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Groundwater as a source of water supply for the Krutinsky **District of the Omsk Region**

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Abstract. The paper presents the results of the analysis of geological and hydro-geological situation in the Krutinsky district of the Omsk region, as well as the assessment of the quality of groundwater in terms of environmental friendliness of their use for potable water supply. In hydro-geological terms, the research area is located within the Irtysh artesian basin, covering a vast territory in the south of the West Siberian lowland. The Cenozoic sediments that compose the described territory contain a number of underground reservoirs, horizons and waterresistant strata separating them. The waters of Quaternary, Neogene and Oligocene sediments are of practical importance as a source of water supply. Groundwater is exploited by wells and shallow waters (in Neogene and Quaternary sediments) are exposed and exploited by many shaft wells. The article provides a generalized characteristic of the quality of underground waters of Quaternary, Neogene and Paleogene deposits, as well as production wells drilled in the Krutinsky district of the Omsk region. As a result of research, it was found that groundwater does not meet the requirements of SanPiN 2.1.4.1074-01. The use of these waters for household and drinking purposes will be environmentally safe for the population only if such indicators as turbidity, color, chlorine, iron, dry residue and microbiological indicators are adjusted.

1. Introduction

The problem of water supply is urgent for the rural population of the Omsk region. Such problems as worn out equipment, lack of water purification facilities, expiration of the service life of existing water supply systems and facilities affect the level of improvement of the populated area. Moreover, providing the population with clean, good-quality water is of great ecological and hygienic importance, since it helps to protect people from various epidemic diseases transmitted through water [1, 2]. The water quality must comply with the requirements of SanPiN 2.1.4.1074-01 [3].

The territory of the Krutinsky region is located in the southwestern part of the West Siberian lowland and is included in the Ishim plain of the Ishim-Irtysh interstream area.

The northern part of the region has many swamps and swampy areas. The distinctive features of the regional territory are such large lakes as Ik and Saltaim. They are located in the southeastern part of the district.

Apart from these lakes, there are smaller lakes ranging from several hundred square meters to 9-16 km². They are located among the swamps or occupied by inter-ridge depressions - Achikul, Sinkul, Kalachiki, Gorkoe. Most of the lakes are characterized by a rounded shape, slightly extended to the

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northeast. The shores of the lakes are flat, overgrown with reeds, often swampy. The lakes are usually closed. Running-water lakes are Zhiloye, Kalykul, Sazykul, connected by the Karasuk River, which springs from the outside of the region and flows into Lake Tenis [4].

Apart from Karasuk River, there are Gorkaya and Solonovka Rivers, which connect with larger Cheldak River. Such streams as Kama, Krutikha, Pochtovy, Stepanikha are the feeders of Ir River.

Most of the lakes are shallow (2-3 m); their shallow depth contributes to intensive heating and flowering of water in the summer. The water in such lakes becomes musty and unsuitable for drinking.

It is necessary to note that the water of lakes Ik and Saltaim constantly contains ammonia nitrogen, nitrite nitrogen and other pollution. In winter, the mineralization of lake water increases as a result of ice formation and feeding of many lakes due to mineralized groundwater and artesian waters. It is not possible to use these waters for potable water supply without expensive purification.

2. Problem statement

The need to solve water supply problems is also typical for the Krutinsky District of the Omsk Region. In this regard, careful choice of a natural source for potable water supply purposes is required. It is necessary to assess the ecological state of surface and underground sources and the possibility of their use for potable water supply providing high sanitary quality of drinking water.

The research object of the work is groundwater as a source of water supply to the Krutinsky district of the Omsk region The main research method is the analytical method based on the generalization and comprehensive assessment of the regional underground water resources, the analysis of geological-hydrogeological, environmental, operational information, research of the water quality of underground sources, obtained according to the ecological passport of the Omsk region territory (the data is available on "Omsk Gubernia" official site).

