«KAZTECO» LLP

«KAZAKHTELECOM» JSC

REPORT ON MONITORING AND ASSESSMENT OF THE IMPACT OF KAZAKHTELECOM JSC 'S ACTIVITIES ON BIODIVERSITY, PHYSICAL IMPACT

Director of «KAZTEK» LLP

Казтэко

* БСН/БИН * 151240023058 *

A.B Balturin

Shymkent, 2024 y.

Report Guide		Environmental engineer - Mukhamatov M.A.
Collection of climate data and analysis of atmospheric air monitoring		Environmental engineer – Aldangarov A.A.
Noise level analysis		Environmental engineer - Aldangarov A.A.
Electromagnetic field analysis		Environmental engineer - Aldangarov A.A.
Collection and analysis of geobotanical information and analysis of floristic studies		Environmental engineer - Ermekbai A.A.
Collection of zoological information and analysis of the results of entomological studies and ichthyofauna		Environmental engineer - Ermekbai A.A.
Laboratory chemist		Tuyakov A. A.

Table of contents

ANNOTATION

The research was conducted as part of the implementation of the Roadmap for the development of ESG practices of Kazakhtelecom JSC (Minutes of the in-person meeting of the Board of Directors of Kazakhtelecom JSC No. 2 dated 01/14/2023).

In order to implement paragraph 17 of Section E of the above-mentioned roadmap, Kazakhtelecom JSC (hereinafter referred to as the Company) entered into a Service Purchase Agreement No. 972983/2024/1 dated April 11, 2024 (Appendix 3) with KAZTEKO LLP (license for environmental design in Appendix 2).

June 20 to July 30, 2024, studies were conducted in the city of Shymkent. During the studies, measurements of atmospheric air, noise levels, electromagnetic field strength were taken, and the types of fauna and vegetation and their condition in places where telecommunications equipment is present were determined.

The company is the national communications operator of Kazakhstan, providing a range of infocommunication services: telephony, data networks, broadband Internet access, IPTV, hosting, SIP telephony, video conferencing. Today the Company covers all the main target markets of infocommunication services consumers. It is engaged in the implementation of a number of large infrastructure projects, modernization and digitalization of telecommunication networks, introduction of new technologies and telephone installation in villages, as well as the development of broadband Internet access. The company also implements key programs for the development of existing fixed-line communications services, primarily based on fiber-optic technologies, including the provision of high-speed fixed-line Internet access, channel leasing and reservation, provision of private virtual networks (IP VPN) and packaging of services based on fixed access.

The Company's facilities are located throughout the Republic of Kazakhstan: the company's regional and city telecommunications networks are located in 237 settlements, of which:

17 cities of republican significance

24 small towns

159 district centers

54 settlements with a dedicated zone code (former district centers).

In 2024, monitoring and assessment of the impact of telecommunications equipment on the environment in the city of Shymkent was carried out. The objects of influence were automatic telephone exchanges, auxiliary equipment, wireless network antennas, and additional power supply sources.

Electromagnetic radiation and noise measurements were taken in areas where telecommunications equipment was present. Studies were also conducted on the impact of 5 G antennas on wildlife (birds) in areas where equipment was present.

The total number of atmospheric air measurements was 84 points for 5 ingredients: nitrogen oxide, nitrogen oxide, carbon, sulfur oxide, carbon monoxide. To determine the maximum one-time ground concentration, measurements were taken in three series, taking into account the wind direction, at a height of 1.5-2.0 m from the ground surface, as well as in close proximity to telecommunications and auxiliary equipment. For physical impact - 32 points, for electromagnetic impact - 35 points.

The conducted studies showed that there are no exceedances for atmospheric air, physical impact, and electromagnetic radiation.

1. GENERAL INFORMATION ABOUT THE ENTERPRISE

The certificate gives the right to carry out activities in accordance with the constituent documents within the framework of the legislation of the Republic of Kazakhstan (the title documents are provided in Appendix 1).

