# RESEARCH ON MINE WELLS DRINKING WATER QUALITY IN ŠIAULIAI DISTRICT

**Violeta Petraškienė**
Šiauliai State College
Lithuania

**Annotation**

*The research on the chemical indicators of 215 mine wells in Šiauliai district, which was carried out in 2002 showed that 141 samples out of 215 did not meet the HN 24:2003 requirements (Šiauliai Public Healthcare Center, 2014). Research of mine wells drinking water quality was carried out to evaluate the drinking water quality of mine wells in Šiauliai district. Water samples were taken from 11 Šiauliai district eldership.*

***Key words:*** *nitrates, nitrites, drinking water, water quality, mine well, Šiauliai district*

**Topic relevance**

Today contamination of water resources by nitrates ($NO_3$-) and nitrites ($NO_2$-) is a relevant issue of drinking water quality (Innocent and all, 2003; Česonienė, 2006). Water gets to the mine wells from the liquid layer that is closest to the surface. $NO_3$- and $NO_2$- are nitric acid salts, which are well soluble in water. These salts get into water from organic nitrogen, which is found in manure, nitrogen fertilizers and human excrements. Nitrates get into mine wells due to inappropriate human economic activities – usually via soil. Concentration of nitrates in groundwater depends on the agricultural intensity, quantities of fertilizers used, insertion time and methods, crop rotations and irrigation (Česonienė, Lukenskienė, 2006).

Inadequate quality of drinking water is one of the primary threats to human wellness. Nitrates themselves are not very harmful for a human. The nitrates create toxic effect when they break into nitrites inside the body, they get into the blood through the digestive tract and bind to methaemoglobin. For this reason, oxygen is no longer being transferred. Babies (up to 3 months) because of the immaturity of rennet systems as well as people suffering from cardiovascular diseases and respiratory diseases, anemia and the elderly are the most susceptible to the toxic effect of methaemoglobin.

Even though the quality of drinking water is regulated by hygiene standard HN 24:2003 "Drinking Water Safety and Quality Requirements" in Lithuania, however, a large part of mine wells water users do not know that they are consuming water contaminated with nitrates.

**The aim of the research** is to evaluate mine wells' water pollution caused by nitrates and nitrites.

**The object of the reseach** – mine wells drinking water in Šiauliai district.

**The research methodology and organization.** The following research methods were used:

**Analysis of sources of literature**

Šiauliai district municipality is situated in the center of Lithuania and occupies the central part of Šiauliai county. The territory of the municipality is divided into 11 townships: Bubiai, Ginkūnai, Gruzdžiai, Kairiai, Kuršėnai rural, Kuršėnai urban, Kužiai, Meškučiai, Raudėnai, Šakyna and Šiauliai rural (Figure 1). There are no state monitoring points of the closest to the surface waterbed for groundwater tests in Šiauliai district municipality. Šiauliai district municipality monitoring program for 2012-2017 has been drawn up, but it is still awaiting its implementation (Šiauliai District Municipality, 2011). The data on groundwater chemical status is sparse in Šiauliai district. Generally occasional tests of drinking water from mine wells for target social group - pregnant women and children using wells water for nutrition are carried out to find out the presence of nitrates and nitrites (Gulbinaitė, 2015).

The main drinking water safety and quality requirements are defined in Lithuanian Hygiene Norm HN 24:2003. Drinking water safety and quality requirements (Lithuanian Hygiene Norm, 2003). HN 24:2003 defines drinking water (including wells) toxic parameters limit of indicator values and parameters indicators' specified indicators' values.

**Sampling**

In this research, water was collected in 1 l plastic containers. Before water collection the plastic container was thoroughly rinsed three times with distilled water and rinsed one more time with water used for examination at the sampling place. Plastic container prepared in this way was filled with the examination water up to the very top and delivered to the laboratory on the same day. Before the examination, samples were kept in a refrigerator at +4 C temperature for 12 hr.

**Photometric method**

Indicators of nitrates and nitrites were identified using Photometer Palintest 7500. The Palintest Nitricol test provides a simple method of measuring nitrite nitrogen levels over the range 0–0.4 mg/L. Higher levels can be determined by diluting the sample.

**Nitrites method**

Nitrites in acid solutions react with sulphanilic acid. The resulting diazo compound couples with N-(1-naphthyl) – ethylene diamine to form a reddish dye. The Palintest Nitricol method features a single tablet reagent containing both reagents in an acidic formulation. The test is simply carried out by adding a tablet to a sample of the water being tested. The intensity of the colour produced is proportional to the nitrite concentration and is measured by comparison against colour standards using a Palintest Comparator and Disc.

