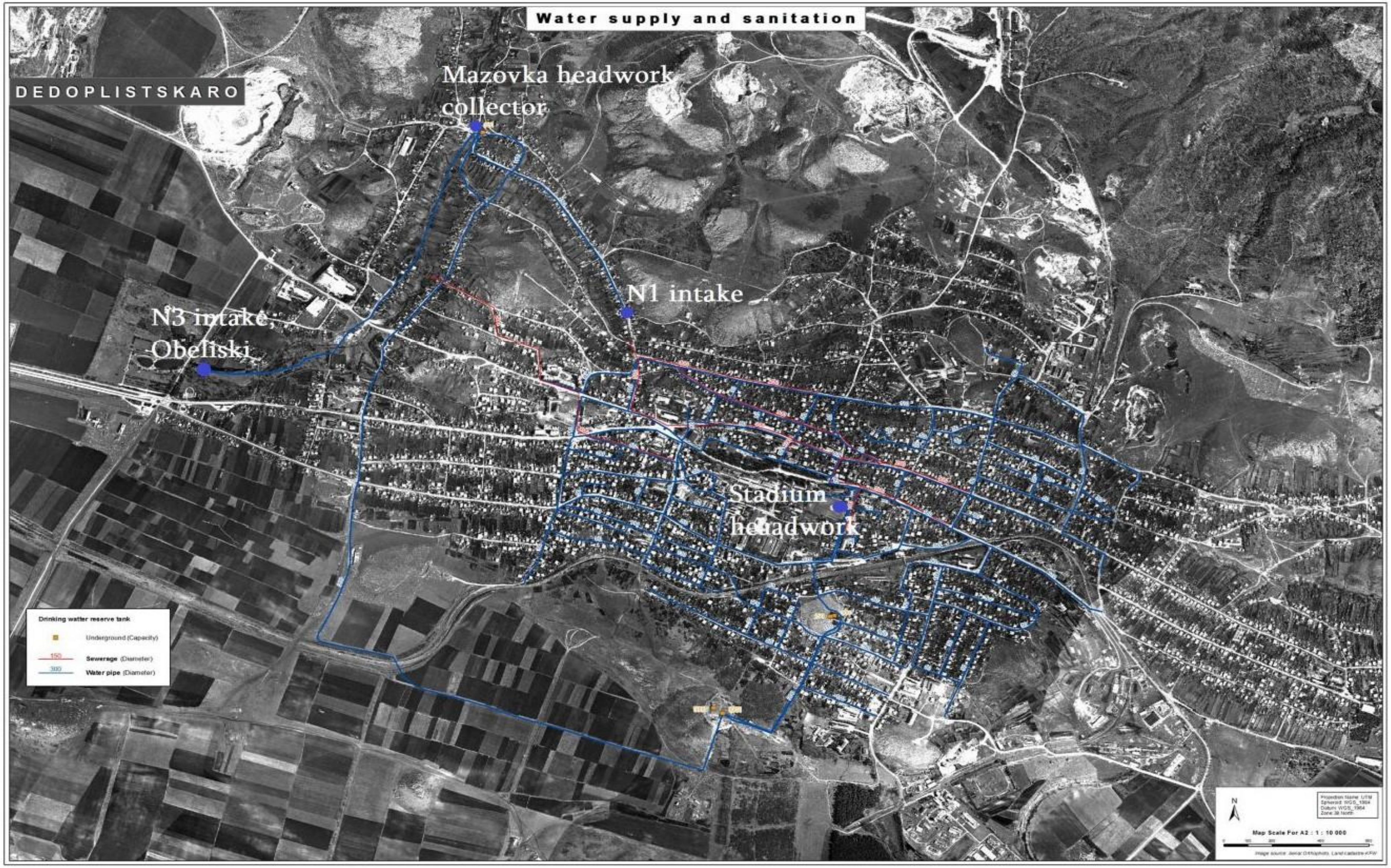
#	Drinking water supply system component	Hazardous event/situation/ hazard source	Hazard	Risk level	Control and monitoring measures		Supporting programs
					Developed by water safety team	Additional measures after validation workshop	
1	Water treatment and disinfection	Inadequate disinfection: Insufficient or high amount 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*** ***Long-term strategy:*** • ***Modernize***	• ***Increase the frequency of water quality monitoring related to***	• ***Strengthe nin g of the technical capacity of the***