1.	**Name of the organization**	JSC «Kazakhtelecom»
2.	BIN	941 240 000 193
3.	Location of legal entity	Astana city, Yesil district Sauran street, 12
4.	Certificate of branch registration	04.12.2007

1.	**Name of the organization**	LLP "KAZTEKO"
2.	BIN	151 240 023 058
3.	Location of legal entity	Aktobe region, Alginsky district, Alga city, microdistrict 4.15, apartment 2
4.	Certificate of branch registration	29.12.2015

2. BRIEF NATURAL AND CLIMATIC CHARACTERISTICS OF THE AREA WHERE THE ENTERPRISE IS LOCATED

The company has two main offices located in the cities of Astana and Almaty. Regional representative offices (branches) are available in all regions of Kazakhstan, in all its parts.

Natural and climatic conditions of the objects.

The climate of Shymkent is warm and temperate climate. In winter, there is significantly more rainfall in Shymkent than in summer. There is a small amount of rainfall in Shymkent throughout the year. The climate here is classified as Csa by the Köppen-Geiger system. The average annual temperature is 13.2 °C in Shymkent. 645 mm is the average annual precipitation rate.

Table 2.1

Climate of Shymkent (851 m) over the last 10 years (2013-2023)													
Indicator	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Average maximum, °C	0.3	1.5	10.5	17.9	23.2	30.0	35.9	30.7	28.4	20.6	8.2	1.4	19.0
Average temperature, °C	-3.6	-2.4	5.8	12.9	17.8	22.4	25.1	23.8	18.7	11.6	3.4	-2	11.1
Average minimum, °C	-7.5	-6.4	1.0	7.7	12.1	16.9	19.3	17.8	12.8	6.2	-0.7	-5.6	6.1

Between the dry and wet months, the difference in precipitation is 90 mm . The average temperature changes during the year by 27.7 ° C . The lowest relative humidity is recorded in August (32.97%). Relative humidity is highest in January (72.53%). On average, the fewest rainy days are in August (1.53 days). The month with the wettest days is March (11.63 days).

Table 2.2

	January	February	March	April	May	June	July	August	September	October	November	December
Average temperature (°C)	-0.8	1.1	7.9	13.8	19.5	24.4	26.9	26.2	20.5	13	5.7	0.1
minimum temperature (°C)	-5.6	-4.4	1.6	7.2	12.4	16.7	19	18.4	13.1	6.7	0.7	-4.7
maximum temperature (°C)	4.5	6.7	13.9	19.6	25.4	30.6	33.2	32.8	27.4	19.4	11.4	5.5
Precipitation norm (mm)	74	82	92	97	65	28	13	7	10	39	66	72
Humidity(%)	73%	70%	65%	62%	55%	41%	35%	33%	37%	51%	69%	71%
Rainy days (D)	8	8	9	8	7	4	2	1	2	4	7	8
length of day (hours)	6.3	7.0	8.5	10.4	12.6	13.6	13.4	12.5	11.1	9.1	7.2	6.2

3. CHARACTERISTICS OF THE OBJECT AS A SOURCE OF INFLUENCE ON THE ENVIRONMENT

According to Article 12 of the Environmental Code of the Republic of Kazakhstan [1], objects that have a negative impact on the environment, depending on the level and risk of such impact, are divided into four categories:

1) objects that have a significant negative impact on the environment (objects of category I);

2) objects that have a moderate negative impact on the environment (category II objects);

3) objects that have an insignificant negative impact on the environment (objects of category III);

4) objects that have minimal negative impact on the environment (objects of category IV).

In accordance with the Decisions on determining the category of an object that has a negative impact on the environment, issued by the territorial government bodies of the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan, the Company's objects were assigned categories III and IV .

The main types of impact on the environment are:

- ***emissions.*** Emissions of pollutants into the atmosphere are formed from stationary (boiler houses, diesel generators) and mobile sources, which are of a short-term seasonal nature or during construction, installation and dismantling works.

- ***wastewater.*** Wastewater is generated from administrative buildings, discharged into the central sewerage networks in accordance with the agreement, with the exception of wastewater at the Company's facilities in the Zhambyl region. Wastewater at these facilities is discharged into screened septic tanks with subsequent disposal in accordance with the agreement.

- ***waste.*** The Company generates both hazardous and non-hazardous waste. All waste has waste passports and is transferred to third-party organizations for disposal or burial.

4. BRIEF DESCRIPTION OF TECHNOLOGICAL EQUIPMENT AS A SOURCE OF INFLUENCE ON THE ATMOSPHERE

Telecommunication equipment is a set of technical means that are designed to transmit, receive and process information in telecommunication systems. It plays an important role in the modern world, providing communication between people in different parts of the planet.

