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# Impact of uncontrolled landfills on ecosystems of Georgia

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A B S T R A C T

Impact of the most noticeable uncontrolled landfills in some regions of East and West Georgia on the pollution degree of adjacent territories is studied. Frequently, it is not manageable to move West from the given territories or take them away and, as a consequence, pollutants remain there for many years and become one of the sources of contamination of adjacent territories by different types of waste. As a result, the sanitary state of these territories significantly worsens. Considering this problem, hydrochemical and microbiological analyses of samples (soil and water) were conducted and key pollutants that cause environment contamination through landfills were identified. All kinds of laboratory analysis were carried out in the accredited Laboratory of the Department of Environmental Pollution Monitoring at the National Environmental Agency, while in the field the physical and chemical indicators (in case if uncontrolled landfills usually being situated on the riverside) of water were measured using portable devices (Hydrometeorological Institute). The degree of the impact of uncontrolled landfills on ecosystems was assessed along with those negative processes, which may develop among population residing in the given region.
***Keywords:*** Uncontrolled landfill, Pollution, Hazardous waste, Biogenic properties, Microbiological properties, Ecosistem.

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## Introduction

As a matter of fact, there are a lot of uncontrolled landfills in Georgia. They are mostly located in the gorges near rivers, pastures and in the vicinity of settlements. Concequently, it is urgent to know the negative impact they produce on surrounding territories and how dangerous they might be for human health. Harmful substances can most probably be found in landfills of this type since there are yet no specific landfills for hazardous waste in our country. At the same time, mercury thermometers, lamps, batteries of different types, equipment and devices of all sorts containing different types of hazardous substances are imported in our country and in case of their fall into disuse they most probably are found in uncontrolled landfills. At the same time local authorities in Georgia, especially in regions, are still unable to provide the population with special equipment for garbage collection and relevant serviceis, due to which the number of uncontrolled landfills on the given territory increases [1].

## Objectives and methods

Under laboratory conditions, using up-to-date methods and equipment (ISO methods) the polluting ingredients which frequently cause pollution of ecosystems as a result of direct impact of this type of landfills [2-9] were identified in the samples. Therefore, we took samples (water, soil – 0-20 cm) in the field and some basic ions ($HCO_3^-$, $CI^-$, $SO_4^{2-}$), some forms of biogenic elements ($NO_2^-$, $NO_3^-$, $NH_4^+$, $PO_4^{3-}$) and heavy metals (Cu, Zn, Pb, Cd, As, Hg) were measured in them. From the viewpoint of assessment of sanitary state of territories adjacent to landfills, microbiological indicators (indicator microorganisms), such as total Coliforms, fecal streptococci, and E-coli were also measured. Physical and chemical indicators (pH, temperature, electric conductivity, water dissolved oxygen, salinity) were measured in the field (if the landfill was situated on the riverside) using a mobile device. Thus, objects of our research were studied fully – from hydro-chemical and physical and chemical as well as from the microbiological standpoint [10-15].

In order to properly evaluate the role and significance of landfills in the process of pollution of surrounding territories objects of survey were selected to define the background pollution. They were compared with the results obtained from other points under the study. In order to make the obtained results more precise, the data were also compared with máximum permisible concentración (MPC) or Estimated Allowable concentrations (EAC) of the determined components [16-28].

## Results and analysis

First expedition was organized in the Kakheti region. Respectively, samples were taken in Nukriani and Zemo Magaro villages and the city of Telavi (territory adjacent to the Railway Station).

Based on the obtained data, such cancerogenic components as Cd and Hg were not found in any sample. As to Cu, Zn and Pb, their concentrations in some samples exceeded corresponding maximum allowable or Estimated Allowable concentrations. For instance, in Nukriani village copper concentration in soil sample exceeded MPC nearly 3 times, zinc content exceeded 1,6 times. In Magaro village copper concentration in samples was almost 2,5 times higher than MPC, while lead in soil samples of Telavi turned out to be 1,7 times higher than MPC. It should be noted that the level of heavy metals in samples taken from territories adjacent to landfills exceeds corresponding level in samples taken from background, which indicates that uncontrolled landfills have some impact on pollution processes of adjacent territories (Figures 1-3).

Table 2 demonstrates the level of some heavy metals in soil samples of territories near uncontrolled landfills situated nearby Ksani river in Mukhrani village (Shida Kartli), while Tables 3-4 show the results of hydro-chemical and microbiological analyses.

