

## **Supplementary Material**

- S1. Method for measuring petroleum hydrocarbons**
- S2 The physicochemical parameter values in all observation points.**
- S3. Definition of individual indicators**
- S4. Results of route studies of Southern Kazakhstan**

## S1 Analysis of samples for petroleum hydrocarbons

Samples were preserved and analyzed according to [1] under conditions specified by [2]. The gas chromatograph is prepared for operation in accordance with the manual (instructions) for the operation of the device. The capillary column is conditioned at a maximum temperature for at least 5 hours. The parameters of the temperature program of the chromatographic separation are selected individually for each column. The initial temperature of the evaporator should be no higher than 50°C, the final temperature should not be lower than 300°C, and the detector temperature should be higher than 300°C. The conditions for chromatographic separation are selected according to the data of the chromatographic analysis of the model solution.

The criteria for the correct choice of conditions for chromatographic separation include:

- The first detectable n-octane peak is separated from the extractant peak;
- The peak of n-tetracontane (n-tricontane) comes out before reaching the end of the temperature program of the chromatographic separation;
- The total time of the chromatographic analysis is not more than 40 minutes;
- The relative standard deviation of the hydrocarbon response factors of the model solution is not more than 25%.

Chromatographic analysis of the obtained eluates is carried out, as indicated in section 6. Using a computer system for processing chromatographic information, a quantitative calculation of chromatograms is carried out. The chromatograms determine the total area of the peaks relative to the baseline in the range of retention X from C8 to C40. Based on the processed data, the calibration dependence of the peak areas of the calibration solutions on the concentration of oil products in these solutions is determined. Linear correlation coefficient—not less than 0.97.

### Preparation of the test water sample for measurement

Add concentrated hydrochloric acid or a 1:1 dilute sulfuric acid solution to pH 2 in a container with a water sample (control by indicator paper).

Add  $(45 \pm 5)$  g magnesium sulfate for every 0.5 L of sample and extractant. If the estimated concentration of oil products in the sample is not more than 5 mg / dm<sup>3</sup>, which is typical for drinking, natural, treated and conditionally pure wastewater, then 4 cm of the extractant is added to the sample. In the study of contaminated surface and wastewater, add 50 cm<sup>3</sup> of extractant.

Insert the extractor stirrer into the container with the water sample prepared in accordance with 5.11.2 and mix intensively for at least 20 minutes with a sample volume of 0.25–0.5 dm<sup>3</sup> and at least 30 minutes with a sample volume of more than 0.5 dm<sup>3</sup>.

After stopping stirring, the emulsion is settled for 5–10 minutes to separate the aqueous and organic phases. If the phase separation is poor, then it is recommended to cool the sample to a temperature of 4 °C–8 °C. Then place the separator on the neck of the container. Bi-distilled water is added to the side branch of the separator, which squeezes the extract into the central branch of the separator, from where it is taken with a syringe for further analysis. The total amount of the collected extract is not less than 1 cm<sup>3</sup>. To remove polar compounds, the extract is passed through a column prepared with a sorbent. The purified extract (eluate) is collected for chromatography as described in Section 6. Carry out a chromatographic analysis of the eluate with a volume of 2–20 µL under these conditions.

Using a computer system for processing chromatographic information, the total peak area of hydrocarbons (petroleum products) is determined. Based on the calibration dependence (see 5.9), the concentration of oil products C (mg/dm) is determined. If the determined concentration in the sample is more than 100 mg/dm<sup>3</sup>, then the eluate is diluted with the extractant used, recording the dilution factor, and the diluted eluate is analyzed chromatographically. The multiplier is calculated using the formula:

$$K_p = V_p / V_{\text{н}}$$

where  $V_p$ —the volume of the diluted eluate, cm;

$V_{\text{н}}$ —the volume of the initial eluate, cm.

If the determined concentration of oil products in the test water sample is more than 1000 mg/dm<sup>3</sup>, then it is necessary to re-pass the eluate through the column with the sorbent, especially if the amount of the

sorbent poured into the column was less than 2 g. If the results of two measurements coincide with an accuracy of 10%, then the arithmetic mean of the results of these measurements is taken as the final result, or the eluate is again passed through the column with the sorbent and measurements are carried out until this condition is met.

If when extracting a water sample according to 5.11.2, 50 ml of an extractant is used, and the measured concentration of oil products turns out to be less than 0.4 mg/dm<sup>3</sup>, then increase the volume of the eluate introduced into the chromatograph, and (or) carry out its concentration according to 5.11.7 and re-concentrate the performed measurements.

Processing measurement results. The concentration of oil products in the test water sample, mg/dm<sup>3</sup>, is calculated using the formula:

$$y = K_p \cdot C \cdot m_{\Pi} / m_T \cdot K_K$$

where  $K_p$ —the dilution factor of the eluate according to 6.3;

$C$ —eluate concentration factor according to 5.11.7;

$m_{\Pi}$ —measured concentration of oil products (see section 6), mg/dm<sup>3</sup>;

$m_T$ —a mass of the investigated water sample (see 4.1), g;

$K_K$ —the weight of the calibration solution, g; calculated according to the formula:

$$m_T = V_T \cdot \rho$$

where  $V_T$ —the volume of the calibration solution according to 5.8.5, cm<sup>3</sup>;

$\rho$ —the density of the solution, taken equal to the density of w [23].