The Company's telecommunications equipment is widely represented throughout Kazakhstan, which emphasizes its importance in providing communications and access to information for individuals and legal entities.

Telecommunication equipment includes various devices: from simple phones and modems to complex network switches and servers. It is used in many industries, such as telecommunications, information technology, aviation, defense and others.

The primary function of telecommunications equipment is to ensure efficient and reliable transmission of information. This includes installing and maintaining network systems, setting up connections, and ensuring the security of transmitted data.

Modern telecommunications equipment not only transmits voice messages, but also transmits data via the Internet. Thanks to it, it becomes possible to communicate via video, exchange messages and access information in real time; without it, it would be impossible to ensure global communication and quick access to information that is necessary in everyday life.

Almost every device we use daily for communication, such as a telephone, computer or television, requires telecommunications equipment to function. It allows voice and video signals to be transmitted, as well as data exchanged over the Internet.

Telecommunication equipment is also used in the construction of communication networks, including cellular and landline telephone networks, data transmission networks, satellite communication systems, and others. It ensures efficient and reliable transmission of information over long distances.

In addition, telecommunications equipment plays an important role in ensuring the security and protection of data during its transmission. It allows for encryption of information and control of access to the network, protecting the privacy of users.

Telecommunication equipment includes various devices that perform different functions. All network equipment is divided into two groups - active and passive. Devices from the first group operate on electricity, but most importantly - they take an active part in the processes of processing and transmitting data between other network elements. In fact, such devices take on the task of transmitting, sorting and grouping information.

The task of passive telecommunication devices is clear from their name alone: they do not actively participate in data processing and transmission, but create conditions for the network to function. This group includes sockets, connectors, patch cords, couplings, crosses, and the like.

Types and their main functions of equipment are:

- Routers: These devices are used to determine the path that data should take on a network. They can do this based on various factors such as protocols, addresses, or connection quality.

- Switches: These are devices that provide connections between different network segments. They allow data to be transmitted between different devices, traffic management, and security.

- Modems: These devices are used to convert digital data to analog format and back. They allow devices to connect to a network and transmit data over data lines or telephone lines.

- Servers: These are powerful computers that perform various functions on the network, such as storing data, processing requests, and providing services to users.

- Telephones: These are devices that are used for telephone communication. They allow voice signals to be transmitted over the network and provide communication between subscribers.

Telecommunication equipment plays a key role in the transmission and exchange of information between users. It provides the functionality necessary for the effective operation of communication networks.

Telecommunication equipment is most actively used by data transmission networks of the following types:

- a structured cabling system (SCS) combines video surveillance areas, as well as telephone and local area networks. It includes coaxial and optical cables and connectors, patch cords, twisted pairs, fiber optic equipment, distributors

- fiber-optic communication lines (FOCL) - acts as a system for transmitting information. Information flows are transmitted by dielectric light fiber.

The main requirement for telecommunications equipment is the interaction of devices with each other.

All of the listed equipment is mainly powered by the electrical network. It can be located in buildings, be separate structures, or be overhead or underground.

4.1. ATMOSPHERIC AIR MONITORING. MONITORING TECHNIQUE. ATMOSPHERIC AIR MEASUREMENT POINTS

Air pollution is one of the most serious environmental factors affecting the health of every person in low-, middle- and high-income countries.

In 2019, ambient (outdoor) air pollution in both urban and rural areas was estimated to have caused 4.2 million premature deaths globally; these deaths are due to exposure to fine particulate matter, which is associated with cardiovascular, respiratory and cancer diseases.

According to WHO estimates, in 2019, about 37% of premature deaths associated with outdoor air pollution were due to ischemic heart disease and stroke, 18% and 23% were due to chronic obstructive pulmonary disease and acute lower respiratory tract infections, respectively, and 11% were due to respiratory cancer.

People living in low- and middle-income countries bear a disproportionate burden of disease from outdoor air pollution, accounting for 89% of the 4.2 million premature deaths. The WHO South-East Asia and Western Pacific regions have the highest disease burden. Recent estimates of the burden of disease point to a major role of air pollution in cardiovascular disease, including death.