In the given case, lead concentration in the soil samples taken from adjacent territory exceeded the corresponding MPC 4,2 times, zinc concentration – 1,7-times, while copper concentration – twice (Table 2). So, the territory adjacent to the given landfill is also polluted by heavy metals and, therefore, their concentrations exceed the ones of background samples (cadmium and mercury were not found in the samples).

Samples of Ksani river were taken in the vicinity of the landfill and on the spot located 500 meters away from it (as a background). Obtained results are given in Tables 3, 4. It turned out that concentration of only one component, ammonia ions ($NH_4^+$) was found above permissib**l**e limit ( 2 MPC in sample taken from territory adjacent to the landfill), that means small impact of the landfill on river water quality, while microbiological pollution in the given testing point of Ksani river was not registered.

In Samtskhe-Javakheti region samples were taken in Aspindza village (territory adjacent to the landfill) and in the city of Akhaltsikhe (territory adjacent to Potskhovi river).

High concentration of lead was registered in samples of Aspindza and Akhaltsikhe equalling to 3,5 and 5 MPC, respectively. It should be noted that the concentration of lead in both cases are higher than that of background points (see Figures 4-5).

During th**e** inventory of uncontrolled landfills in Imereti region we singled out uncontrolled landfills of Chognari and Kukhi villages, where samples (soil, water) were taken from their surrounding territories. According to the obtained results, lead concentration in soil samples taken from territories adjacent to Chognari landfills exceeded MPC values 1,8 times, while in Kukhi village reached 1,5 MPC. Slightly increased concentrations were registered in case of lead (Figures 6-7).

As to Gubistskali river (Kukhi village), the results of its chemical, microbiological, physical and chemical analyses demonstrate that uncontrolled landfills located in its vicinity have no impact on water quality of this river.

## Conclusion

According to the results of the conducted analyses, we can conclude that uncontrolled landfills studied by us have certain impact on their adjacent territories. Therefore, though small but still negative role of these landfills is noticeable in river pollution processes. Increased concentrations of such heavy metals as Pb, Cu, Zn were identified in soil samples, while presence of Cd and Hg was registered in none of the cases. Slightly increased level of ammonia ions are sometimes noticed in rivers. According to the results of microbiological analyses, we can state that uncontrolled landfills located nearby the rivers have small impact on their ecological state.

It should be noted that on the territories of this type of landfills we frequently encountered cattle feeding in this anti-sanitary conditions with organic fractions of waste disposed on this territory. That may pose threat to the health of local population and cause very unfavorable results.

## Acknowledgement

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**Table 1.** *The heavy metal concentration in the soil samples collected from the surrounding areas of the uncontrolled landfill sites in Kakheti Region*

| Sampling location | Pb | Cd | Zn | Cu | Hg |
|---|---|---|---|---|---|
| | mg/kg | | | | |
| Vil. Gombori (background) | 22,26 | N.D. | 170,00 | 120.30 | N.D. |
| Vil.Nukriani (Sighnaghi Region) | 35.65 | N.D. | 359,38 | 384.35 | N.D. |
| Vil. Zemo Magharo (Sighnaghi Region) | 25,34 | N.D. | 233,41 | 324,47 | N.D. |
| Telavi City (near the railway station) | 52.86 | N.D. | 327,69 | 270,47 | N.D. |
| MPC (mg/kg) | 32 | 2 | | | |
| EAC (mg/kg) | | | 220 | 132 | |