## S2 The physicochemical parameters values in all observation points.

| Name of observation point                          | Depth of dug well/m | pH   | Hardness/<br>mg-eq/L | Mineralization,<br>mg/L | K   | Ca   | Mg   | Na    | Fe <sub>3</sub> | CO <sub>3</sub> | HCO <sub>3</sub> | Cl    | SO <sub>4</sub> | NO <sub>3</sub> | NH <sub>4</sub> | F    | The formula of the salt composition  |
|--|---------------------|------|----------------------|-------------------------|-----|------|------|-------|-----------------|-----------------|------------------|-------|-----------------|-----------------|-----------------|------|--|
| Kapchagai, Nikolaevskoye groundwater deposit, Arna | 60                  | 7.31 | 5.7                  | 670                     | 2.5 | 60.1 | 32.8 | 85.5  | <0.1            | <8              | 231.9            | 53.2  | 170.4           | 19.8            | <0.05           | 1.4  | M 0.67 $\frac{HCO_3\ 41\ SO_4\ 38\ Cl\ 16}{Na_{39}\ Ca\ 32\ Mg\ 26}$ pH 7.31             |
| Shengeldi  | 65                  | 7.58 | 7.3                  | 956                     | 1.1 | 80.1 | 40.1 | 132.5 | <0.1            | <8              | 146.4            | 63.8  | 377.8           | <b>98.9</b>     | <0.05           | 0.39 | M 0.96 $\frac{SO_4\ 58\ HCO_3\ 18\ Cl\ 13\ NO_3\ 12}{Na_{44}\ Ca_{31}\ Mg_{25}}$ pH 7.58 |
| Taldykorgan city, well No.13                       | 50                  | 7.26 | 4.3                  | 367                     | 2   | 68.1 | 10.9 | 6.4   | <0.1            | <8              | 219.7            | 7.1   | 23.5            | 16              | <0.05           | 0.2  | M 0.37 $\frac{HCO_3\ 79\ SO_4\ 11}{Ca_{73}\ Mg_{19}}$ pH 7.26                            |
| Kosozen village, Almaty region                     | 80                  | 7.22 | 5.2                  | 467                     | 6.7 | 76.1 | 17   | 12.1  | <0.1            | <8              | 292.9            | 7.1   | 22.2            | 20.5            | <0.05           | 0.36 | M 1.8 $\frac{HCO_3\ 83}{Ca_{64}\ Mg_{24}}$ pH 7.22                                       |
| Aksu river, Karakoz village                        | 45                  | 7.71 | 2.7                  | 281                     | 3   | 30   | 14.6 | 23    | 0.1             | <8              | 152.5            | 7.1   | 35              | 3.7             | <0.05           | 0.41 | M 0.28 $\frac{HCO_3\ 71\ SO_4\ 21}{Ca_{40}\ Mg_{32}\ Na_{26}}$ pH 7.71                   |
| Head water intake, Usharal village                 | 150                 | 7.67 | 2.1                  | 188                     | 0.5 | 30   | 7.3  | 6.4   | <0.1            | <8              | 115.9            | 3.5   | 15.2            | 1.6             | <0.05           | 0.12 | M 0.19 $\frac{HCO_3\ 81\ SO_4\ 14}{Ca_{63}\ Mg\ 25\ Na_{12}}$ pH 7.67                    |
| HPP on the Kopa River                              | 160                 | 7.48 | 1.6                  | 137                     | 1.2 | 28   | 2.4  | 3     | <0.1            | <8              | 79.3             | 3.5   | 12.8            | 1.4             | 0.4             | 0.14 | M 0.14 $\frac{HCO_3\ 77\ SO_4\ 16}{Ca_{79}\ Mg\ 11}$ pH 7.48                             |
| Tekeli filtering station                           | 80                  | 7.75 | 1.9                  | 155                     | 0.9 | 24   | 8.5  | 3     | <0.1            | <8              | 79.3             | 3.5   | 28              | 1.8             | <0.05           | 0.15 | M 0.16 $\frac{HCO_3\ 64\ SO_4\ 29}{Ca_{58}\ Mg\ 34}$ pH 7.75                             |
