Carrying out an integrated components’ research of the environmental natural environment in the area of the ASTRC “Veduchi” water supply line construction

L A Kesheva¹*, N V Teunova¹, S A Bekkivea², L V Khuchunaeva¹

¹FSBI “High Mountain Geophysical Institute”, 2, Lenin Ave., Nalchik, 360030, Russia
²Federal State Budgetary Educational Establishment “Kabardino-Balkarian State Agrarian University named after V.M. Kokov ”, 1B, Lenin Ave., Nalchik, 360030, Russia

E-mail: kesheva.lara@yandex.ru

Abstract. Veduchi is a small village in the Itum-Kalinsky district of the Chechen Republic, which is located in a very picturesque, historical place near the famous Argun gorge. The area here is literally strewn with sights, that is why it is of great interest to both nature lovers and those who are interested in the history of the Chechen people. The resort “Veduchi” is developed as an all-weather recreational area. On the territory of the all-season tourist and recreational complex “Veduchi” there are two hotel complexes. To discharge treated wastewater, the water supply line construction is necessary. The work considers the ecological state of the environment in the territory of the water supply line construction.

Introduction
The All-Season Tourist and Recreation Complex Resort (ASTRC) “Veduchi” is a tourist place being created in the Itum-Kalinsky district, in the Republic of Chechnya, near the village with the same name. It was located in the beautiful gorge of Argun. Thanks to the beautiful mountain ranges of Chechnya, the tourists who want to get acquainted with the hospitable Caucasus, its traditions and customs, can see the unique natural and cultural heritage and enjoy it [1, 2].

The mountains relief has been formed as a result of a long geological process. The primary relief created by the internal forces of the Earth underwent a transformation under the external forces influence and became more complex.

The resort “Veduchi” is developing as the all-season tourist and recreational complex. Basic ski infrastructure will be located on the upper plateau of the southern slope. In summer, the resort will have an equestrian club, ATV and mountain bike rentals, as well as a tour desk, where guests can buy a guided tour to the historical attractions of the Chechen Republic by ATVs or jeeps.

Two hotel complexes operate on the territory of the “Veduchi” resort, with a total of more than 320 places for tourists.

To ensure the life of the hotels, it was necessary to build a water supply line to discharge treated effluents. Domestic wastewater is supposed to be diverted in an organized way through the sewer to the local sewage treatment plant of ASTRC “Veduchi” household and sanitary sewer. Wastewater treatment plants (WTP) are the equipped complexes designed for the purification and disinfection of
sewage water, necessary to preserve the environmental ecology [3]. The treated wastewater discharge will be carried out through the sewage system to the nearest watercourse. When designing the construction objects, an important role is played by the environmental engineering surveys to assess the current state and assess the possible environmental changes under the anthropogenic stress influence. The beginning of the water supply line is supposed to be at an altitude of 1512 m and the discharge point at an altitude of 1268 m.

The vegetation in the study area is not very rich. The slopes are forested and sod, grassy vegetation is found.

The treated effluents sewage discharge soils in the construction territory are located in the mountain-steppe and mountain-forest soil-geographical zones. The main soil type for this territory is humus petrozem, low-power highly washed-out on rocky soils [4,5]

![Figure 1. View of the slope for the treated water sewage placement](image)

In the scope of field work on environmental engineering, water and soil were sampled. Surface water is represented by a stream, into which it is supposed to discharge clarified water after the household sewage local treatment facilities (LTF). The designed communications routes cross the creek valley in the middle course. The stream channel in the area below Veduchi village is littered with both plant and household waste.

**Water Pollution Studies**

Taking the territorial location peculiarities into account, its functional use, geological structure, etc., 2 surface water samples were taken to assess the level of chemical pollution in the studied area. 1 sample at the intersection of the water supply line with the stream and 2 points directly in the treated effluents discharge place.