A key measure to protect public health is the fight against air pollution, which is the second most important risk factor for the development of non-communicable diseases.

Most sources of air pollution cannot be controlled by individuals, requiring concerted action by local, national and regional policy makers in sectors such as energy, transport, waste management, urban planning and agriculture.

There are many examples of successful policies to reduce air pollution:

- in industry: the introduction of clean technologies that help reduce emissions into the atmosphere at industrial enterprises; improvement of systems for the removal of municipal and agricultural waste, including the capture of methane generated at waste disposal facilities as an alternative to its incineration (for use as biogas);
- in energy: ensuring access to affordable energy sources at home for cooking, heating and lighting;
- in transport: transition to environmentally friendly methods of energy production; priority development of high-speed urban transport, pedestrian and bicycle traffic in cities, as well as intercity rail freight and passenger transport; transition to cleaner diesel engines for heavy-duty vehicles, low-emission vehicles, as well as cleaner fuels, including fuel with a reduced sulphur content;
- in urban planning: increasing the energy efficiency of buildings, greening and reducing the area of cities, increasing their energy efficiency;
- in the power sector: increased use of low-emission fuels and non-combustion-based renewable energy sources (such as solar, wind or hydropower); combined heat and power; and distributed energy generation (such as small-scale electricity grids and rooftop solar panels);
- in the area of municipal and agricultural waste management: waste reduction strategies, waste separation, waste recovery and reuse or recycling, and improved bio-waste management techniques such as anaerobic digestion of waste to produce biogas, are feasible low-cost alternatives to open burning of solid waste, except where incineration is unavoidable and combustion technologies with strict emission controls must be used; and
- in health: moving health services onto a low-carbon path can contribute to more sustainable and cost-effective service delivery and reduce environmental risks to the health of patients, health workers and communities. By supporting climate-smart policies, the health sector can demonstrate societal leadership and improve health service delivery.

Particulate matter (PM). PM concentration is a commonly used proxy for air pollution levels. There is strong evidence that exposure to this pollutant has adverse effects on human health. The main components of PM are sulfates, nitrates, ammonia, sodium chloride, soot, mineral dust, and water.

Carbon monoxide (CO) Carbon monoxide is a colorless, odorless, tasteless, toxic gas produced by the incomplete combustion of carbon-containing fuels such as wood, gasoline, charcoal, natural gas, and kerosene.

Ozone (O3) Ground-level ozone – not to be confused with ozone in the upper atmosphere – is one of the main components of photochemical smog and is formed by reactions with gases in sunlight.

Nitrogen dioxide (NO2) NO2 is a gas that is commonly emitted during fuel combustion in transport and industry.

Sulfur dioxide (SO2). SO2 is a colorless gas with a pungent odor. It is formed during the combustion of fossil fuels (coal and oil) or the smelting of mineral ores containing sulfur.

Air pollution is the contamination of the indoor and outdoor environment with any chemical, physical substance or biological agent that alters the natural characteristics of the atmosphere.

Air quality is closely linked to the Earth’s climate and ecosystems worldwide. Many of the drivers of air pollution (i.e. burning fossil fuels) also result in greenhouse gas emissions. Policies to reduce air pollution therefore offer a win-win strategy for both climate and health, reducing the burden of air pollution-related diseases and contributing to short- and long-term climate change mitigation.

According to the World Broadband Association, the carbon footprint of the telecommunications industry currently accounts for about 2% of global emissions. Under pressure from governments and climate change programs, telecommunications companies are facing pressure to reduce their energy consumption. A study by the French think tank The Shift Project shows that by 2025, the digital industry could account for 5% to 6% of global greenhouse gas emissions. This is due to various factors, such as the growth of internet traffic, shorter average lifespans, and increased energy intensity of equipment. The introduction of 5G technology will require more cell towers to support higher data speeds and capacity, which will lead to increased e-waste, increased energy consumption, negative impacts on animal life, and pollution from increased heat.

In order to assess the impact of the Company's activities on environmental components (flora, fauna, land, water resources, atmospheric air, physical impact, electromagnetic radiation), an external comprehensive assessment and monitoring has been carried out since 2023. In 2023, the objects of the study were antenna mast structures and fiber optic cables far from populated areas. According to the research results, the Company's telecommunications equipment does not have a negative impact on the environment. There are no anomalies in the development of plants and animals in the areas where the equipment is located. A comparative analysis of the concentration of pollutants at the Company's facilities did not reveal any differences from background indicators.