| Head water intake 1 Tastobe                        | 85                  | 6.98 | 2.9                  | 279                     | 1.4 | 42   | 9.7  | 10.8  | 0.1             | <8              | 164.8            | 7.1   | 27.6            | 3.3             | <0.05           | 0.19 | M 0.28 $\frac{HCO_3\ 76\ SO_4\ 16}{Ca_{62}\ Mg\ 23\ Na_{14}}$ pH 6.98                    |
| Saryozek settlement                                | 90                  | 7.42 | 4.6                  | 885                     | 0.4 | 50.1 | 25.5 | 171.3 | <0.1            | <8              | 268.5            | 42.5  | 297.2           | 14.8            | <0.05           | 0.93 | M 0.89 $\frac{SO_4\ 51\ HCO_3\ 36\ Cl\ 10}{Na_{62}\ Ca_{21}\ Mg_{17}}$ pH 7.42           |
| Zharkent Water intake №1                           | 250                 | 7.68 | 2.2                  | 301                     | 1.8 | 30   | 8.5  | 36.3  | <0.1            | <8              | 164.8            | 3.5   | 29.6            | 15.2            | <0.05           | 0.12 | M 0.30 $\frac{HCO_3\ 74\ SO_4\ 17}{Na_{41}\ Ca_{39}\ Mg_{18}}$ pH 7.68                   |
| Zharkent starch plant wastewater                   | 200                 | 8.18 | 3.9                  | 927                     | 6.2 | 16   | 67.7 | 170.2 | 0.2             | <8              | 512.6            | 127.6 | 24.7            | <0.2            | <b>10</b>       | 0.08 | M 0.93 $\frac{HCO_3\ 67\ Cl\ 29}{Na_{61}\ Mg_{26}}$ pH 8.18                              |
| Chundzha, main water intake well No. 1             | 100                 | 7.78 | 2.5                  | 266                     | 0.8 | 32   | 10.9 | 20.4  | <0.1            | <8              | 140.3            | 7.1   | 32.5            | 2.4             | 0.4             | 0.18 | M 0.27 $\frac{HCO_3\ 71\ SO_4\ 21}{Ca\ 47\ Mg\ 26\ Na_{26}}$ pH 7.78                     |
| Narynkol village, main water intake                | 100                 | 7.78 | 2.8                  | 244                     | 0.8 | 36   | 12.2 | 7.7   | <0.1            | <8              | 152.5            | 7.1   | 17.7            | 2               | <0.05           | 0.23 | M 0.24 $\frac{HCO_3\ 80\ SO_4\ 12}{Ca\ 57\ Mg\ 32\ Na_{11}}$ pH 7.78                     |
| Kegen village, head water intake                   | 100                 | 7.72 | 2.8                  | 406                     | 1.2 | 32   | 14.6 | 61.6  | <0.1            | <8              | 195.3            | 28.4  | 58.4            | 1.6             | <0.05           | 0.36 | M 0.41 $\frac{SO_4\ 61\ HCO_3\ 23\ Cl\ 15}{Na\ 49\ Ca\ 29\ Mg_{22}}$ pH 7.72             |
| Otegen batyr village                               | 45                  | 8.04 | 1.5                  | 230                     | 1.4 | 18   | 7.3  | 33.3  | <0.1            | <8              | 97.6             | 7.1   | 49.4            | 4.1             | <0.05           | 1.01 | M 0.23 $\frac{HCO_3\ 54\ SO_4\ 35}{Na\ 49\ Ca\ 30\ Mg\ 20}$ pH 8.04                      |
| Ili district, the village of Japek batyr           | 50                  | 6.59 | 1.9                  | 200                     | 2.5 | 26   | 7.3  | 13.3  | <0.1            | <8              | 122              | 3.5   | 11.5            | 1.4             | <0.05           | 1.01 | M 0.20 $\frac{HCO_3\ 83\ SO_4\ 10}{Ca\ 51\ Mg\ 24\ Na_{23}}$ pH 6.59                     |
| Vodnik, Ili district                               | 100                 | 7.39 | 1.7                  | 181                     | 1.9 | 28   | 3.6  | 11.8  | <0.1            | <8              | 103.7            | 3.5   | 14.4            | 1.2             | <0.05           | 1.1  | M 0.18 $\frac{HCO_3\ 78\ SO_4\ 14}{Ca\ 62\ Na_{23}\ Mg\ 13}$ pH 7.39                     |