The surface water bodies’ supply of the site territory is carried out mainly due to the surface runoff. In this regard, the surface water chemical pollution level assessment was carried out according to [6,7].
Figure 2. Sampling of spring water

Table 1. Concentration of pollutants in the surface water samples

| No. | Defined indicators                        | Units       | Hygienic standard | Sample Content No.1 | Sample Content No.2 |
|-----|------------------------------------------|-------------|-------------------|---------------------|---------------------|
| 1   | Phenol                                   | [mg/dm³]    | 0.001             | less 0.0002         | less 0.0002         |
| 2   | Nickel                                   | [mg/dm³]    | no more 0.02      | less 0.003          | less 0.003          |
| 3   | Chromium (6+)                            | [mg/dm³]    | no more 0.05      | less 0.001          | less 0.001          |
| 4   | COD (bichromate oxidizability)           | [mg/dm³]    | 30                | less 4              | less 4              |
| 5   | Nitrite (by NO2)                         | [mg/dm³]    | no more 3.3       | less 0.2            | less 0.2            |
| 6   | Sulphates                                | [mg/dm³]    | no more 500       | 89.0 ± 8.9          | 57.70 ± 5.77        |
| 7   | Petroleum products (total)               | [mg/dm³]    | 0.1 (0.3)         | less 0.005          | less 0.005          |
| 8   | Aluminum                                 | [mg/dm³]    | 0.2 (0.5)         | less 0.02           | less 0.02           |
| 9   | Molybdenium                              | [mg/dm³]    | no more 0.07      | less 0.0025         | less 0.0025         |
| 10  | Nitrates (by NO3)                        | [mg/dm³]    | no more 45        | 2.2                 | 2.4                 |
| 11  | Chlorides                                | [mg/dm³]    | no more 350       | 6.00 ± 1.44         | 6.700 ± 1.608       |
| 12  | Anionic surfactants                      | [mg/dm³]    | no more 0.5       | less 0.006          | less 0.006          |
| 13  | Iron                                     | [mg/dm³]    | no more 0.3 (1)   | less 0.05           | less 0.05           |
| No. | Defined indicators | Units         | Hygienic standard | Sample Content No.1 | Sample Content No.2 |
|-----|--------------------|---------------|-------------------|---------------------|---------------------|
| 14  | Phosphates         | [mg / dm³]    | no more 3.5       | less 0.25           | less 0.25           |
| 15  | Manganese          | [mg / dm³]    | no more 0.1       | less 0.01           | less 0.01           |
| 16  | Calcium            | [mg / dm³]    | -                 | 19.70 ± 1.97       | 19.90 ± 1.99       |
| 17  | Suspended matter   | [mg / dm³]    | -                 | less 3              | less 3              |
| 18  | Dissolved oxygen   | [mg / dm³]    | >4                | 13.0 ± 1.3         | 13.0 ± 1.3         |
| 19  | BOD5               | mg / dm³      | no more 4         | 1.700 ± 0.102      | 1.700 ± 0.102      |
| 20  | Total mineralization (solids) | [mg / dm³] | no more 1000 | 158.0 ± 15.8 | 158.0 ± 15.8 |
| 21  | Lead               | [mg / dm³]    | no more 0.01      | less 0.0005         | less 0.0005         |
| 22  | Arsenic            | [mg / dm³]    | no more 0.01      | less 0.001          | less 0.001          |
| 23  | Cadmium            | [mg / dm³]    | no more 0.001     | less 0.0005         | less 0.0005         |
| 24  | Mercury            | [mg / dm³]    | no more 0.0005    | less 0.0005         | less 0.0005         |
| 25  | Copper             | [mg / dm³]    | no more 1         | less 0.0005         | less 0.0005         |
| 26  | Zinc               | [mg / dm³]    | no more 1         | less 0.001          | less 0.001          |
| 27  | pH                 | [unit.pH]     | 6.5-8.5           | 7.7±0.2             | 7.3±0.16            |
| 28  | Ammonium ion       | [mg / dm³]    | 1.5               | 0.16±0.06           | 0.13±0.03           |

According to the results of surface waters’ quantitative chemical analysis (Table 1) and microbiological pollution of surface waters (Table 2), no excesses of permissible standards were found.

**Table 2.** Pollutants’ concentration in the surface water samples for microbiological pollution

Soil pollution studies

Soil, as an environmental technogenic nature chemicals depot and a factor in the transmission of infectious and parasitic diseases, can have an adverse effect on the living conditions of the population and its health.

The main sources of soil pollution in the survey area are: emissions vehicles, construction and road dust, unauthorized landfills, etc.