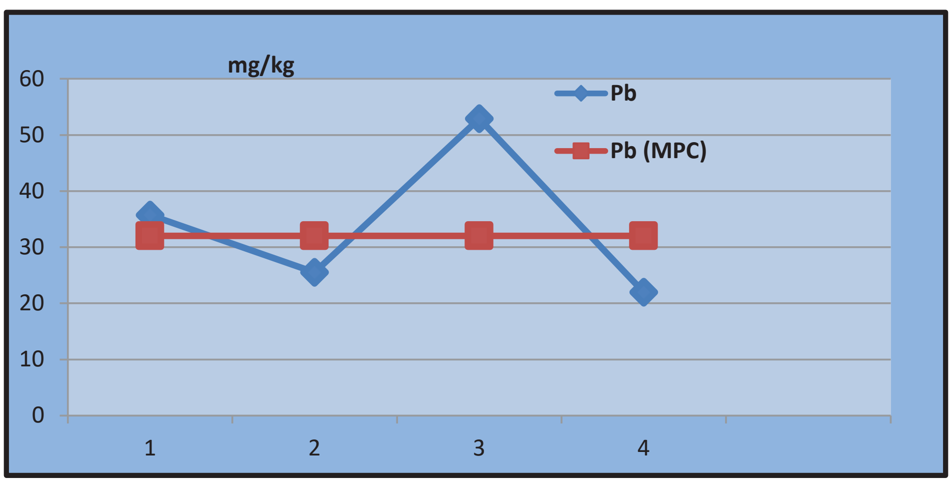


**Fig. 1.** *The Lead concentration in the soil samples collected in Kakheti Region*

**vil.Nukriani**
**vil. Zemo Magharo**
**Telavi city**
**background**

**Pb - concentration**
**Pb - MPC**

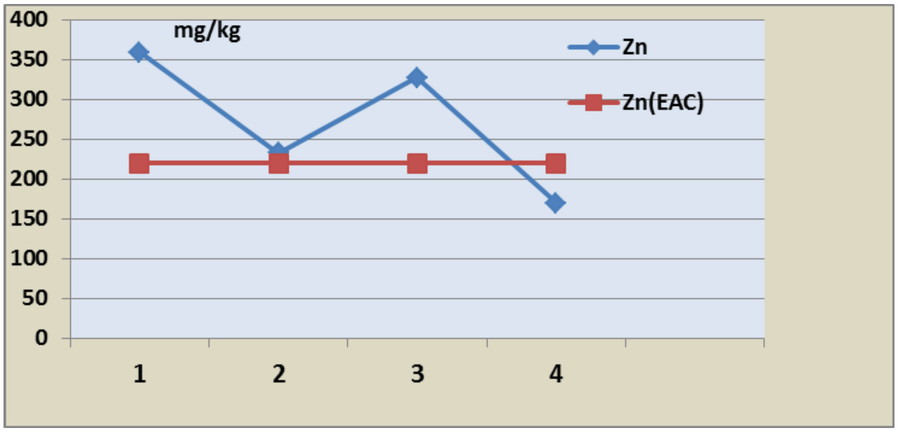


**Fig. 2.** *The Zinc concentration in the soil samples collected in Kakheti Region*

**1 - vil. Nukriani**
**2 - vil. Zemo Magharo**
**3 - Telavi city**
**4 - background**

**Zn - concentration**
**Zn - EAC**

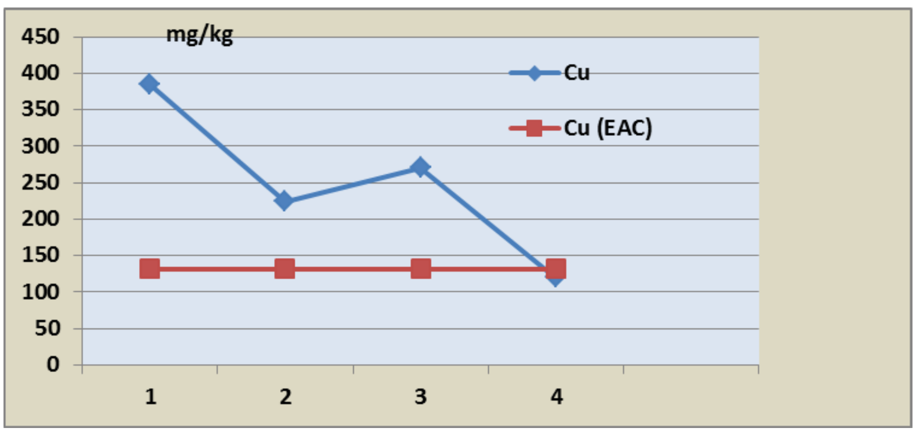


**Fig. 3.** *The copper concentration in the soil samples collected in Kakheti Region*

**1 - vil.Nukriani**
**2 - vil. Zemo magharo**
**3 - Telavi city**
**4 - background**

**Cu - concentration**
**Cu - EAC**

**Table 2.** *The heavy metal concentration in the soil samples collected from the surrounding areas of the uncontrolled landfill sites in Shida Kartli Region*

| **Sampling location** | **Pb** | **Cd** | **Zn** | **Cu** | **Hg** |
|---|---|---|---|---|---|
| | **mg/kg** | | | | |
| **Vil. Mukhrani** | 137,66 | N.D. | 375,88 | 256.31 | N.D. |
| **MPC (mg/kg)** | 32 | 2 | | | |
| **EAC (mg/kg)** | | | 220 | 132 | |