|  |     |      |       |      |     |      |      |            |             |    |       |       |              |      |       |      |   |
|--|-----|------|-------|------|-----|------|------|------------|-------------|----|-------|-------|--------------|------|-------|------|---|
| Taraz city, Kumshagal water intake               | 100 | 7.82 | 4.1   | 497  | 3.3 | 42   | 24.3 | 50.9       | 0.1         | <8 | 219.7 | 10.6  | 111.1        | 20.7 | <0.05 | 0.54 | M 0.50 $\frac{HCO_3\ 55\ SO_4\ 35}{Na\ 35\ Ca\ 33\ Mg\ 31}$ pH 7.82         |
| Taraz city, Kumshagal water intake well No. 1    | 100 | 7.72 | 5.3   | 551  | 3.1 | 48   | 35.3 | 39.2       | <0.1        | <8 | 274.6 | 12.4  | 88.9         | 33.9 | <0.05 | 0.54 | M 0.55 $\frac{HCO_3\ 62\ SO_4\ 25}{Mg\ 41\ Ca\ 34\ Na\ 24}$ pH 7.72         |
| Taraz city, main water intake, Jalpaktobe        | 100 | 7.71 | 4.7   | 451  | 3.3 | 55.1 | 23.7 | 20.3       | <0.1        | <8 | 213.6 | 17.7  | 89.7         | 14.1 | <0.05 | 0.44 | M 0.45 $\frac{HCO_3\ 57\ SO_4\ 31}{Ca\ 49\ Mg\ 34\ Na\ 16}$ pH 7.71         |
| Zhetisai city, head water intake                 | 270 | 8.22 | 2.9   | 957  | 1.5 | 24   | 20.7 | <b>257</b> | 0.1         | <8 | 91.5  | 198.6 | 351.5        | <0.2 | <0.05 | 0.63 | M 0.45 $\frac{HCO_3\ 57\ SO_4\ 31}{Ca\ 49\ Mg\ 34\ Na\ 16}$ pH 7.71         |
| Myrzakent, head water intake                     | 250 | 8.03 | 3.15  | 548  | 2.2 | 33   | 18.2 | 98         | 0.1         | <8 | 97.6  | 78    | 209.1        | <0.2 | <0.05 | 0.42 | M 0.54 $\frac{SO_4\ 53\ Cl\ 27\ HCO_3\ 20}{Na\ 57\ Ca\ 22\ Mg\ 20}$ pH 8.03 |
| Atakent, Komkhoz water intake                    | 250 | 8.08 | 3.1   | 535  | 1.8 | 35   | 16.4 | 98         | 0.1         | <8 | 91.5  | 109.9 | 169.6        | <0.2 | <0.05 | 0.26 | M 0.54 $\frac{SO_4\ 43\ Cl\ 38\ HCO_3\ 18}{Na\ 58\ Ca\ 24\ Mg\ 18}$ pH 8.08 |
| Asykata kent, Maktaral district, well No. 1      | 250 | 8.12 | 2.65  | 722  | 1.4 | 22   | 18.8 | 159        | <0.1        | <8 | 128.1 | 53.2  | 328.5        | <0.2 | <0.05 | 0.63 | M 0.72 $\frac{SO_4\ 65\ HCO_3\ 20\ Cl\ 14}{Na\ 72\ Mg\ 16\ Ca\ 12}$ pH 8.12 |
| Shardara city, water source of the Syrdarya r.   | 250 | 7.93 | 10.55 | 1058 | 5.5 | 110  | 61.4 | 92         | 0.1         | <8 | 170.9 | 79.8  | 524.4        | 5    | <0.05 | 0.56 | M 1.06 $\frac{SO_4\ 68\ HCO_3\ 17\ Cl\ 14}{Ca\ 37\ Mg\ 34\ Na\ 27}$ pH 7.93 |
| Arys ground drainage system                      | 300 | 7.54 | 6.7   | 874  | 2.1 | 50.1 | 51.1 | 112        | <0.1        | <8 | 274.6 | 69.1  | 289.8        | 9    | <0.05 | 0.83 | M 0.87 $\frac{SO_4\ 48\ HCO_3\ 36\ Cl\ 15}{Na\ 42\ Ca\ 36\ Mg\ 22}$ pH 7.54 |
| Ordabasinsky district, Temirlan village          | 150 | 7.77 | 5.1   | 508  | 0.8 | 64.1 | 23.1 | 28         | <0.1        | <8 | 244.1 | 10.6  | 119.4        | 7.2  | <0.05 | 0.3  | M 0.51 $\frac{HCO_3\ 58\ SO_4\ 36}{Ca\ 51\ Mg\ 30\ Na\ 19}$ pH 7.77         |