3. Materials and methods

The certain aspects concerning the assessment of the hydrological and hydro-geological state of water resources, as well as engineering issues of the design of underground water supplies are reflected in the works of I.M. Zemskova, D.N. Volovik, G.L. Samsonova, N.I. Plotnikov and S. Kraevsky, as well as in the following works [5, 6].

In hydro-geological terms, the territory of the Krutinsky district is located within the Irtysh artesian basin, which covers a vast territory in the south of the West Siberian lowland.

The geological section of the Cenozoic group is represented by the following sediments (to the depths by production wells):

• *Paleogene system* (Tavdinskaya rock formation - P_{2-3} td, Chertalinskaya rock formation - P_3 črt, Zhuravskaya rock formation - P_3 gr);

 Neogene system (Abrosimovskaya rock formation - N₁ab, Beshcheulskaya rock formation - N₁bš, Tavolzhanskaya rock formation - N₁tv, Pavlodar rock formation - N₂pv, Kochkovskaya rock formation - N₂kč, Smirnovskaya rock formation - N₂-Q₁smr);

• *Quaternary period* (Karasukskaya rock formation - $Q_{n-m}krs$, Deposits of the Quaternary terrace above the flood-plain of the Irtysh river - $4Q_n$, Covering sediments - Q_m , Modern period - $Q_{1\nu}$).

The Cenozoic sediments composing the described territory contain a number of underground reservoirs and horizons and water-resistant strata separating them.

The waters of Quaternary, Neogene and Oligocene sediments are of practical importance as a source of water supply. Groundwater is exploited by wells, and shallow waters (in Neogene and Quaternary sediments) are exposed and exploited by many shaft wells.

Quaternary deposits are wide spread (Table 1). The Upper Quaternary cover sediments throughout the entire territory are permeable, but practically waterless. Therefore, they were removed from schematic hydro-geological maps and reserves.

Modern lacustrine-boggy sediments (lbQ_{IV}) are widespread in the northern part of the region. They compose numerous lacustrine-boggy depressions, potholes and basins of many lakes.

Underground reservoir	Mineralization,	Total hardne	ess, mg • eq / l		
name	g/l -	fresh	saltish	- Composition of salt	
Modern lacustrine- boggy sediments (lbQ _{IV})	0.40.8	5.8-10.2		bicarbonate sodium- calcium	
Deposition of low and high formations (lQ _{IV} , lQ _{III})	0.4-0.9	6.4-21.2		bicarbonate and bicarbonate-sulfate magnesium-calcium, less often chloride- bicarbonate calcium-	
Underground reservoir of Middle-Upper Quaternary alluvial and lacustrine deposits of the Karasuk Formation (a,lQ _{II-III} κRkrs)	0.4-10.0		8.0-47.7	magnesium	

Table 1. Groundwater quality characteristics (Quaternary sediments)

The underground reservoir is supplied as a result of the infiltration of atmospheric precipitation and partly due to the inflow of groundwater from the underlying sediments. The underground reservoir is discharged into lakes, valleys of small rivers and their ravines (Ir, Gorkaya, Cheldak Rivers).

Deposition of low and high formations (lQ_{IV} , lQ_{III}), marked out by a narrow strip along the shores of large lakes Ik and Saltaim, contains groundwater everywhere. The thickness of the water-bearing rocks is 1.4-4.8 m. The waters are non-artesian, the depth of the static level is 0-4 m; there is a regular decrease in the absolute marks of the level to the water edge in the lakes.

The underground reservoir of the *Middle-Upper Quaternary alluvial and lacustrine deposits of the Karasuk Formation* (a,lQ_{II-III}KRKrs) is underlain by sandy-silty and silty-clayey sediments, which are loamy, in places with sand interlayers.

The depth of the bed of the water-bearing layers is 0.9-3.5 m. The total thickness of the waterbearing rocks is 1.0-4.7 m. The water is non-artesian, occurs at depths of 0.7-5.4 m. The absolute marks of the groundwater levels are 96.4 -108.6 m. A decrease in levels is noted towards lakes Ik, Saltaim and to Ir river, which are areas of groundwater discharge.