2	Headworks and water abstraction points	Increased water turbidity and changed color during heavy (seasonal) rains (especially at the N3 intake)	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	• Increase the frequency of water quality monitoring; • improve the sanitary condition of the artificial lake located on the	• Training of laboratory staff in water monitoring; • Improvement of the interpretation and reporting of the results of laboratory testing (particularly microbial contamination parameters); • Identification of actual water supply-demand and water losses (development of real water balance); • Setting up of a hydraulic model of water supply system; • Development of an action plan for public information and recommendation in the event of drinking water pollution and emergency situation; • Elaboration of a
		Domestic and wild animals can access the water catchment area, which could result in the animal fecal matter entering into the water supply system	Microbial pathogens.	E (Extreme risk, immediate action required)	*Short- term strategy:* • Fence N3 intake point – Obeliski of the Mazovka headworks and provide a round the clock guard/supervisor; • Identify the exact location of the N2 intake point of the Mazovka headworks, fence it and provide a round the clock guard/supervisor	• Increase the frequency of water quality monitoring; • Improve the sanitary condition of the artificial lake located on the territory of the N3 intake facility of the Mazovka headwork	
		People can access the water catchment area and intentionally 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:* • Fence N3 intake point – Obeliski of the Mazovka headworks and provide round the clock guard/supervisor • Identify the exact location of the N2 intake point of the Mazovka headworks, fence it and provide a round the clock guard/supervisor • Provide a round the clock guard/supervisor at the N1 intake point of the Mazovka headworks	• Increase the frequency of water quality monitoring	
		Damaged headworks structures may result in easy access of organic and chemical pollutants into source water	Microbial, physical and chemical	E (Extreme risk, immediate action required)	*Short- term strategy:* • Fence N3 intake point – Obeliski of the Mazovka headworks and provide a round the clock guard/supervisor • Identify the exact location of the N2 intake point of the Mazovka headworks, fence it and provide a round the clock guard/supervisor • Provide a round the clock guard/supervisor at the N1 intake point	• Increase the frequency of water quality monitoring • improve the sanitary condition of the artificial lake located on the territory of the N3 intake facility of the Mazovka headworks	

					collection units • ***<u>Arrange water technological treatment modules (sedimentation and clarification tanks) at</u>***	
3	**Reservoirs**	Domestic and wild animals can access the Reservoirs	Microbial pathogens and physical	H (High risk, management attention needed)	***Short-term strategy:*** • Repair reservoir covers and ventilation windows ***Long-term strategy:*** • Modernize reservoirs with technical equipments (water level meter, window for observation, etc.) • ***<u>Renovate (currently non-functioning) N1 6,000m³ immediate regulating/storage reservoir</u>***	• Increase the frequency of water quality monitoring • Equip reservoirs with automatic valves (self-closing ***<u>gate valve)</u>***
4	**Main pipes and distribution network**	Damaged pipes and insufficient pressure, and water interruption can result in backflow from consumer systems into the network	Microbial pathogens	H (High risk, management attention needed)	***Short-term strategy:*** • ***<u>Add bore wells at the headworks</u>*** • ***<u>Repair damaged valves</u>*** • ***<u>Install pressure regulation valves at points with high pressure</u>*** ***Long-term strategy:***	• ***<u>Increase the frequency of water monitoring in the network</u>*** • ***<u>enhance headworks capacities by adding new sources</u>***