| Ordabasinsky district, Zhenis village, "Taza Su" | 230 | 6.58 | 10.2  | 1559 | 2.9 | 92.1 | 68.1 | <b>278</b> | <0.1        | <8 | 280.7 | 182.6 | <b>628.1</b> | 11.9 | <0.05 | 0.44 | M 1.6 $\frac{SO_4\ 57\ Cl\ 22\ HCO_3\ 20}{Na\ 54\ Mg\ 25\ Ca\ 21}$ pH 6.58  |
| Well No. 2, Zhetysu village "Taza Su"            | 200 | 7.07 | 11.1  | 1651 | 3   | 105  | 71.1 | <b>298</b> | <b>2.45</b> | <8 | 250.2 | 248.2 | <b>652.8</b> | 6.4  | <0.05 | 0.42 | M 1.65 $\frac{SO_4\ 55\ Cl\ 28\ HCO_3\ 17}{Na\ 53\ Mg\ 24\ Ca\ 22}$ pH 7.07 |
| Well No. 3, Temirlan, Kemer village              | 150 | 7.06 | 14.8  | 1763 | 2.1 | 131  | 100  | 231        | <0.1        | <8 | 390.5 | 97.5  | <b>753.2</b> | 39.5 | <0.05 | 0.65 | M 1.8 $\frac{SO_4\ 62\ HCO_3\ 25\ Cl\ 11}{Na\ 40\ Mg\ 33\ Ca\ 26}$ pH 7.06  |
| Akbakai-Karasu water intake                      | 100 | 7.01 | 3.35  | 310  | 0.4 | 47   | 12.2 | 9.5        | <0.1        | <8 | 183.1 | 10.6  | 29.6         | 11.6 | <0.05 | 0.26 | M 0.31 $\frac{HCO_3\ 73\ SO_4\ 15}{Ca\ 62\ Mg\ 27\ Na\ 11}$ pH 7.01         |
| Shymkent, well No. 10                            | 70  | 7.71 | 3.8   | 354  | 0.5 | 53.1 | 14   | 12.8       | <0.1        | <8 | 213.6 | 5.3   | 34.6         | 13.4 | <0.05 | 0.24 | M 0.35 $\frac{HCO_3\ 76\ SO_4\ 16}{Ca\ 61\ Mg\ 26\ Na\ 13}$ pH 7.71         |
| Shymkent, Badam-Sairam water intake              | 75  | 7.37 | 6.9   | 596  | 1.9 | 83.1 | 33.4 | 15.9       | <0.1        | <8 | 335.6 | 17.7  | 53.5         | 41.3 | <0.05 | 0.3  | M 0.6 $\frac{HCO_3\ 71\ SO_4\ 14}{Ca\ 54\ Mg\ 36}$ pH 7.37                  |
| Sholakkorgan main water intake                   | 120 | 7.63 | 7.7   | 689  | 1.2 | 108  | 28   | 33.6       | <0.1        | <8 | 164.8 | 8.9   | 316.1        | 17.1 | <0.05 | 0.65 | M 0.69 $\frac{SO_4\ 67\ HCO_3\ 27}{Ca\ 59\ Mg\ 25\ Na\ 16}$ pH 7.63         |
| Kentau, head water intake                        | 80  | 7.83 | 4.15  | 351  | 0.2 | 56.1 | 16.4 | 7.7        | <0.1        | <8 | 177   | 10.6  | 71.6         | 5.7  | <0.05 | 0.26 | M 0.35 $\frac{HCO_3\ 61\ SO_4\ 21}{Ca\ 62\ Mg\ 30}$ pH 7.83                 |
| Kentau city, central water intake                | 80  | 7.57 | 7.8   | 767  | 0.8 | 88.1 | 41.3 | 63.7       | <0.1        | <8 | 262.4 | 24.8  | 250.3        | 24.4 | <0.05 | 0.22 | M 0.77 $\frac{SO_4\ 49\ HCO_3\ 41}{Ca\ 42\ Mg\ 32\ Na\ 26}$ pH 7.57         |
| Turkestan city                                   | 80  | 7.28 | 8.9   | 1539 | 0.8 | 93.1 | 51.7 | <b>270</b> | <0.1        | <8 | 439.3 | 65.6  | <b>590.2</b> | 12.7 | 0.2   | 0.5  | M 1.5 $\frac{SO_4\ 57\ HCO_3\ 33}{Na\ 57\ Ca\ 23\ Mg\ 21}$ pH 7.28          |
| Karatau city, main water intake                  | 75  | 7.79 | 4.1   | 376  | 0.3 | 51.1 | 18.8 | 11.4       | <0.1        | <8 | 213.6 | 10.6  | 45.3         | 15.6 | <0.05 | 0.29 | M 0.38 $\frac{HCO_3\ 70\ SO_4\ 19}{Ca\ 55\ Mg\ 34\ Na\ 11}$ pH 7.79         |
| Zhanatas city, Berkut water intake               | 250 | 7.84 | 4.55  | 450  | 0.3 | 54.1 | 22.5 | 25         | <0.1        | <8 | 244.1 | 12.4  | 65.9         | 15.6 | <0.05 | 0.52 | M 0.45 $\frac{HCO_3\ 67\ SO_4\ 23}{Ca\ 48\ Mg\ 33\ Na\ 19}$ pH 7.84         |