**Nitrates method**

In the Palintest Nitratest method nitrate is first reduced to nitrite, the resultin g nitrite is then determined by a diazonium reaction to form a reddish dye. The reduction stage is carried out using the unique zinc-based Nitratest Powder, and Nitratest Tablet which aids rapid flocculation after the one minute contact period. The test is conducted in a special Nitratest Tube – a graduated sample container with hopper bottom to facilitate settlement and decanting of the sample. The nitrite resulting from the reduction stage is determined by reaction with sulphanilic acid in the presence of N-(1-n aphthyl)-ethylene diamine to form a reddish dye. The reagents are provided in a single Nitricol tablet which is simply added to the test solution.

The intensity of the colour produced is proportional to the nitrate concentration and is measured by comparison against colour standards using a Palintest Comparator and Disc.

**Analysis of the research results**

Results of the research were analyzed using Microsoft Excel software. Results are presented Fig.ically to briefly and visually present research data.

**The research conditions and the process**

The research was carried out implementing Šiauliai District Municipality project "Evaluation of Mine Wells Water Quality (Nitrates, Nitrites)". Project promoter is Šiauliai State College. Eleven elderships of Šiauliai district took part in the research: Bubiai, Ginkūnai, Gruzdžiai, Kairiai, Urban Kuršėnai, Rural Kuršėnai, Kužiai, Meškuičiai, Raudėnai, Šakyna and Urban Šiauliai, see. Figure 1.


Fig. 1. Šiauliai District Municipality (Šiaulių rajono savivaldybė, 2011)

Total of 250 water samples were taken from the mine wells located in Šiauliai district municipality elderships. Parameters observed – nitrates ($NO_3^-$) and nitrites ($NO_2^-$). The research took place in November 2014. Water samples were examined in Environmental Research Laboratory of Environmental Engineering Department at the Šiauliai State College.

**Nitrates Test Procedure steps:**

1. Take a clean Nitratest Tube and add 1 ml of sample using the measuring syringe. Fill the Nitratest tube to the 20 ml mark with deionised water.

2. Add one level spoonful of Nitratest Powder and one Nitratest tablet. Do not crush the tablet. Replace screw cap and shake the tube well for one minute.

3. Allow the tube to stand for about one minute, then gently invert three or four times to aid flocculation. Allow the tube to stand for two minutes or longer to ensure complete settlement.

4. Remove screw cap and wipe around the top of the tube with a clean tissue. Carefully decant the clear solution into a round test tube, filling to the 10 ml mark.

5. Add one Nitricol tablet, crush and mix to dissolve.

6. Stand for 10 minutes to allow full colour development.

7. Place the test tube in the Comparator and match against the disc in the usual manner.

8. The disc reading represents the nitrate nitrogen concentration present in the sample as mg/l of $NO_3$.

**Nitrites Test Procedure steps:**

1. Fill a square test tube with the sample to the 10 ml mark.

2. Add one Nitricol tablet, crush and mix to dissolve.

3. Stand for 10 minutes to allow full colour development.

4. Place the test tube in the Comparator and match against the disc in the usual manner.

5. The disc reading represents the nitrites concentration present in the sample as mg/l $NO_2$.

The identified indicators of nitrates and nitrites in mine wells water were evaluated comparing them with the threshold value according to the HN 24:2003 requirements.

**The results of the research and conclusions**

Table 1

Mine Wells Water Quality in Šiauliai District Municipality

| Measurement units Elderships | Number of samples, units | Number of contaminated wells, units | Nitrates above 50 mg/l | Nitrites above 0.5 mg/l |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| Urban Kuršėnai | 23 | 2 | 2 | 2 |
| Rural Kuršenai | 23 | 13 | 14 | 0 |
| Bubiai | 23 | 12 | 12 | 2 |
| Kužiai | 23 | 17 | 16 | 3 |
| Meškučiai | 23 | 19 | 16 | 6 |
| Gruzdžiai | 23 | 18 | 19 | 7 |
| Rural Šiauliai | 23 | 19 | 14 | 10 |
| Kairiai | 23 | 18 | 16 | 11 |
| Šakyna | 22 | 13 | 12 | 5 |
| Raudėnai | 22 | 11 | 10 | 4 |
| Ginkūnai | 22 | 16 | 15 | 9 |

The first column lists places where the samples were taken, second column - the number of samples taken for examination, third - number of wells in which nitrates and nitrites ion medium values in the water exceeded the maximum permissible concentration (DLK), the fourth - number of wells in which nitrate ion medium values in water exceeded the maximum permissible concentration (DLK), and fifth - number of wells in which nitrite ion average values in water exceeded the maximum permissible concentration (DLK),

The analysis of water of mine wells, showed that average values of nitrates ion in water of mine wells in Šiauliai district exceed the maximum permissible concentration (DLK) in drinking water in 146 water samples and nitrite ion in 89 water samples.82.6 percent of the examined wells did not meet the HN 24:2003 requirements in Gruzdžiai eldership. The biggest exceeding concentration of nitrates was found in Dr. J. Šliūpo street – from 80 to 92 mg/l, Taikos str. – from 56 to 87 mg/l. The nitrite concentration ranged from 0.5 to 5 mg/l in villages of Račiai, Lyguotai, Tauraliai as well as Taikos str., Žagarės str., Vaitkaus str.