The *Neogene system* includes deposits of the Smirnovskaya, Kochkovskaya, Pavlodar, Tavolzhanskaya, Beshcheulskaya and Abrosimovskaya formations (Table 2).

Underground reservoir sediments of the Upper Pliocene-Lower Quaternary lacustrine sediments of the Smirnov Formation (N₂-Q₁smr) are widespread, occupying the entire northern half of the region. The thickness of underground reservoirs and lenses is 0.5-9.0 m, but more often does not exceed 3 m. They are exposed at depths of 2-23 m. In some areas, the entire formation is composed of clays and is practically waterless. The waters are artesian, leaky artesian and non-artesian, the pressure is 0-22 m. Non-artesian and leaky artesian waters are opened in the upper part of the section, in the lower part of the water is artesian. The groundwater level is established below the daily surface at a depth of 1-6.2 m (absolute level marks are 100-120 m). A decrease in levels is noted in the western (towards the Ir river valley) and southeastern directions (towards Ik and Saltaim large lake basins).

The water content of the sediments is low, the flow rates of wells are 0.04-0.091/s with a decrease in the level of 1.3-1 m, specific flow rates are $0.03-0.091/s \cdot m$. The low water content is explained by the small thickness of the water-bearing layers and lenses, the fine granulometric composition of the rocks and their low water loss. The main sources of groundwater supply are precipitation and melt water. Water discharge is carried out in the valley of Ir River and in the region of the depressions of lakes Ik and Saltaim and partly by smaller lakes (Zhiloe, Shipunovo).

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Underground reservoir	Mineralization,	Total hardn	ess, mg • eq $/1$	- Composition of salt	
name	g/1 -	fresh	saltish		
Upper Pliocene-Lower Quaternary lacustrine sediments of the Smirnov Formation (N ₂ -O ₁ smr)	0.3-3.3	5.4-14.1	8.2-40	bicarbonate-chloride magnesium-calcium waters	
Upper Pliocese lacustrine deposits of the Kochkovskaya formation (N ₂ ĸč)	0.4-11.1	4.1-9.6	15.7-44.8	fresh water - bicarbonate magnesium-sodium, magnesium, sodium, sodium-magnesium;	
Lower-middle Pliocene lacustrine- bog sediments Pavlodar formation (N ₂ pv) Middle Miocene	0.4-9.6	2.4-27.6	29.5-49.4	brackish - bicarbonate- chloride and chloride- bicarbonate sodium- magnesium, magnesium. chloride-bicarbonate-	
sediments of the Tavolzhanskaya Formation (N ₁ tv)	0.3-9.2	3.8-38.6		magnesium-sodium and bicarbonate-chloride- magnesium-calcium waters	
Lower-Middle Miocene deposits of the Beshcheulskaya formation (N ₁ bš)	0.3-1.9	5.6-17.6		bicarbonate sodium- magnesium and bicarbonate-chloride sodium-magnesium waters.	
Lower Miocene deposits of the Abrosimov formation (N_1ab)	0.3-10.4 prevail (0.3-0.9 g/l) and (1.0-2.9 g/l)	5.2-13.4	21.8-61.8		

Table 2. Characteristics of groundwater quality (Neogene sediments)

The waters of the sporadic distribution of the Upper Pliocese lacustrine deposits of the Kochkovskaya Formation ($N_2\kappa\check{c}$) are distributed in the form of isolated areas. Groundwater is connected to interlayers of loams, silts, sands and calcareous-marly nodules in clays. They are exposed at depths of 1.5-15.7 m. The thickness of the water-flooded layers is 0.7-12 m. They are underlain by deposits of the Tavolzhanskaya, Beshcheulskaya and Abrosinovskaya formations.