\*Samples that exceed the MPC for this indicator are indicated in bold.


### S3. Definition of individual indicators






| No. | Observation point                              | Cu    | Zn    | Ni   | Cd            | Pb           | Co   | Mn    | Sr   | Hg      | Cr    | Se      | As     |
|-----|--|-------|-------|------|---------------|--------------|------|-------|------|---------|-------|---------|--------|
|     |  | mg/L  | mg/L  | mg/L | mg/L          | mg/L         | mg/L | mg/L  | mg/L | mg/L    | mg/L  | mg/L    | mg/L   |
| 1   | Taraz city, Kumshagal water intake             | <0.01 | <0.01 | 0.01 | 0.0013        | 0.009        | 0.01 | <0.01 | 0.5  | <0.0002 | 0.01  | 0.0006  | 0.01   |
| 2   | Taraz city, Kumshagal water intake, well No.1  | <0.01 | <0.01 | 0.01 | 0.0014        | 0.01         | 0.01 | <0.01 | 0.7  | <0.0002 | 0.01  | 0.0005  | <0.005 |
| 3   | Taraz, head water intake, Zhalpaktobe          | <0.01 | <0.01 | 0.01 | 0.0014        | 0.011        | 0.01 | <0.01 | 0.4  | <0.0002 | 0.01  | 0.0007  | <0.005 |
| 4   | Zhetisai city, head water intake               | <0.01 | <0.01 | 0.02 | <b>0.0025</b> | 0.015        | 0.01 | 0.03  | 0.8  | <0.0002 | 0.02  | <0.0001 | <0.005 |
| 5   | Myrzakent, Komkhoz water intake                | <0.01 | <0.01 | 0.01 | 0.0014        | 0.01         | 0.01 | 0.02  | 0.9  | <0.0002 | 0.02  | <0.0001 | <0.005 |
| 6   | Atakent, Komkhoz water intake                  | <0.01 | <0.01 | 0.01 | 0.0013        | 0.01         | 0.01 | 0.05  | 0.6  | <0.0002 | 0.02  | <0.0001 | 0.01   |
| 7   | Asykata kent, well No.1                        | <0.01 | <0.01 | 0.01 | 0.0014        | 0.011        | 0.01 | 0.02  | 0.9  | <0.0002 | 0.04  | 0.0006  | <0.005 |
| 8   | Shardara city, water source of the Syrdarya r. | <0.01 | <0.01 | 0.01 | <b>0.0024</b> | 0.016        | 0.01 | 0.01  | 2.2  | <0.0002 | 0.01  | 0.0012  | <0.005 |
| 9   | Arys city, Arys ground drainage system         | <0.01 | <0.01 | 0.01 | <b>0.0020</b> | 0.014        | 0.01 | 0.01  | 1    | <0.0002 | 0.01  | 0.0019  | <0.005 |
| 10  | Ordabasy district, Temirlan village            | <0.01 | <0.01 | 0.01 | 0.0016        | 0.013        | 0.01 | 0.02  | 0.7  | <0.0002 | 0.01  | 0.0006  | <0.005 |
| 11  | Akbakai-Karasu water intake                    | <0.01 | <0.01 | 0.01 | 0.0013        | 0.01         | 0.01 | 0.01  | 0.5  | <0.0002 | <0.01 | 0.0002  | <0.005 |
| 12  | Shymkent, Badam-Sairam water intake            | <0.01 | <0.01 | 0.01 | 0.0019        | 0.015        | 0.01 | 0.01  | 0.7  | <0.0002 | 0.01  | 0.0004  | <0.005 |
| 13  | Sholakkorgan village, main water intake        | <0.01 | <0.01 | 0.01 | 0.0019        | 0.016        | 0.01 | 0.02  | 2.9  | <0.0002 | 0.01  | 0.0012  | <0.005 |
| 14  | Kentau, head water intake                      | <0.01 | <0.01 | 0.01 | 0.0019        | 0.018        | 0.01 | <0.01 | 0.3  | <0.0002 | 0.01  | 0.0005  | <0.005 |
| 15  | Kentau city, central water intake              | <0.01 | <0.01 | 0.01 | <b>0.0021</b> | 0.016        | 0.01 | <0.01 | 0.6  | <0.0002 | 0.01  | 0.0012  | <0.005 |
| 16  | Turkestan, central water intake well No. 2     | <0.01 | <0.01 | 0.01 | <b>0.0022</b> | 0.012        | 0.01 | <0.01 | 0.6  | <0.0002 | 0.01  | 0.0011  | <0.005 |
| 17  | Turkestan city                                 | <0.01 | <0.01 | 0.01 | 0.0015        | 0.008        | 0.01 | <0.01 | 0.3  | <0.0002 | 0.01  | 0.0004  | <0.005 |
| 18  | Karatau city, main water intake                | <0.01 | <0.01 | 0.01 | 0.0013        | 0.008        | 0.01 | <0.01 | 0.4  | <0.0002 | <0.01 | 0.0006  | <0.005 |
| 19  | Zhanatas city, Berkut water intake             | <0.01 | <0.01 | 0.02 | 0.0017        | 0.009        | 0.01 | <0.01 | 0.4  | <0.0002 | <0.01 | 0.0006  | <0.005 |
| 20  | Ili district, Otegen Batyr village             | <0.01 | 0.02  | -    | 0.0013        | 0.005        | -    | <0.01 | -    | -       | -     | 0.0006  | -      |
| 21  | Kapchagay, Nikolaevsky water deposit           | <0.01 | <0.01 | -    | <b>0.0028</b> | 0.012        | -    | <0.01 | -    | -       | -     | 0.0014  | -      |
| 22  | Shengeldi (central water intake)               | 0.01  | 0.01  | -    | <b>0.0042</b> | <b>0.018</b> | -    | <0.01 | -    | -       | -     | 0.0024  | -      |
| 23  | Saryozek (central water intake)                | <0.01 | 0.02  | -    | <b>0.0032</b> | 0.013        | -    | <0.01 | -    | -       | -     | 0.002   | -      |
| 24  | Ucharal, head water intake                     | <0.01 | <0.01 | -    | 0.001         | 0.006        | -    | <0.01 | -    | -       | -     | 0.0002  | -      |
| 25  | Karatal district, Tastobe well No. 1           | <0.01 | 0.01  | -    | <b>0.0022</b> | 0.008        | -    | <0.01 | -    | -       | -     | 0.0002  | -      |
| 26  | Taldykorgan, well No. 5                        | <0.01 | <0.01 | -    | <b>0.0023</b> | 0.009        | -    | <0.01 | -    | -       | -     | 0.0002  | -      |
| 27  | Zharkent city, main water intake               | <0.01 | 0.01  | -    | 0.0018        | 0.006        | -    | <0.01 | -    | -       | -     | 0.0002  | -      |
| 28  | Chundzha                                       | <0.01 | 0.01  | -    | 0.0019        | 0.006        | -    | <0.01 | -    | -       | -     | 0.0003  | -      |
| 29  | Narynkol, Rayymbek district                    | <0.01 | <0.01 | -    | 0.0014        | 0.006        | -    | <0.01 | -    | -       | -     | 0.0002  | -      |
| 30  | Kegen district                                 | <0.01 | 0.01  | -    | 0.0016        | 0.008        | -    | <0.01 | -    | -       | -     | 0.0006  | -      |





\*Samples that exceed the MPC for this indicator are indicated in bold.