In 2024, research was conducted in the metropolis of the Republic of Kazakhstan – Shymkent.

Instrumental monitoring was carried out on the basis of the agreement between KAZTEKO LLP and AktyubNIGRI LLP No. 18 dated 01.07.2024 (accreditation certificate No. KZ . T.05.1004 dated 07.12.2020. Valid until 07.12.2025) (documents are presented in Appendix 4).

As part of this monitoring and assessment of the impact of the Company's activities on the environment, atmospheric air measurements were taken at facilities located within the city limits. The measurements were taken in close proximity to the telecommunications facility in order to obtain data on air quality indicators and to eliminate the impact from other facilities.

The main points for measuring atmospheric air are the locations of telecommunications equipment.

Atmospheric air measurements were carried out in accordance with ST RK 2.302-2021 "Methodology for performing measurements. Determination of the mass concentration of harmful substances in atmospheric air, in the air of the working area, in industrial emissions using a gas analyzer."

Determination of the mass concentration of harmful substances in the atmospheric air, in the air of the working area was carried out by the gas analyzer "GANK-4", which has a valid verification passport. (Appendix 5,6)

The atmospheric air measurement points and measurement results are given in Table 4.1.

Table 4.1.

No.	Sampling address	Measuring point	Meteorological factors, parameters, units of measurement.			Pollutants (shares of MPC (MPD))				
			temperature, °C	humidity, %	pressure, mmHg	NO_2,	NO,	WITH	SO2 ,	CO,
						0.2	0.4	0.15	0.5	5
						Actual data, mg/ m3				
1	2	**3**	**4**	**5**	**6**	**7**	**7**	**8**	**9**	**10**
1	RK, Shymkent, Beibitshilik street	Residential area, South	35	16	754	0.0359	0.0654	<0.025	0.0328	1.75
2		Residential area, North	35	16	754	0,0416	0.0584	<0.025	0.0357	1.78
3		Residential area, East	35	16	754	0.0385	0.0557	<0.025	0.0362	2.14
4		Residential area, West	35	16	754	0.0374	0.0565	<0.025	0.0331	2.05
5	RK, Shymkent, Beibitshilik street	Telecommunication equipment	35	16	754	0.0252	0.0457	<0.025	0.0328	1.56
6	RK, Shymkent, Kazybek bi st. 16A	Residential area, South	35	16	754	0,0418	0.0527	<0.025	0.0259	1.94
7		Residential area, North	35	16	754	0,0442	0.0542	<0.025	0.0247	2.05
8		Residential area, East	35	16	754	0.0451	0.0553	<0.025	0.0268	2.14
9		Residential area, West	35	16	754	0.0469	0.0372	<0.025	0.0251	2.11
10	RK, Shymkent, Kazybek bi st. 16A	DGA	35	16	754	0.0357	0,0482	<0.025	0.0345	1.61
11		Acid batteries	35	16	754	0.0314	0.0388	<0.025	0.0322	1.72
12		precision air conditioners	35	16	754	0.0243	0.0329	<0.025	0.0367	1.74
13		RRL (4 radiating antennas on AMS)	35	16	754	0.359	0.0331	<0.025	0.0346	1.68
14	RK, Shymkent, Kazybek bi st. 24	Residential area, South	35	16	754	0,0412	0.0553	<0.025	0.0224	2.24
15		Residential area, North	35	16	754	0.0425	0.0548	<0.025	0.0276	2.15
16		Residential area, East	35	16	754	0.0436	0.0515	<0.025	0.0289	2.22
17		Residential area, West	35	16	754	0.0474	0,0488	<0.025	0.0258	2.16
18		DGA	35	16	754	0,0413	0.0271	<0.025	0.0314	1.67