Contaminated soil, in turn, affects surface air, surface contaminated soil, in turn, affects surface air, surface and groundwater and root systems of plants.
To assess the quality of the soil, the work consisting of environmental soil survey of the land plot for chemical pollution, sanitary-parasitological and sanitary-bacteriological indicators has been performed.

Soil sampling was carried out at the point where the water supply line was tapped into the treatment plant, at the point where the water supply line and the spring intersected, and in the place of discharge.

**Figure 3.** Sampling for chemical pollution

The concentrations of heavy metals (copper, zinc, lead, cadmium, mercury, nickel) and arsenic were determined by inversion voltammetry TA analyzers according to [8]. The hydrogen index determination was carried out according to [9].

There are two approaches for assessing the soil pollution category. In the first approach, the assessment is made according to sanitary and epidemiological indicators, such as MPC and APC of pollutants in the soil cover [10].

The MPC of a pollutant should be understood to be such concentrations that, with prolonged exposure to the soil and plants growing on it, do not cause any pathological changes or anomalies during biological soil processes, and also do not lead to the toxic elements’ accumulation in crops and, therefore, cannot violate the biological optimum for animals and humans.

According to the data obtained (Table 6), the concentrations of all the studied substances in all samples do not exceed the MPC, MPD, MPE in the layer of 0.0 - 0.2 m and in the layer of 0.2 - 1.0 m in the samples No. 1-3.

**Table 3.** The heavy metals’ concentration, arsenic (mg / kg dry soil) pH values in soil samples

| No. | Depth of selection [m] | N | mercury [mg/kg] | lead, [mg/kg] | arsenic, [mg/kg] | zinc, [mg/kg] | nickel, [mg/kg] | copper, [mg/kg] | cadmium, [mg/kg] | pH, [unit pH] |
|-----|------------------------|---|----------------|---------------|----------------|-------------|---------------|---------------|----------------|-------------|
|     | Hygienic standard [mg/kg] |   | 2.1 | 32.0 | 2.0 | 220.0 | 80.0 | 132.0 | 2.0 | - |
| 1   | 0.0-0.2 | not upd. < 0.2 | not upd. < 2.5 | not upd. <0.4 | 45.47± 10.91 | 17.25± 4.66 | 13.69± 2.6 | 1.5± 0.1 | 7.21 ± 0.2 |
|     | 0.2-1.0 | not upd. < 0.2 | not upd. < 2.5 | not upd. <0.4 | 45.35± 10.88 | 31.16± 8.41 | 13.53± 2.57 | 1.18± 0.47 | 7.29 ± 0.2 |


The second assessment approach is based on the soils’ chemical pollution level as an indicator of adverse effects on human health according to the indicators developed in conjugate geochemical and hygienic studies.

Such indicators are the concentration coefficient of a chemical substance (Kcᵢ), which is determined by the ratio of the actual content of the analyte in the soil (Ci, mg/kg) to the regional hum (Chᵢ, mg/kg): Kcᵢ = Cᵢ / Chᵢ;

Ci — is the actual content of the i-th chemical element in soils and ground, mg / kg;

Chᵢ — is the hum content i-th chemical element in soils and ground, mg / kg.

Total pollution Zₑ characterizes the effect of a group of elements. The total pollution indicator is equal to the sum of the chemical elements-pollutants’ concentration coefficients and is expressed by the following formula:

\[ Zₑ = Kc₁ + ... + Kcₙ \]

when n — is the number of chemical elements;
Kcᵢ — is the concentration ratio i-th component greater than one.

The total indicators of chemical pollution in the soil of the surveyed area for each sample are shown in the Table 4.