#### S4. Results of route studies of Southern Kazakhstan

| # | Description of observation points   | Coordinates  |              | Name of object                          | Pictures  |
|---|---|--------------|--------------|---|---|
|   |   | Latitude     | Longitude    |   |   |
| 1 | Head water intake Kumshagal, well No. 17. The depth of the well is 100 m. The electric submersible pump is installed at a depth of 30–35 m. Currently, 15 wells are in constant operation. In the southwestern water intake, all 12 wells are in operation. Absolute elevation 668 m.   | 42°50'23.43" | 71°19'46.98" | Taraz city. Head water intake Kumshagal |    |
| 2 | Well No. 1. The depth of the wells is 100m. the pump is installed at a depth of 30–35m. The well was drilled in the 1980s. Equipped with 3CO I belt. Fenced with a concrete slab 1.9 m high. The well is located in a well. Samples taken: 1.5 liters for PCA, for analysis without air, for organic matter, for metal. Absolute elevation 662 m. | 42°50'0.05"  | 71°20'58.79" | Taraz city. Head water intake Kumshagal |    |
| 3 | Water intake Zhalkpak Tobe, Taraz. There are 21 wells in the water intake. Drilled in 1964. The depth of the well is up to 100 m. The pump is installed at a depth of 30 m. Well No. 6 is located in the pavilion. Samples taken: 1.5 liters for PCA, for analysis without air, for organic matter, for metal. Absolute elevation 680 m.          | 42°49'49.69" | 71°27'3.01"  | Water intake Zhalkpak Tobe              |   |
| 4 | There are 4 production wells in the water intake. Well depth 270m. drilled in 1970. Water is supplied through 1000 m³ tanks. The water intake is fenced. There are no polluting sources nearby. Absolute elevation 270m. Samples taken: 1.5 liters for PCA, for analysis without air, for organic matter, for metal.                              | 40°46' 006"  | 68° 19' 480" | Zhetysai city                           |  |

|   |  |              |              |  |  |
|---|--|--------------|--------------|--|--|
| 5 | Head water intake. Operating well No. 3. Reserve (not active) 4, well depth from 150–250 m, drilled in the 1980s. Water is supplied through a tank. There are no polluting sources near the water intake. Samples taken: 1.5 liters for PCA, for analysis without air, for organic matter, for metal. Absolute elevation 262m.   | 40°39' 620"  | 68° 32' 619" | Myrzakent  |   |
| 6 | The well was drilled in the 1970s. Well depth 250m. Well No. 4. The well is located in the pavilion. There are no polluting sources nearby. The water is clean and transparent. Samples taken: 1.5 liters for PCA, for analysis without air, for organic matter, for metal. The absolute elevation is 252m.  | 40°51'20.84" | 68°29'40.30" | village Atakent, Maktaral district<br>Head water intake<br>Komkhoz |   |
| 7 | Well No. 1 is the main water intake. There are 3 wells, 1 of which is reserve. The well was drilled in 2012 to a depth of 250 m. Next to the wells there is a reservoir of 500x2=1000m3. The water is clean and transparent. No polluting sources were found. The well is located in the well between the pavilion and the clean water tank. Samples taken: 1.5 liters for PCA, for analysis without air, for organic matter, for metal. Absolute elevation 264 m. | 40° 53' 376" | 68° 22' 258" | village Atakent, Maktaral district<br>Head water intake<br>Komkhoz |   |
| 8 | The central pumping station is located at a distance of about 1.5 km from the shore of the reservoir in a northern direction in a hill with an absolute elevation of 310 m. The technical condition of the pumping station is satisfactory. Samples taken: 1.5 liters for PCA, for analysis without air, for organic matter, for metal.  | 41°15'29.39" | 67°58'48.73" | Shardara, Central pumping station                                  |  |
| 9 | There are 14 wells on the territory of Akdala village. Well depth is from 250–300m. The wells were drilled in 1970, some of the wells were drilled in 1990. The distance between wells is about 1 km. No polluting sources were found nearby. Samples taken: 1.5 liters for PCA, for analysis without air, for metal. The absolute elevation is 237 m.   | 42°27'13.73" | 68°54'28.49" | Arys group water supply system                                     |  |