19	RK, Shymkent, Kazybek bi st. 24	Acid batteries	35	16	754	0.0382	0.0264	<0.025	0.0325	1.82
20		precision air conditioners	35	16	754	0.0374	0.0249	<0.025	0.0321	1.77
21	RK, Shymkent, Tynybaev St. 4	Residential area, South	35	16	754	0.0352	0,0541	<0.025	0.0341	2.12
22		Residential area, North	35	16	754	0,0401	0,0473	<0.025	0.0326	2.44
23		Residential area, East	35	16	754	0.0329	0.0428	<0.025	0.0372	2.13
24		Residential area, West	35	16	754	0,0405	0.0519	<0.025	0.0336	2.75
25	RK, Shymkent, Tynybaev St. 4	DGA	35	16	754	0.0353	0,0416	<0.025	0.0225	1.85
26		Acid batteries	35	16	754	0.0327	0.0397	<0.025	0.0276	1.88
27		precision air conditioners	35	16	754	0.0255	0.0385	<0.025	0.0267	1.82
28		RRL (4 radiating antennas on AMS)	35	16	754	0.0228	0.0346	<0.025	0.0331	1.74
29	RK, Shymkent, Republic Ave. 25g	Residential area, South	35	16	754	0.0329	0,0477	<0.025	0.0562	1.92
30		Residential area, North	35	16	754	0.0367	0.0459	<0.025	0.0491	1.85
31		Residential area, East	35	16	754	0.0451	0,0482	<0.025	0.0452	1.76
32		Residential area, West	35	16	754	0.0392	0.0465	<0.025	0,0477	1.93
33	RK, Shymkent, Republic Ave. 25g	DGA	35	16	754	0.0255	0.0423	<0.025	0,0412	1.84
34		Acid batteries	35	16	754	0.0221	0.0475	<0.025	0,0403	2.19
35		precision air conditioners	35	16	754	0.0243	0.0396	<0.025	0.0415	2.37
36	RK, Shymkent st. Elshibek Batyr b/n	Residential area, South	35	16	754	0,0466	0.0572	<0.025	0.0602	2.14
37		Residential area, North	35	16	754	0,0489	0.0553	<0.025	0.0581	2.17
38		Residential area, East	35	16	754	0.0445	0.0518	<0.025	0.0574	2.23
39		Residential area, West	35	16	754	0.0518	0.0562	<0.025	0.0634	2.11
40	RK, Shymkent st. Elshibek Batyr b/n	DGA	35	16	754	0.0345	0.0389	<0.025	0,0468	2.13
41		Acid batteries	35	16	754	0.0358	0.0393	<0.025	0.0452	2.16
42		precision air conditioners	35	16	754	0,0316	0.0375	<0.025	0,0444	2.08
43	RK, Shymkent microdistrict Saule b/n	Residential area, South	35	16	754	0.0389	0.0445	<0.025	0.0514	1.95
44		Residential area, North	35	16	754	0.0367	0,0483	<0.025	0.0522	1.82
45		Residential area, East	35	16	754	0.0415	0.0458	<0.025	0.0554	2.16
46		Residential area, West	35	16	754	0.0392	0.0491	<0.025	0,0481	1.84
47	RK, Shymkent microdistrict Saule b/n	DGA	35	16	754	0.0287	0.0364	<0.025	0.0547	1.64
48		Acid batteries	35	16	754	0.0325	0,0343	<0.025	0,0482	1.81
49		precision air conditioners	35	16	754	0.0284	0.0376	<0.025	0.0428	1.78
50	RK, Shymkent	Residential area, South	35	16	754	0.0522	0,0485	<0.025	0.0619	2.55