The waters are mainly non-artesian and less often they are with low pressure (up to 4.5 m), their level is established at depths of 0.8-10.5 m. The flow rates of wells are 0.01-0.4 1/s, wells 0.2-0, 3 1/s with a decrease in levels, respectively 2.6-10.2 m and 1.1-1.2 m. Filtration coefficients of flooded rocks is 0.3-1.8 m/day, water permeability is $1-4 \text{ m}^2/\text{day}$.

The water supply is carried out due to the infiltration of precipitation and lake waters.

The waters of the sporadic distribution of the *Lower-Middle Pliocene lacustrine-boggy deposits of the Pavlodar Formation* (N₂pv) occupy small areas in the south of the region and are represented by variegated, mainly fatty clays. Groundwater is connected to sandy interlayers and accumulations of calcareous-marly nodules. The waters are leaky.

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The thickness of water-containing layers and lenses ranges from several tens of centimeters to 2-3 m. They are exposed at depths of 2-10.1 m. According to the sections of many wells, the entire stratum of the Pavlodar formation is composed of clays and is practically waterless.

The water content of the sediments is low. The flow rates of the wells do not exceed 0.221 / s with a decrease in the level of 1m. Specific flow rates are 0.006-0.221 / s • m.

The only sources of water supply for the Pavlodar formation is precipitation and melt water. Water discharge occurs in the area of the basins of Ik, Tenis and Saltaim lakes.

The waters of sporadic distribution of Middle Miocene sediments of the Tavolzhanskaya Formation (N₁tv). The thickness of the underground reservoir is 0.5-5.8 m, more often it does not exceed 3 m. The underground waters are leaky and non-artesian. Groundwater levels are established at a depth of 0.6-5.9 m below the daily surface. The water inflow of the deposits of the Tavolzhanskaya formation is low: the flow rates of wells do not exceed 0.061 1 / s with a decrease in the level of 1 m. Specific flow rates are 0.02-0.061 / s • m.

Groundwater supplies occur mainly due to the infiltration of atmospheric precipitation and melt water. Confined waters are less involved below the underlying Oligocene sediments. Water discharge is carried out in the basins of lakes Ik and Saltaim.

The underground waters of the underground reservoir of *the Lower-Middle Miocene sediments of the Beshcheulskaya formation* (N₁bš) are connnected to interlayers and lenses of fine-grained sands and sandy silts [7]. The depth of the underground reservoirs is 1-8.2 m; the thickness is 0.7-8.3 m. The waters are leaky; their piezometric levels are established at a depth of 1.2-8.2 m. The deepest position of the levels is noted in the north-western part of the area where there is draining influence of the Ir River.

Specific flow rates are 0.02-1 1 / s, m. Filtration coefficients calculated from the results of pumping from wells and wells range from 0.8 to 5.9 m / day, water permeability of rocks is from 4 to 35 m² / day.

The sources of groundwater supply are precipitation and melt water. In addition, the underground reservoir of the Beshcheulskaya formation supplies the confined waters of the underlying Oligocene sediments with close hydrodynamic connection. Water discharge is carried out in Ir River valley and in the area of Ik and Saltaim lakes basins [8].

The groundwater of the underground reservoir of the Lower Miocene sediments of the Abrosimov Formation (N_1ab) is connected to the interlayers and lenses of fine-grained sands and sandy silts and to the lines of thin interbedding. The depth of the individual underground reservoirs is 7.9-47.3 m, the thickness is from 0.8-19 m, but more often it does not exceed 5 m.

The waters are artesian; piezometric levels are located at depths of 0.5-10.8 m. The water content of the rocks is low. Well flow rates is 0.12-1.4 l/s with a decrease in the level, respectively, 16.7 and 19.0 m. Specific flow rates are $0.006-0.1 \text{ l/s} \cdot \text{m}$. Significant fluctuations in flow rates are associated with sharp changes in the mechanical composition of water-bearing rocks, thickness and inconsistency of underground reservoirs along strike. The filtration coefficient of rocks, calculated according to the results of pumping from wells, is 0.23-3.65 m/day, water permeability is $1-10 \text{ m}^2/\text{day}$; less often it is $30 \text{ m}^2/\text{day}$.