**Table 3.** *The results of hydrochemical and microbiological analysis of Ksani river ( Near landfill, Mukhrani)*

| № | Ingredients | Unit | Results | MPC | Methods |
|---|---|---|---|---|---|
| 1 | $NH_4^+$ | mgN/L | 0,685 | 0,39 | ISO 7150-1:2010 |
| 2 | $NO_2^-$ | mgN/L | 0,015 | 1.0 | ISO 10304-1:2007 |
| 3 | $NO_3^-$ | mgN/L | 0,177 | 10.0 | |
| 4 | $PO_4^{3-}$ | mg/L | 0,035 | 3.5 | |
| 5 | $SO_4^{2-}$ | mg/L | 9,199 | 500 | |
| 6 | $Cl^-$ | mg/L | 1,107 | 350 | |
| 7 | $Br^-$ | mg/L | 0,108 | 0.2 | |
| 8 | $F^-$ | mg/L | 0,003 | | |
| 9 | **E-coli** | Unit per liter | 450 | 5000 | Membrane-filtration |
| 10 | **Total Coliforms** | Unit per liter | 1300 | | |
| 11 | **Feacal Streptococci** | Unit per liter | 450 | | |

**Table 4.** *The results of hydrochemical and microbiological analysis of Ksani river ( 500m. from the landfill, Mukhrani)*

| № | Ingredients | Unit | Results | MPC (mg/l) | Methods |
|---|---|---|---|---|---|
| 1 | $NH_4^+$ | mgN/L | 0,352 | 0,39 | ISO 7150-1:2010 |
| 2 | $NO_2^-$ | mgN/L | 0,061 | 1.0 | ISO 10304-1:2007 |
| 3 | $NO_3^-$ | mgN/L | 3,781 | 10.0 | |
| 4 | $PO_4^{3-}$ | mg/L | 0,436 | 3.5 | |
| 5 | $SO_4^{2-}$ | mg/L | 17,044 | 500 | |
| 6 | $Cl^-$ | mg/L | 7,316 | 350 | |
| 7 | $Br^-$ | mg/L | 0,081 | 0.2 | |
| 8 | $F^-$ | mg/L | 0,103 | | |
| 9 | **E-coli** | Unit per liter | -- | 5000 | Membrane-filtration |
| 10 | **Total Coliforms** | Unit per liter | 600 | | |
| 11 | **Feacal Streptococci** | Unit per liter | -- | | |