|    |   |              |              |   |   |
|----|---|--------------|--------------|---|---|
|    |   |              |              |   |    |
| 10 | Well No. 1673. Drilled in 2010. Depth 150m. Group water supply. Kazhymukhan-Karaspan. branch. Ontustik auyz su. The water intake has 8 wells, up to 150m deep. All wells are production. No polluting sources were found nearby. The water intake has sanitary protection zone in the first zone. Samples taken: 1.5 liters for PCA, for analysis without air, for metal. Absolute elevation 305 m. | 42°36'31.68" | 69°16'47.04" | Ordabasinsky district, Temirlan village                           |    |
| 11 | Well depth 230m. Drilled in 1980 The well is located in a well, 1.5 m deep. Water is supplied to the water tower, from there, through a membrane installation, it is supplied to water consumers. Samples taken: 1.5 liters for PCA from 2 wells, for analysis without air. The absolute elevation is 238m.   | 42° 48' 825" | 68° 58' 315" | Ordabasinsky district, Zhenis village. State Enterprise "Taza Su" |    |
| 12 | Group of wells. The depth of the wells is about 100 meters. NS-1 well 5-6. Samples were taken from the pumping station. The wells were not allowed in. No polluting sources were found. Protected area. Samples taken: 1.5 liters for PCA, for analysis without air, for organic matter, for metal. Absolute elevation 665 m.   | 42° 23' 583" | 69°52'30"    | Akbay-Karasu water intake   |   |
| 13 | Well No. 10. The well is located in a well. Samples taken: 1. PCA. The distance from PS-1 is about 60 m and there are about 40 wells.   | 42° 23'578"  | 69° 52' 181" | Shymkent city   |  |

|    |  |               |               |   |   |
|----|--|---------------|---------------|---|---|
| 14 | There are 23 wells in the water intake; Currently, 19 wells are in operation. Well depth is from 68 to 78 m. Water level is 22–24m. The pump is installed at a depth of 35–40m. Well No. 12. Samples taken: 1.5 liters for PCA, for analysis without air, for organic matter, for metal. The absolute elevation is 538 m.  | 42°17' 196"   | 69°37' 632"   | Shymkent. Badam-Sairam water intake.                    |    |
| 15 | Head water intake. There are 5 water intake production wells. The water intake is fenced; there is a sanitary protection zone of the first zone. No polluting sources were found nearby. Currently there are 3 wells in operation. Well No. 5. The depth of the wells is 120m. The pump is installed at a depth of 60m. Water level at a depth of 20m from the surface of the earth. Drilled in 2012 Samples taken: 1.5 liters for PCA, for analysis without air, for metal. The absolute elevation is 497m.               | 43° 45' 111'' | 69° 09' 816'' | Turkestan region, Suzak district, village, Sholakkorgan |    |
| 16 | There are 6 pumping stations, about 40 wells. Well depth is up to 80m. Drilled in 1980. Fully supplies the city of Kentau with drinking water. Also, approximately 1200 m3/day is supplied to the city of Turkestan. The water intake is located on the territory of the Mirgalimsay mine. Samples taken: 1.5 liters for PCA, for analysis without air, for metal. The absolute elevation is 484m.   | 43° 32' 002"  | 68° 31' 328"  | Head water intake of the Mirgalimsay mine               |    |
| 17 | There are 6 production wells in the water intake. At the moment there are 2 wells in the area; the pump is installed at a depth of 40 meters. The water level is at a depth of 20 meters from the surface of the earth. Well No. 1. Drilled in 1980. The depth is supposedly 70–80m. The water intake is fenced; there is a sanitary protection zone of the first zone. Well in the pavilion. Samples taken: 1.5 liters for PCA, for analysis without air, for organic matter, for metal. The absolute elevation is 216 m. | 43°18' 569"   | 68° 13' 211"  | Turkestan, central water intake                         |  |

|    |  |              |              |   |   |
|----|--|--------------|--------------|---|---|
| 18 | Well No. 2 was also drilled in the 1980s. The well is located in the pavilion. The depth of the wells is 70–80m. The water is light and clean. Water is supplied to consumers through tanks located next to wells No. 1 and 2. Samples taken: 1.5 liters for PCA, for metal. The absolute elevation is 222 m.  | 43° 18' 563" | 68° 13' 221" | Turkestan. Central water intake. Well No. 2         |    |
| 19 | Well without name, depth about 30m. A 1.5 liter water sample was taken for PCA.  | 43° 18' 563" | 68° 13' 221" | Turkestan. Near the central water intake            |    |
| 20 | Head water intake "25 spring". There are 7 wells, 5 of which were drilled in 2014. The depth of the wells is 75m. the pump is installed at a depth of about 25m. There are no polluting sources near the water intake. The water intake is fenced. Samples taken: 1.5 liters for PCA, for analysis without air, for metal. The absolute elevation is 604m. | 43° 09' 630" | 70° 22' 695" | Talas district, Karatau city                        |    |
| 21 | The depth of the well is about 250m. There are 4 wells in the water intake. Well No. 6 was drilled in 2016. Well No. 6 is located in the pavilion. The water intake is fenced. There is a sanitary protection zone in the first zone. Guarded by security service. Samples taken: 1.5 liters for PCA, for metal. Absolute elevation 654 m.                 | 43° 28' 477" | 69° 45' 474" | Zhanatas, Sarysu district, Berkutinsky water intake |   |
| 22 | The well was drilled in 1980. Depth 250 m. Located in the pavilion. Samples taken: 1.5 liters for PCA, for metal. Absolute elevation 622 m.  | 43°28' 575"  | 69° 45' 545" | Zhanatas, Berkutinsky head water intake. Well No. 2 |  |

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