51	microdistrict Otrar b/n	Residential area, North	35	16	754	0.0453	0.0367	<0.025	0.0663	2.43
52		Residential area, East	35	16	754	0.0512	0.0492	<0.025	0.0542	2.69
53		Residential area, West	35	16	754	0,0485	0.0518	<0.025	0.0577	2.14
54	RK, Shymkent microdistrict Otrar b/n	Acid batteries	35	16	754	0.0287	0.0345	<0.025	0.036	1.62
55		precision air conditioners	35	16	754	0.0314	0.0338	<0.025	0.0352	1.67
56	RK, Shymkent, Tverskaya street b/n	Residential area, South	35	16	754	0,0476	0.0517	<0.025	0.0618	2.12
57		Residential area, North	35	16	754	0.0458	0.0562	<0.025	0.0633	2.34
58		Residential area, East	35	16	754	0.0365	0,0481	<0.025	0.0591	2.19
59		Residential area, West	35	16	754	0.0397	0.0553	<0.025	0.0545	2.78
60	RK, Shymkent, Tverskaya street b/n	Acid batteries	35	16	754	0.0251	0.0312	<0.025	0,0471	1.74
61		precision air conditioners	35	16	754	0.0229	0.0356	<0.025	0.0452	1.59
62	RK, Shymkent microdistrict Vostok w/n	Residential area, South	35	16	754	0.0333	0.0422	<0.025	0.0512	1.89
63		Residential area, North	35	16	754	0,0411	0.0375	<0.025	0,0477	1.92
64		Residential area, East	35	16	754	0.0385	0,0461	<0.025	0.0524	1.73
65		Residential area, West	35	16	754	0.0423	0.0548	<0.025	0.0455	2.07
66	RK, Shymkent microdistrict Vostok w/n	Acid batteries	35	16	754	0.0285	0.0332	<0.025	0.0543	1.68
67		precision air conditioners	35	16	754	0.0264	0,0366	<0.025	0.0579	1.65
68	RK, Shymkent, Baitursynov St. 70	Residential area, South	35	16	754	0.0352	0.0523	<0.025	0,0644	2.57
69		Residential area, North	35	16	754	0.0346	0,0487	<0.025	0.0595	2.64
70		Residential area, East	35	16	754	0.0328	0,0463	<0.025	0.0618	2.49
71		Residential area, West	35	16	754	0.0415	0,0477	<0.025	0.0573	2.34
72	RK, Shymkent, Baitursynov St. 70	DGA	35	16	754	0.0286	0.0455	<0.025	0.0479	2.17
73		Precision air conditioners	35	16	754	0.0248	0.0367	<0.025	0,0413	2.21
74	RK, Shymkent microdistrict Korotkiy	Residential area, South	35	16	754	0,0447	0.0377	<0.025	0.0658	2.31
75		Residential area, North	35	16	754	0.0452	0,0361	<0.025	0,0611	2.26
76		Residential area, East	35	16	754	0,0483	0,0419	<0.025	0.0589	2.45
77		Residential area, West	35	16	754	0.0425	0,0433	<0.025	0.0593	2.18
78	RK, Shymkent city, microdistrict Short	DGA	35	16	754	0.0358	0.0394	<0.025	0,0416	1.85
79		Acid batteries	35	16	754	0.0346	0.0372	<0.025	0.0399	1.89
80	RK, Shymkent 21 microdistrict, 57	Residential area, South	35	16	754	0.0329	0,0449	<0.025	0.0523	2.25
81		Residential area, North	35	16	754	0.0355	0.0452	<0.025	0.0548	2.34
82		Residential area, East	35	16	754	0,0361	0,0437	<0.025	0.0496	2.45

83		Residential area, West	35	16	754	0.0384	0.0435	<0.025	0.0518	2.78
84	RK, Shymkent city, 21 microdistrict, 57	Telecommunication equipment	35	16	754	0.0305	0.0348	<0.025	0.0423	1.74

To determine the maximum one-time ground concentration, measurements were taken in three series, taking into account the wind direction, at a height of 1.5-2.0 m from the ground surface. Since pollutants entering the atmospheric air are subject to dispersion under the influence of meteorological factors, these parameters were measured during the monitoring period. The wind regime and temperature have the greatest influence on the dispersion of impurities. The spread of atmospheric pollutants was measured and analyzed at different distances from the source of pollution, taking into account meteorological conditions.

Photo 4.1.
Shymkent st. Elshibek Batyra b/n

Photo 4.2.
Shymkent microdistrict. Saule b/n

Table 4.1.