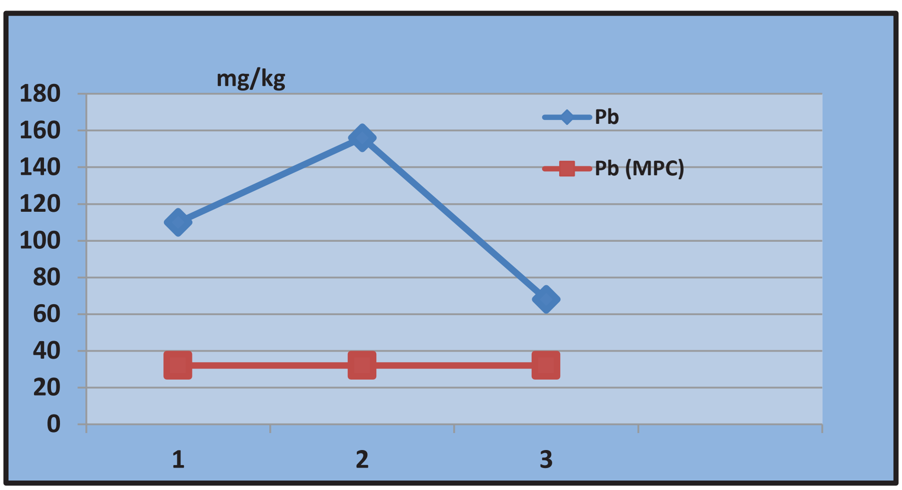


**Fig. 4.** *The Lead concentration in the soil samples collected in Samtskhe-Javakheti Region*

**1 - Aspindza**
**2 - Akhaltsikhe**
**3 - background**

**Pb - concentration**
**Pb - MPC**

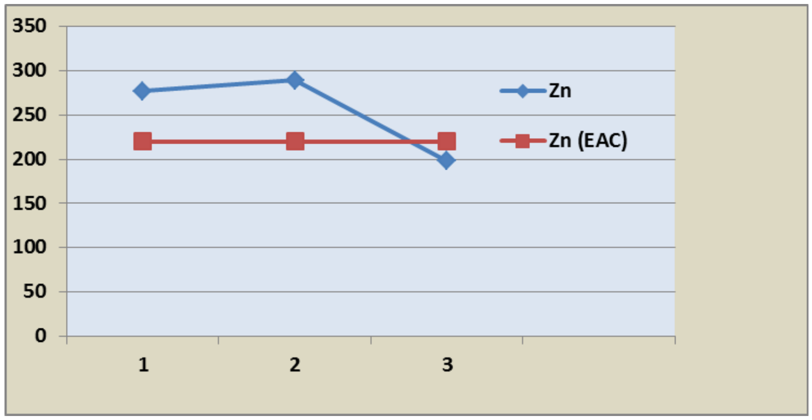


**Fig. 5.** *The Zinc concentration in the soil samples collected in Samtskhe-Javakheti Region*

**1 - Aspindza**
**2 - Akhaltsikhe**
**3 - background**

**Zn - concentration**
**Zn - EAC**

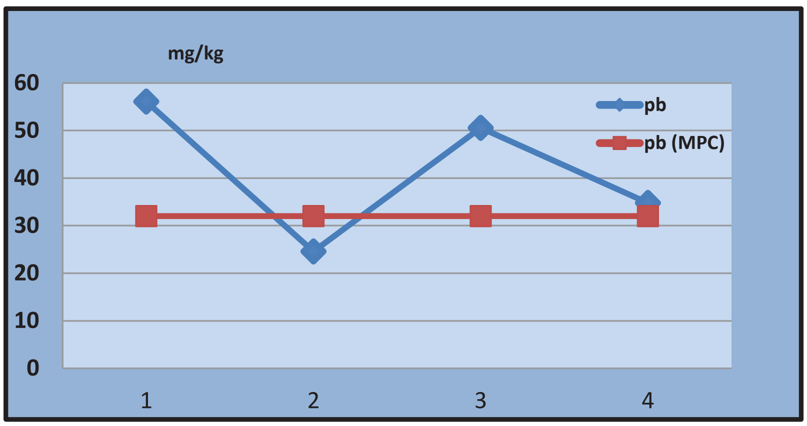


**Fig. 6.** *The Lead concentration in the soil samples collected in Imereti Region*

**1 - vil. Chognari**
**2 - vil. Chognari (background)**
**3 - vil. Kukhi**
**4 - vil. Kukhi (background)**

**Pb - concentration**
**Pb - MPC**

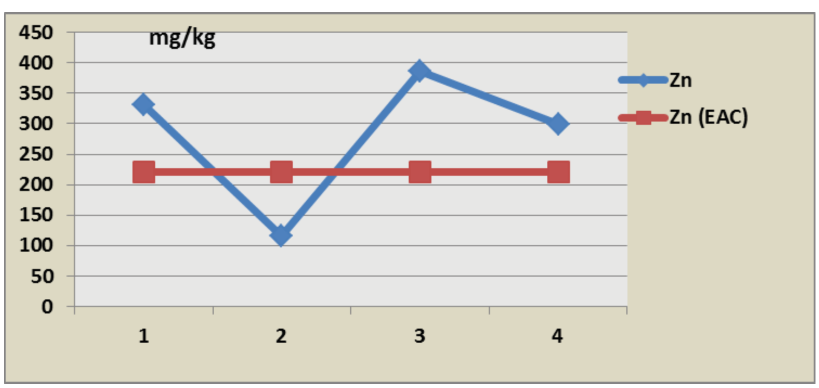


**Fig. 7.** *The Zinc concentration in the soil samples collected in Imereti Region*

**1 - vil. Chognari**
**2 - vil. Chognari (background**
**3 - vil. Kukhi**
**4 - vil. Kukhi (background)**

**Zn - concentration**
**Zn - EAC**

**Table 5.** *The results of hydrochemical and microbiological analysis of Gubistskali river ( Near landfill)*

| № | Ingredients | Unit | Results | MPC (mg/l) | Methods |
|---|---|---|---|---|---|
| 1 | $NH_4^+$ | mgN/L | 0,554 | 0,39 | ISO7150-1:2010 |
| 2 | $NO_2^-$ | mgN/L | 0.122 | 1.0 | ISO 10304-1:2007 |
| 3 | $NO_3^-$ | mgN/L | 0.727 | 10.0 | ISO 10304-1:2007 |
| 4 | $PO_4^{3-}$ | mg/L | 0.192 | 3.5 | ISO 10304-1:2007 |
| 5 | $SO_4^{2-}$ | mg/L | 48.25 | 500 | ISO 10304-1:2007 |
| 6 | $CI^-$ | mg/L | 4.79 | 350 | ISO 10304-1:2007 |
| 7 | $Br^-$ | mg/L | 0,082 | 0.2 | ISO 10304-1:2007 |
| 8 | $F^-$ | mg/L | 0.115 | | ISO 10304-1:2007 |
| 9 | E-coli | Unit per liter | 3500 | 5000 | Membrane-filtration |
| 10 | Total coliforms | Unit per liter | 8200 | | Membrane-filtration |
| 11 | Feacal Streptococci | Unit per liter | 550 | | Membrane-filtration |

**Table 6.** *The results of hydrochemical and microbiological analysis of Gubistskali river ( 300m. from the the landfill)*

| № | Ingredients | Unit | Results | MPC (mg/l) | Methods |
|---|---|---|---|---|---|
| 1 | $NH_4^+$ | mgN/L | 0,354 | 0,39 | ISO7150-1:2010 |