69.6 percent of the examined wells did not meet the HN 24:2003 requirements in elderships of Kairiai, Meškučiai and Kužiai. The concentration of nitrates ranged from 50 to 80 mg/l and nitrite – from 0.5 to 30 mg/l in Kairiai. The concentration of nitrates ranged from 50 to 80 mg/l, the nitrites – from 0.5 to 10 mg/l in Meškuičiai. The concentration of nitrates ranged from 50 to 90 mg/l, and nitrites – from 0.5 to 5 mg/l in Kužiai eldership.

68.2 percent of the examined wells did meet HN 24:2003 requirements in Ginkūnai eldership. Among them the highest range of concentration of nitrates was found in Šapnagiai village (from 50 to 88 mg/l, nitrite – from 0.5 to 25 mg/l.)

Po 60.9 percent of the examined wells did not meet the HN 24:2003 requirements in Kuršėnai rural eldership neither in Šiauliai rural eldership. The concentration of nitrates ranged from 50 to 90 mg/l, and concentration of nitrites did not exceed in Kuršėnai rural eldership. The concentration of nitrates ranged from 50 to 91 mg/l, and nitrites – from 0.5 to 25 mg/l in Šiauliai rural eldership.

52.2 percent of wells did not meet the HN 24:2003 requirements in Bubiai and Šakyna elderships. The concentration of nitrates ranged from 50 to 74 mg/l and nitrites – from 0.5 to 0.6

mg/l in Bubiai eldership. The concentration of nitrates ranged from 50 to 86 mg/l, the nitrites – from 0.5 up to 10 mg/l in Šakyna eldership.

45.5 percent of wells did not meet the HN 24:2003 requirements in Raudėnai eldership. The concentration of nitrates ranged from 50 to 90 mg/l and nitrites – from 0.5 up to 10 mg/l.

8.7 percent of the analyzed wells did not meet the HN 24:2003 requirements in Kuršėnai town. The concentration of nitrates exceeds in Maironio str. and J. Biliūno str. (from 50 to 59 mg/l, and nitrites – from 0.5 to 1.4 mg/l).

**Conclusions and recommendations**

1. The research showed that even 82.6 percent of mine wells in Gruzdžiai eldership exceeds the HN 24:2003 threshold due to the indicators of nitrates and nitrites.

2. The research data also showed that the most heavily contaminated mine wells are in Voveriškiai village of Šiauliai rural eldership. The concentration of nitrates exceeds the HN 24:2003 threshold almost twice.

**References**

1. Česonienė, L., Bitarytė, J. (2008). Šulinio aplinkos įtaka šachtinių šulinių vandens kokybei. *Žmogaus ir gamtos sauga; respublikinės mokslinės konferencijos medžiaga*. LŽŪU, Kaunas, 103–105.

2. Česonienė, L., Lukenskienė, R. (2006). Lapių sąvartyno įtaka Marilės upelio vandens taršai azoto junginiais. *Žmogaus ir gamtos sauga.* LŽŪU, Kaunas, 131–133.

3. Innocent, S. I. Ogbu & Vitalis, C. Echebiri (2003). Nitrate and Nitrite Content of Well Water in Enugu, Southeast Nigeria. *Archives of Environmental Health: An International Journal*, 58:9, 590–591.

4. *Lietuvos higienos norma HN 24:2003*, patvirtinta LR sveikatos apsaugos ministro 2003 m. liepos 23 d. įsakymu Nr. V- 455. Accessed on 15-09-2015 http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=216309.

5. Juodkazis, V. (2004). Geriamasis vanduo – aktuali Lietuvai dabarties problema. *Geologijos pažanga*. LŽŪU, Kaunas, 6–15.

5. Šiaulių visuomenės sveikatos centras. Accessed on 10-12-2014 http://www.svsc.lt/index.php?id=361.

6. *The Palintest System Instructions*. Palintest House, Kingsway, Team Valley, Gateshead, Tyne & Wear, England.

7. *Šiaulių rajono savivaldybės aplinkos monitoringo programa*. *Dalis: Požeminis vanduo*. Galiojimo metai 2012-2017. Šiauliai, 2011, p. 35. Accessed on 10-12-2014 http://195.182.85.235/aktai/Default.aspx?Id=3&DocId=14213.

8. Šiaulių visuomenės sveikatos centras. Accessed on 10-12-2014 http://www.svsc.lt/index.php?id=361.

9. Gulbinaitė, I. *Šulinių vandens kokybė Lietuvoje negerėja*. Accessed on 20-03-2015 http://www.tv3.lt/naujiena/828239/suliniu-vandens-kokybe-lietuvoje-negereja/1.

**Received: 27 October 2015**
**Accepted: 29 February 2016**