**Table 4. The Total indicator of the soils’ chemical pollution**

| Items | mercury | lead | arsenic | cadmium | zinc | nickel | copper |
|-------|---------|------|---------|---------|------|--------|--------|
| Hum. [mg/kg] | 0.1 | 15 | 2.2 | 0.12 | 45 | 20 | 15 |
| Test №1 |
| K  | not upd. | < 0.2 | not upd. | < 2.5 | not upd. | < 0.4 | 44.76± 10.75 | 30.99± 8.37 | 13.14± 2.5 | 1.46± 0.58 | 7.26± 0.2 |
| 0.2-1.0 | not upd. | < 0.2 | not upd. | < 2.5 | not upd. | < 0.4 | 30.36± 7.29 | 31.18± 8.42 | 13.42± 2.55 | 1.58± 0.63 | 7.41± 0.2 |
| Zₑ  | 0.0-0.2 | < 0.2 | < 2.5 | < 0.4 | 1.5 | 45.47 | 17.26 | 13.69 |
| 0.2-1.0 | < 0.2 | < 2.5 | < 0.4 | 1.18 | 45.35 | 31.16 | 13.53 |
| Test №2 |
| K  | 0.0-0.2 | < 0.2 | < 2.5 | < 0.4 | 1.46 | 44.76 | 30.99 | 13.14 |
| 0.2-1.0 | < 0.2 | < 2.5 | < 0.4 | 1.58 | 30.36 | 31.18 | 13.42 |
| Zₑ  | 0.0-0.2 | 15.58 |
| 0.2-1.0 | 15.36 |
| Test №3 |
| K  | 0.0-0.2 | < 0.2 | < 2.5 | < 0.4 | 1.53 | 29.97 | 18.09 | 16.57 |
| 0.2-1.0 | < 0.2 | < 2.5 | < 0.4 | 1.53 | 29.91 | 18.03 | 17.34 |
| Zₑ  | 0.0-0.2 | 15.51 |
| 0.2-1.0 | 15.41 |
As $Z_c$ in all the studied samples is less than 16; according to [11,12], the soil contamination in the studied territory can be considered as permissible.

As an indicator of the presence of carcinogenic PAHs in soils and grounds, the unsubstituted individual hydrocarbon 3,4-benzapyrene is most often determined as a hazard class I substance, which is a strong carcinogen. It does not have a threshold level, i.e. its presence in any detectable amount is dangerous to a living organism.

According to the analytical studies’ results, the pollution category of 3,4-benzapyrene samples No. 1-3 from a depth of 0.0 - 0.2 m and 0.2 - 1.0 m the soil is assessed as clean [9].

Petroleum products are toxic substances of hazard class III. Petroleum products, which are the marketable products of refineries, include crude oil and its refined products. Oil is a complex mixture of hydrocarbons and their derivatives; each of these compounds can be considered as an independent toxicant.

The research results showed that the concentration of oil products in soil samples No. 1–3 in the study area belong to the permissible pollution category (1 level).

Sanitary and bacteriological indicators indicate a change in the number, species diversity, optimal ratio of different types of soil mesofauna and microorganisms, soil contamination with pathogenic microorganisms, and deterioration of the sanitary and epidemiological situation.

During the sanitary-bacteriological studies on the territory of the project under construction, the soil samples were taken to determine the presence of E. coli, enterococci, pathogenic bacteria of the intestinal class (including salmonella) in them.

The sanitary-bacteriological studies’ results are presented in Table 5.

**Table 5. Results of sanitary-bacteriological studies of soil samples**

| No. | Selection depth (m) | Research results | Pollution category |
|-----|---------------------|------------------|--------------------|
|     |                     | The index of bacteria of the group of Escherichia coli, [cells / g] | Enterococcus Index [cl / g] | Pathogen Index |                     |
| 1   | 0.0-0.2             | <1               | <1                 | not detected   | clean            |
| 2   | 0.0-0.2             | <1               | <1                 | not detected   | clean            |

In the study area in the samples No. 1-3 (at a depth of 0.0 - 0.2 m, the content of bacteria of the Escherichia coli group, the index of enterococci, the index of pathogenic microorganisms in soils and soils does not exceed the level established by the Sanitary (sanitary-epidemiological) rules 2.1.7.1287-03 item 4.1, the category of soil contamination is assessed as clean.

Among all the environmental objects, the soil is most often and intensively polluted by pathogens of intestinal parasitic diseases: helminthiasis, giardiasis, amoebiasis, etc. Soil for geohelminths eggs (roundworm, whipworm, toxocarid, hookworm, strongyloid, etc.) is an integral medium for their biological cycle development and a temporary residence for eggs of bio helminths, as well as the cysts of intestinal pathogenic protozoa.