Annexes

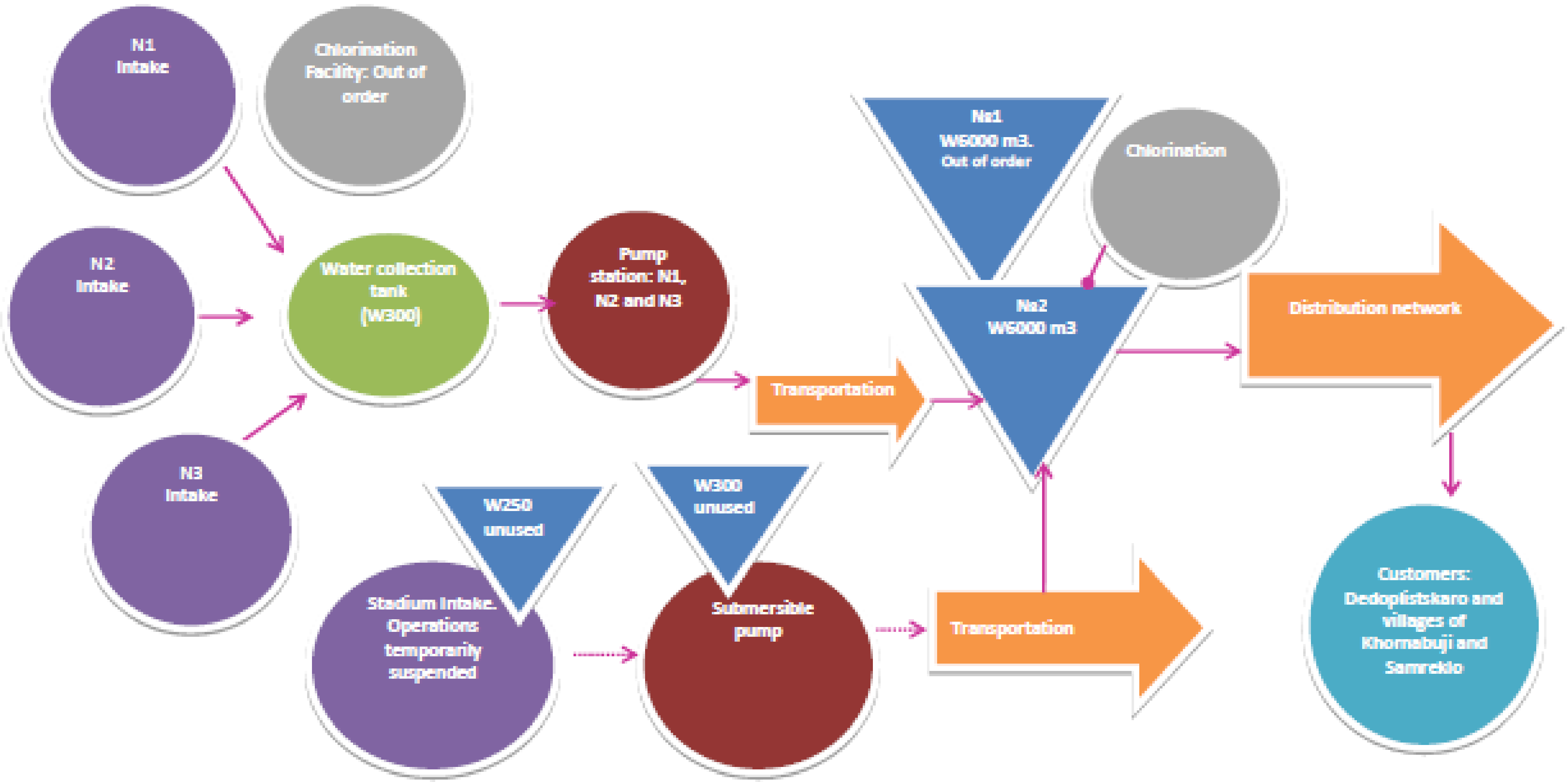
Annex 1. Map of the Dedoplistskaro Water Supply System



Annex 2. Basic Data on Dedoplistskaro Water Supply System[19]

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 Capacity of Water Collector Reservoirs	Water Treatment Method	Total Metric Length of the System
7800	2500 households 93 organizations.	2593	Mazovka – ground waters; capacity: 28 L/sec Stadium – ground waters; capacity: 8 L/sec	6000 m^3 two reservoirs. N1 is out of order.	Chlorination (chlorine lime)	52.7 km