Paleogene sediments are wide spread on the territory of the region. According to their lithological composition, they are divided into two strata: the lower (Tavdinskaya formation) and upper (Zhuravskaya, Chertalinskaya formation).

The underground waters of the reservoir of the *Upper Oligocene sediments of the Zhuravskaya formation* (P₃gr) are widespread and confined to interlayers and lenses of fine-grained sands and sandy silts.

The Zhuravskaya formation at the top is overlain by the Abrosimovskaya formation and is underlain by the Chertalinskaya formation, having a close hydraulic connection with the waters contained in these deposits.

The depth of the individual underground reservoirs ranges from 42.7 to 97.0 m, the thickness is 1.3-17 m and more often it does not exceed 9 m.

Water is artesian, the levels are established at a depth of 0.5-1.2 m below the daily surface The minimum marks are noted in the valley of Ir River and in the area of the Ik-Tenisskaya depression, the maximum marks are in watersheds (in the north and southwest).

Well flow rates are 0.1-1.3 l / s with a decrease in levels, respectively, 17.1-49.0 m. Filtration coefficients of rocks are 0.23-3.65 m / day. The water conductivity of sediments is 1-26 m² / day and most often it does not exceed 10 m² / day.

Underground reservoir	Mineralization, g/l	$\frac{1}{1}$ Total hardness, mg • eq / 1			
name	-	fresh saltish		 Composition of salt 	
Upper Oligocene				chloride-	
sediments of the	0.4-4.6	4.1-10.5	14.2-40.3	hydrocarbonate	
Zhuravskaya formation					
(P_3gr)					
Lower-middle				chloride-bicarbonate	
Oligocene deposits of				sodium-magnesium	
Chertalinskaya 0.7-11.7		8.9-59.8		-	
formation					
(P ₃ črt)					

Table 3. Characteristics of groundwater quality (Paleogene sediments)

The underground waters of the underground reservoir of the *Lower-Middle Oligocene deposits of the Chertalinskaya Formation* (P₃črt) are connected to lenses of fine-grained sands and sandy silts and to members of their frequent intercalation. They occur at depths of 79-213 m. The prevailing thickness of water-bearing rocks is 7-14 m.

Groundwater is artesian. Piezometric levels are established at a depth of 0.9-16 m. The decrease in absolute levels is observed in Ir River valley and in the region of the Ik-Tenisskaya depression. Specific flow rates are $0.001-1.1151/s \cdot m$.

The filtration coefficient, calculated from the results of pumping from wells, is 0.1-3.2 m / day. The water permeability of sediments is $1-27 \text{ m}^2 / \text{day}$ and the prevailing values do not exceed $10 \text{ m}^2 / \text{day}$.

4. Results and discussion

According to the results of the inspection of production wells, it was found that there are no zones of strict sanitary regime on the wells. The existing wells with sanitary regimes are half destroyed. The territory of the zones is in an unsatisfactory condition: it is littered with garbage, logs, waterlogged due to the disordered spill of water. The access roads are not organized.

Many supply units do not have technical documentation for drilled wells. The wells which are out of service are not pulled on time. In Shipunovo, the abandoned, inactive wells are covered with soil. Some wells are being drilled without permission. The noncompliance with the required distance between the wells, excluding their influence on each other, leads to a decrease in the flow rate of both the newly drilled and the existing well.

The recommendations on the conditions for the use of groundwater, given to supply units when issuing a water use permit, are not being fulfilled.

The groundwater of the territory of the Krutinsky district does not meet the requirements of SanPiN 2.1.4.1074-01 in terms of quality, especially in its southern part, where there are large blocks of saline soils, the formation of which is provided by groundwater of increased mineralization due to the accumulation of salts from underground reservoirs and the gradual salt enrichment of soils.