During sanitary-parasitological studies on the territory of the project under construction, the soil samples were taken to determine the presence of eggs and larvae of helminths cysts of intestinal pathogenic protozoa in them.

The sanitary-parasitological studies’ results are presented in Table 6.

**Table 6. The sanitary-parasitological studies’ results of the soil samples**

| No. | Selection depth [m] | Research results | Pollution category |
|-----|---------------------|------------------|--------------------|
|     |                     | Intestinal protozoa cysts, Helmite eggs, |                     |
|   | [unit/100g] | [unit / kg]      |
|---|-------------|------------------|
| 1 | 0.0-0.2     | not detected     |
| 2 | 0.0-0.2     | not detected     |
| 3 | 0.0-0.2     | not detected     |

Analysis of the eggs' detection and helminths larvae, cysts of intestinal pathogenic protozoa showed that no eggs and helminths larvae, cysts of intestinal pathogenic protozoa were found on the territory of the planned construction.

Summary
As a result of the surface water and soil cover studies on the territory of the sewage discharge ASTRC “Veduchi” construction, it was found that:

1. According to the results of the quantitative chemical analysis and microbiological contamination of surface water in all the investigated samples, excesses of permissible standards were not detected.

2. The results of the soils and ground studies showed:
   - chemical pollution with heavy metals (copper, zinc, lead, cadmium, mercury, nickel) and arsenic concentrations in all samples from a depth of 0.0 - 0.2 m and 0.2 - 1 m do not exceed the maximum permissible concentration;
   - by the level of chemical pollution of soils and ground with 3,4-benzapyrene, the pollution category of all the samples from a depth of 0.0 - 0.2 m is assessed as pure;
   - concentrations of oil products in all soil samples belong to the permissible pollution category (level 1);
   - in the study area in all the samples at a depth of 0.0 - 0.2 m, the Escherichia coli group bacteria content, the enterococci index, the pathogenic microorganisms index in soils and ground, the soil contamination category is assessed as pure;
   - the tests for the helminths eggs and larvae detection, cysts of intestinal pathogenic protozoa showed that no helminths eggs and larvae, cysts of intestinal pathogenic protozoa were found on the territory of the planned construction.

The total indicator of the chemical elements-pollutants (Ze) coefficients’ concentration in all the samples is less than 16. Accordingly, the level of chemical pollution, as an indicator of the adverse effects on the vacationers’ health, in all the studied samples belongs to the “permissible” category of pollution.

References
[1] Information on https://skipedia.ru/resorts/kavkaz/veduchi.html
[2] Information on https://skiings.ru/veduchi.html
[3] Information on https://vodasovet.ru/
[4] Umarov M U, Akhmedova K S 2008 “From the history of botanical research in the Chechen Republic (1963-2007 GG.) And the priorities of their development” History of science and technology. Moscow 3 31-34.,
[5] Bayrakov I A, Bolotkhanov E B, Avtorkhanov A I, Taymaskhanov H E, Shakhtamirov I Ya 2006 (Chechen Republic: nature, economy and ecology. Grozny) 375.
[6] Hygienic standard 2.1.5.1315-03 “Maximum permissible concentrations (MPC) of chemicals in the water of water bodies of drinking, cultural and domestic water use”.
[7] Hygienic standard 2.1.5.22880-07 “Maximum permissible concentrations (MPC) of chemicals in the water of water bodies of drinking, cultural and domestic water use”.
[8] Federal environmental regulations (PND F) 16.1: 2: 2.2: 2.3.46-06 Methodology for measuring the mass fraction of acid-soluble forms of heavy metals and toxic elements (Cd, Pb, Cu, Zn, Bi, Ti, Ag, Fe, Se, Co, Ni, As, Sb, Hg, Mn) in soils, soils, bottom sediments, sewage sludge by inversion voltammetry.
[9] State standard (GOST) 26423-85 Soil. Methods for determining the electrical conductivity, pH and the solid residue of the aqueous extract.
[10] Guidelines 2.1.7.730-99 Hygienic assessment of soil quality in populated areas.
[11] Sanitary rules and norms (SanPiN) 2.1.7.1287-03 Sanitary and epidemiological requirements for soil quality.
[12] SanPiN 42-128-4433-87 Sanitary standards for permissible concentrations (MPC) of chemicals in the soil.