[19]Data is provided by UWSCG



Legend:

Operation stage (water abstraction, purification and consumption)

Accumulation stage (reservoirs and tanks)

Transportation stage

Uninterrupted process

Interrupted 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	Standards Not Exceeding
Odor	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
Mesophilic 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, 2011, Kakheti Regional Branch Office, Dedoplistskaro Service Center

NAMES OF INDEPENDENT WATER SUPPLY SYSTEMS: 1. Mazovka Headworks; 2. Stadium Headworks													Period of Time
Number of Potable Water Quality Inspections at Control Units													
	Headwork At Surface Water Headwork (raw water)			At Ground Water Headworks (raw water)			Released (treated) Potable Water			Potable Water in Distribution System			
		inter alia			inter alia			inter alia			inter alia		
TOTAL INSPECTIONS	TOTAL	Within normal range	Divergence from a norm (+)	TOTAL	Within normal range	Divergence from a norm (+)	TOTAL	Within normal range	Divergence from a norm (+)	TOTAL	Within normal range	Divergence from a norm (+)	
310				**14**	**14**	**0**	**7**	**6**	**1**	**289**	**267**	**22**	**Total**
6										**6**	**6**	**0**	**January**
5										**5**	**4**	**1**	**February**
14				**1**	**1**	**0**				**13**	**10**	**3**	**March**
13				**1**	**1**	**0**				**12**	**12**	**0**	**April**
19				**1**	**1**	**0**				**18**	**18**	**0**	**May**
20				**2**	**2**	**0**				**18**	**18**	**0**	**June**
24				**1**	**1**	**0**	**1**	**1**	**0**	**22**	**20**	**2**	**July**
40				**1**	**1**	**0**	**2**	**1**	**1**	**37**	**35**	**2**	**August**
45				**1**	**1**	**0**	**1**	**1**	**0**	**43**	**41**	**2**	**September**
36				**2**	**2**	**0**	**1**	**1**	**0**	**33**	**29**	**4**	**October**
33				**3**	**3**	**0**	**1**	**1**	**0**	**29**	**25**	**4**	**November**
55				**1**	**1**	**0**	**1**	**1**	**0**	**53**	**49**	**4**	**December**

Annex 6. 2011 Registered Cases of Contagious Diseases for the City of Dedoplistskaro
Source: Statistical Yearbook, Medical Statistics, 2011

#	Cases of Contagious Diseases, 2011	
	Dedoplistskaro	
1	Viral hepatitis A	0
2	Acute viral hepatitis B	1
3	Acute viral hepatitis C	2
4	Chronic viral hepatitis B	0
5	Chronic viral hepatitis C	3
6	Typhus	0
7	Para typhus A, B, C	0
8	Salmonellosis	0
9	Shigellosis (shigella infection)	0
10	Other bacterial intestinal diseases	0
10.1	including escherichiosis	0
11	Yersiniosis	0
12	Amebiasis	0
13	Food poisoning	37
13.1	including botulism	1
14	Diarrhea	32
15	Brucellosis	10
16	Leishmania	1
17	Malaria	0

Picture 1. Mazovka Pump Station

Picture 2. Mazovka Water Collection Reservoir

Picture 3. Former Chlorination Station at Mazovka Headworks

Picture 4. Entrance to the N1 Intake Point

Picture 5.1 and 5.2. Collection Wells at N1 Intake


Picture 6. Area of N3 Intake Point of Mazovka Headworks


Picture 7. Observation Wells at N3 Intake Point


Picture 8. Shaft Well at Stadium Headworks


Picture 9. Deep Pump at Stadium Water Collection Well

Picture 10. Sanitary Zone of the Stadium Headworks

Picture 11. N1 Storage/Regulating Reservoir

Picture 12. N2 Regulating Reservoir - Functional Unit

Picture 13. Chlorination Facility at Regulating Reservoir

Picture 14. Chlorination Equipment

Picture 15. Regulation Unit of the Regulating Reservoir

Picture 16. Pressure Control Valve with Manometer

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