

obtained after evaporation of the filtered water sample and drying to constant weight at 110 °C [15]. The water samples evaporated in a water bath and dried to constant weight in a thermostat at 110 °C. The dry residue of drinking quality water should be no more than 1.5 g/L [12]. For all drinking water samples, the dry residue was below 1.5 g/L thus meeting the requirements for drinking water quality of Kazakhstan sanitary norms [11, 12].

4.2. pH measurement

According to the norms, the pH of drinking water should be in the range from 6.0 to 9.0. The pH was determined using a pH meter pH-150MI. The results of the pH of the water lie in the range from 6.0 to 9.0 and meet the requirements for the quality of drinking water of Kazakhstan sanitary norms [11, 12].

4.3. Water hardness

Water hardness is a combination of properties due to the content of calcium and magnesium cations in water. It can also be caused by salts of barium, strontium, iron and heavy metals dissolved in water, but their content in most sources used for water consumption is negligible, therefore the hardness of natural waters is characterized by the total content of calcium and magnesium cations. The sum of their concentrations, expressed in mmol/L, is called the total hardness [11, 12].

The concentration of Ca^{2+} and Mg^{2+} ions in water, equivalent to the content of the HCO_3^- ion, determines the carbonate hardness of water, and the concentration of Ca^{2+} and Mg^{2+} ions, equivalent to all other anions (SO_4^{2-} , Cl^- , etc.), determines the non-carbonate hardness. The sum of carbonate and non-carbonate hardness determines the total hardness of water. The non-carbonate hardness is caused by the presence of sulfates and chlorides of calcium and magnesium in the water.

According to the magnitude of the total hardness, natural waters are divided into very soft, soft (0–1.5 mmol/L), medium hardness (1.5–3 mmol/L), hard (3–5 mmol/L) and very hard (>7 mmol/L). Regulatory requirements for the hardness of drinking water in water supply systems, according to current Kazakhstan sanitary rules, should not exceed 7 mmol/L [11, 12].

When monitoring the quality of drinking water, the total hardness is determined by complexometric method, using Na-EDTA as a titrant until the

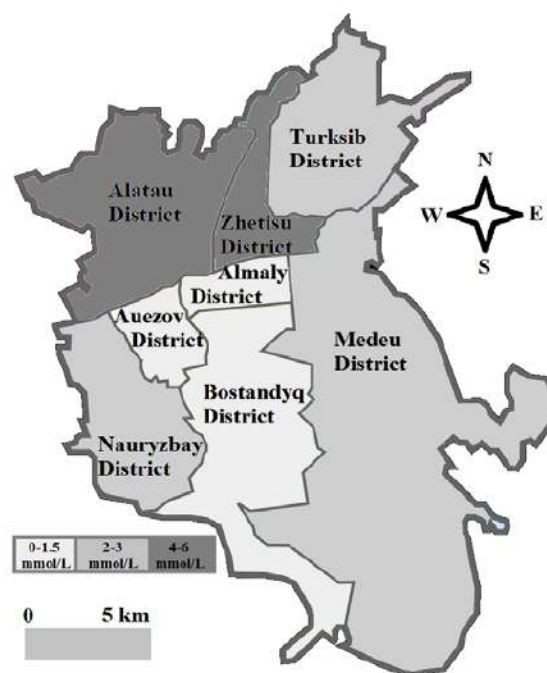


Fig. 2. Hardness map of Almaty.

pink color of the solution changes to blue in the presence of the eriochrome black indicator T.

As a result of the experiment to determine the total hardness of drinking water, it was found that the drinking water of the districts of Almaty, according to the scale of water types in terms of total hardness, varies from soft water (0–1.5 mmol/L) to moderate water hardness (4–6 mmol/L). The results of the experiment showed that soft water corresponds to tap water from the Medeu, Almaty and Bostandyq districts (hardness indicators, respectively, 1.5; 1.7 and 1.4 mmol/L); water of medium hardness in the Nauryzbay and Turksib districts of Almaty (hardness indicators 2.8 and 2.0 mmol/L); the hardest water was found in the Alatau and Zhetysay districts of Almaty (hardness indicators 4.3 and 5 mmol/L). Soft water from Medeu, Almaty and Bostandyk districts, which are located in the southern part of the city, is due to the mountain origin of drinking water. In the districts of Almaty (Nauryzbay and Turksib), where the water has an average hardness, there is a mixture of mountain and underground water. Hard water in the districts of Almaty (Alatau and Zhetysay), which are located in the northern and eastern parts of the city, is caused by underground sources. It is recommended to use drinking water treatment plants based on ion exchange or reverse osmosis methods to soften hard water. The results of determining the total hardness of water are mapped and presented in Fig. 2.