Despite the variety of chemical composition and mineralization, groundwater is intensively used for household and drinking purposes. Water supply of large farms in the Krutinsky District of the Omsk Region is based entirely on groundwater obtained from wells. In many villages, the local population uses underground reservoir captured by shallow shaft wells (Kiterma village, Zimino

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village, Oglukhino village, Ryzhkovo village) for individual household drinking water supply. For watering livestock on farms and pastures of these farms they drill wells providing groundwater with increased mineralization.

According to the Federal Agency for Subsoil Use of the Omsk branch of the Federal State Budgetary Institution "Territorial found of geological information of the Siberian federal district", 294 production wells were drilled in different underground reservoirs (Table 4) in the households and farms of the region. The total groundwater withdrawal in the area from 99 operating production wells amounted to 3.9 thousand m^3 / day .

The table shows that in 46 settlements it is possible to obtain groundwater from fresh (mineralization up to 1 g / l) to highly saline (mineralization 9.4 g / l). In most settlements, the water is suitable for livestock watering (mineralization up to 2.4 g / l), only in some villages all reservoirs provide groundwater with a mineralization exceeding 2.4 g / l (Olgino, Kiterma, Zaozernaya, Cheldak).

The hydro-geological conditions of the region are difficult. The *northern part* of the territory is characterized by the predominance of fresh water in lacustrine-boggy sediments and slightly saline water in the sediments of the *Smirnovskaya formation*.

Groundwater in lacustrine-boggy sediments occurs near the surface, the flow rates of capturing wells with a decrease in the level of 1 m are 0.001-0.05 1/s with a water salinity of 0.4-0.8 g/l. The waters of lacustrine-boggy sediments can be widely used for water supply in field facilities and for watering cattle in pastures.

The small demand for water for household needs and individualpotable water supply in the northern part of the region can be satisfied by weakly saline and fresh waters in the sediments of the Smirnovskaya formation.

These waters are not suitable for centralized water supply due to the low water content of waterbearing rocks. The flow rates of wells do not exceed $0.09 \ 1/s$ with a decrease in the level of 1.1 m. The depth of formation of water-bearing layers is 2-23 m. 3-0.8 g / l). Large potabke water supply within this part of the region can be provided by fresh and slightly saline waters of the Miocene-Oligocene sediments.

The underground waters of the Abrosimovskaya formation occur in the northern part of the region at a depth of 13-33 m. The waters are predominantly fresh with a salinity of 0.4-0.8 g / l. Well flow rates are 0.28-0.97 l / s with a decrease in levels of 11-17 m, and they can be increased by using filters of a longer length (8-10 m), larger diameter (146-168 mm), always with gravel sprinkling [9, 10].

For watering cattle, household and technical needs, it is possible to recommend the lower-lying underground slightly saline waters in the rocks of the Zhuravskaya and Chertalinskaya formations.

The underground waters of the Zhuravskaya formation occur at a depth of 42.7-80 m, the waters of Chertalinskaya formation occur at a depth of 79-209 m. Well flow rates are 0.1-2.0 l / s with a decrease in the level of 17-39 m. Mineralization of underground waters is 1.1-2, 7 g / l.

The central, western and southern parts of the district are characterized by the development of slightly saline, less often fresh groundwater. In the central part, there are reservoirs of the Karasukskaya and less often the Beshcheulskaya formation, in the southwestern part there are the sporadic waters of the Tavolzhanskaya formation.

The water content of the deposits of the Karasukskaya Formation is low. Well flow rates usually do not exceed $0.055 \, 1/s$. The waters are slightly saline with a mineralization of $1.3-2.5 \, g/l$, they are less often fresh with a dense residue of up to $1 \, g/l$. Due to low water content of the water-bearing rocks, the waters of the Karasukskaya formation can be recommended only for individual potable water supply and for the economic needs of industries with a low water demand.