| 2 | $NO_2^-$ | mgN/L | 0.112 | 1.0 | ISO 10304-1:2007 |
| 3 | $NO_3^-$ | mgN/L | 0.527 | 10.0 | ISO 10304-1:2007 |
| 4 | $PO_4^{3-}$ | mg/L | 0.162 | 3.5 | ISO 10304-1:2007 |
| 5 | $SO_4^{2-}$ | mg/L | 47.22 | 500 | ISO 10304-1:2007 |
| 6 | $CI^-$ | mg/L | 4.99 | 350 | ISO 10304-1:2007 |
| 7 | $Br^-$ | mg/L | 0,098 | 0.2 | ISO 10304-1:2007 |
| 8 | $F^-$ | mg/L | 0.101 | | ISO 10304-1:2007 |
| 9 | E-coli | Unit per liter | 2400 | 5000 | Membrane-filtration |
| 10 | Total coliforms | Unit per liter | 7400 | | Membrane-filtration |
| 11 | Feacal streftococci | Unit per liter | 380 | | Membran-filtration |

**Table 4.** *Physico - Chemical properties of Gubistskali river*

| Sampling location | pH | Conductivity, msm/cm | salinity, (%) | Dissolved oxygen, mg/L | $t^0c$ |
|---|---|---|---|---|---|
| Gubistskali river (near landfill) | 7.9 | 224 | 0.1 | 7.8 | 13.8 |
| Gubistskali river (500m. from the landfill) | 7.95 | 210 | 0.1 | 7.6 | 13.6 |

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|---|---|---|---|---|---|
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| 3 | $NO_3^-$ | mgN/L | 0.727 | 10.0 | ISO 10304-1:2007 |
| 4 | $PO_4^{3-}$ | mg/L | 0.192 | 3.5 | ISO 10304-1:2007 |
| 5 | $SO_4^{2-}$ | mg/L | 48.25 | 500 | ISO 10304-1:2007 |
| 6 | $CI^-$ | mg/L | 4.79 | 350 | ISO 10304-1:2007 |
| 7 | $Br^-$ | mg/L | 0,082 | 0.2 | ISO 10304-1:2007 |
| 8 | $F^-$ | mg/L | 0.115 | | ISO 10304-1:2007 |
| 9 | E-coli | Unit per liter | 3500 | 5000 | Membrane-filtration |
| 10 | Total coliforms | Unit per liter | 8200 | | Membrane-filtration |
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|---|---|---|---|---|---|
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| 2 | $NO_2^-$ | mgN/L | 0.112 | 1.0 | ISO 10304-1:2007 |
| 3 | $NO_3^-$ | mgN/L | 0.527 | 10.0 | ISO 10304-1:2007 |
| 4 | $PO_4^{3-}$ | mg/L | 0.162 | 3.5 | ISO 10304-1:2007 |
| 5 | $SO_4^{2-}$ | mg/L | 47.22 | 500 | ISO 10304-1:2007 |
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| 7 | $Br^-$ | mg/L | 0,098 | 0.2 | ISO 10304-1:2007 |
| 8 | $F^-$ | mg/L | 0.101 | | ISO 10304-1:2007 |
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