The largest areas of groundwater in the reservoir of the Beshcheulskaya formation can be recommended for individual potable water supply. Flow rates are up to $0.099 \ 1/s$ with a decrease in the level of 1.2 m. The waters are mostly fresh with mineralization up to $1 \ g/l$.

Out of them								
Settlement	Amount of	operating	In need of		abandonned	well depth. m	Mineralization. g/l	
	wells		repair	abandonment	- -	(from-to)	(from-to)	
1	2	3	4	5	6	7	8	
Zimino	17	4	3	1	9	34-231	0.4-0.7	
Gulyay Pole	7	2	-	2	3	48-230	0.8-1.8	
Olgino	6	-	-	6	-	40-124	3.4-7.8	
Stakhanovka	5	1	1	3	-	61-162	1.3-2.0	
Ulyanovka	1	-	-	-	1	157	-	
Shiryaevo	2	-	-	2	-	68-72	1.8	
Krutinka	49	15	3	6	25	76-205	0.8-4.2	
Kalachiki	2	2	-	-	-	76-85	1.5-2.1	
Samarovka	15	5	2	-	8	34-81	1.2-9.4	
Kaban'ye	5	1	-	1	3	26-61	-	
Kulgino	4	1	-	1	2	83	0.9	
Kytherma	5	1	1	-	3	120	2.9-3.9	
Saltaim	5	2	1	-	2	47-60	0.4-0.6	
Ust-Kiterma	3	2	-	-	1	175	1.3	
Zaozernaya	2	-	-	2	-	112	4.6	
Kolomenka	2	-	-	2	-	82	2.2	
Mysy	2	-	-	2	-	66-200	-	
Novokarasuk	5	-	-	5	-	120	-	
Starich'ye	1	-	-	-	1	76	1.2	
Ust-Logatka	7	-	-	3	4	82-111	1.0-4.0	
Chagino	5	1	-	1	3	60-129	1.1-2.6	
Oglukhino	21	8	4	6	3	49-140	1.2-2.7	
Pushkino	5	3	-	1	1	57-150	1.5-3.8	
Chikishevo	5	1	2	1	1	52-70	1.5-4.5	
Chumanovka	10	2	3	-	5	40-126	0.8-3.0	
Panovo	18	4	3	-	11	92-152	0.7-5.1	
Kamchatka	7	4	-	-	3	35-157	1.2-2.8	
Kazulino	5	4	1	-	-	83-182	1.8-3.3	
Krasny Yar	5	4	1	-	-	31-81	0.2-0.9	
Kolodtsy	9	3	-	-	6	70-205	0.8-3.2	
Ryzhkovo	20	7	-	-	13	69-169	0.7-4.2	
Orlovo	5	2	-	-	3	72-156	0.8-1.6	
Verhny Yaman	6	2	-	-	4	120-150	2.1-2.4	
Tolokontsevo	3	-	-	-	3	60-234	0.4-1.3	
Troitsk	1	-	-	-	1	88	-	
Shipunovo	14	-	5	-	9	32-230	0.6—2.8	
Gorkove	3	1	1	-	1	150	2.4	
Mikhailovka	4	-	-	-	4	76-166	2.4-3.3	
Singul	3	2	1	-	_	18-212	-	
Sladkove	3	-	_	-	3	215	1.8	
Cheldak	2	1	-	-	1	88	4.7	
Yaman	18	7	-	-	11	54-167	1.0-7.1	
Novopokrovka	7	2	1	-	4	100-156	0.9-3.3	
Ik	7	-2	-	-	5	61-210	0.9-2.0	
Krasnyy	,	-				02 166	1.6.2.1	
Pakhar'	7	3	-	-	4	83-166	1.6-3.1	
Sibirka	5	-	2	-	3	90-120	-	
Total	294	99	35	45	164	-	-	

Table 4.	Characteristics	of production	wells dril	led in the	Krutinsky	district of t	he Omsk	region

The flow rates of wells exploiting groundwater of sporadic distribution in the rocks of the Tavolzhanskaya formation do not exceed 0.061 l/s with a decrease in the level of 1 m. Fresh waters with a mineralization of 0.3-0.9 g/l prevail, less often they are slightly saline (1.1 - 2, 9 g/l).

Due to the low water content of the water-bearing rocks, their low thickness, the underground waters of the Tavolzhanskaya formation can be recommended only for small-scale household and potable water supply.

Fresh and slightly saline waters of the underlying sediments of the Abrosimovskaya and Zhuravskaya formations are recommended for large potable and utility water supply.

The underground waters of the Abrosimovskaya formation occur at a depth of 12-47.3 m. The waters are mostly slightly saline (1.2-2.2 g/1) in the western and southern parts they are fresh (0.3-0.9 g/1). Well flow rates are up to 11/5 with a decrease in the level of 19.0 m.

In the sediments of the Zhuravskaya formation, groundwater is found at a depth of 62-97 m. In a larger area, the waters are slightly saline with a dense residue of 1.4-2.3 g / l, in the southeastern part the waters are fresh with a mineralization of up to 0.9 g / l. Well flow rates are 0.08-1.3 l / s with a decrease in the level of 9.5-17.1 m. In most of the territory water salinity does not exceed 1.2-1.4 g / l. After the agreement with Russian Agency for Health and Consumer Rights, these waters can be recommended for potable water supply to settlements. Almost everywhere, the underground waters of the Zhuravskaya formation can be used for watering livestock on farms and distant pastures.

The reservoirs of high and low formations, which surround the shores of lakes Ik, Saltaim and Tenis contain fresh groundwater. The water content of the lake formation deposits is insignificant - 0.013-0.028 I/s with a decrease in the level of 1 m. The waters are predominantly fresh with a dense residue of 0.4-0.9 g/l. Due to the low water abundance of rocks and the small area of their distribution, these waters are recommended only for individual potable water supply of individual farms.

5. Conclusion

In this part of the district, groundwater of the Abrosimovskaya and Zhuravskaya formations are recommended for potable and household water supply. Groundwater in the sediments of the Abrosimovskaya formation occurs at a depth of 16-35 m. Well flow rates are 0.07-0.5 l / s with a decrease in the level of 4.8-7.6 m. Fresh water has a salinity of 0.4-0.7 g / l. In the rocks of the Zhuravskaya formation, groundwater is found at a depth of 47-53 m. The waters are mainly slightly saline with a mineralization of 1.5-1.8 g / l, chloride-hydrocarbonate magnesium-sodium composition. Well flow rates are 0.08-1.5 l / s with a decrease in the level of 9.5-49 m.

The hydro-geological conditions of the territory of the district, as well as of the entire Omsk region, are unfavorable for artificial groundwater recharge: there are no natural reservoirs to create additional reserves, since artesian reservoirs, although they lie at the optimal depth, do not correspond to the conditions of recharge in terms of filtration properties - the water permeability of rocks is on average 80 m^2 / day (for rational recharge of groundwater reserves, the lower limit of water permeability should be 100-150 m² / day).

Artificial recharge of groundwater reserves does not correspond to the depth of the bottom of impermeable and poorly permeable rocks from the earth surface. The value of the filtration coefficient of rocks in the saturation zone (0.7-4.4 m / day) is insufficient for the effective operation of infiltration basins (it should be more than 10 m / day).

For potable water supply we recommend underground waters of the Karasukskaya, Beshcheulskaya and Tavolzhanskaya formations (interval is 2-23 m, mineralization is up to 1 g / l), for watering livestock and household needs we recommend the waters of Abrosimovskaya formation (depth is 12-47 m, mineralization is 1.2-2, 2 g / l) and Zhuravskaya formation (depth is 62-97 m, mineralization is 1.4-2.3 g / l).

Further, during the design of specific groundwater supply facilities in the studied area, it is planned to carry out the analysis of water from the projected reservoir using the equipment of the collective use center of Omsk State Agrarian University "Agricultural and technological research".

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