Analysis of atmospheric air monitoring values at the facilities of JSC Kazakhtelecom
in comparison with the background 3-year values of RSE "Kazhydromet"

No.	Sample collection location	Indicators	Factual data for 2024		Background concentration values			
				MPC	2024	2023	2022	Notes
1.	RK, Shymkent, Beibitshilik street Residential zone, South	Nitrogen dioxide	0.0359	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0654	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0328	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.75	5	0.35	0.39	0.37	
2.	RK, Shymkent, Beibitshilik street Residential zone, North	Nitrogen dioxide	0,0416	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0584	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0357	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.78	5	0.35	0.39	0.37	
3.	RK, Shymkent, Beibitshilik street Residential zone, East	Nitrogen dioxide	0.0385	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0557	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0362	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.14	5	0.35	0.39	0.37	
4.	RK, Shymkent, Beibitshilik street Residential zone, West	Nitrogen dioxide	0.0374	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0565	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0331	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.05	5	0.35	0.39	0.37	

5.	RK, Shymkent, Kazybek bi st. 16A, Residential zone, South	Nitrogen dioxide	0,0418	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0527	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0259	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.94	5	0.35	0.39	0.37	
6.	RK, Shymkent, Kazybek bi st. 16A, Residential zone, North	Nitrogen dioxide	0,0442	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0542	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0247	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.05	5	0.35	0.39	0.37	
7.	RK, Shymkent, Kazybek bi st. 16A, Residential zone, East	Nitrogen dioxide	0.0451	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0553	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0268	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.14	5	0.35	0.39	0.37	
8.	RK, Shymkent, Kazybek bi st. 16A, Residential zone, West	Nitrogen dioxide	0.0469	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0372	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0251	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.11	5	0.35	0.39	0.37	
9.	RK, Shymkent, Kazybek bi street 24, Residential zone, South	Nitrogen dioxide	0,0412	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0553	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0224	0.5	0.09	0.01	0.02	

		Carbon monoxide	2.24	5	0.35	0.39	0.37	
10.	RK, Shymkent, Kazybek bi street 24, Residential zone, North	Nitrogen dioxide	0.0425	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0548	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0276	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.15	5	0.35	0.39	0.37	
11.	RK, Shymkent, Kazybek bi st. 24, Residential zone, East	Nitrogen dioxide	0.0436	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0515	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0289	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.22	5	0.35	0.39	0.37	
12.	RK, Shymkent, Kazybek bi st. 24, Residential zone, West	Nitrogen dioxide	0.0474	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0488	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0258	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.16	5	0.35	0.39	0.37	
13.	RK, Shymkent, Tynybaeva street 4, Residential zone, South	Nitrogen dioxide	0.0352	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0541	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0341	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.12	5	0.35	0.39	0.37	
14.	RK, Shymkent, Tynybaeva street 4, Residential zone, North	Nitrogen dioxide	0,0401	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0473	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	

		Sulfur dioxide	0.0326	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.44	5	0.35	0.39	0.37	
15.	RK, Shymkent, Tynybaeva street 4, Residential zone, East	Nitrogen dioxide	0.0329	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0428	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0372	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.13	5	0.35	0.39	0.37	
16.	RK, Shymkent, Tynybaeva street 4, Residential zone, West	Nitrogen dioxide	0,0405	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0519	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0336	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.75	5	0.35	0.39	0.37	
17.	RK, Shymkent, Republic Ave. 25g, Residential zone, South	Nitrogen dioxide	0.0329	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0477	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0562	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.92	5	0.35	0.39	0.37	
18.	RK, Shymkent city, Republic Ave. 25g, Residential area, North	Nitrogen dioxide	0.0367	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0459	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0491	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.85	5	0.35	0.39	0.37	
19.	RK, Shymkent city, Republic Ave. 25g, Residential area, East	Nitrogen dioxide	0.0451	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0482	0.4	0.02	0.04	0.04	

		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0452	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.76	5	0.35	0.39	0.37	
20.	RK, Shymkent city, Republic Ave. 25g, Residential area, West	Nitrogen dioxide	0.0392	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.465	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0477	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.93	5	0.35	0.39	0.37	
21.	Republic of Kazakhstan, Shymkent, Elshibek Batyr street b/n, Residential zone, South	Nitrogen dioxide	0,0466	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0572	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0602	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.14	5	0.35	0.39	0.37	
22.	RK, Shymkent, Elshibek Batyr street b/n, Residential zone, North	Nitrogen dioxide	0,0489	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0553	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0581	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.17	5	0.35	0.39	0.37	
23.	Republic of Kazakhstan, Shymkent, Elshibek Batyr street b/n, Residential zone, East	Nitrogen dioxide	0.0445	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0518	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0574	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.23	5	0.35	0.39	0.37	
24.		Nitrogen dioxide	0.0445	0.2	0.05	0.05	0.04	

	RK, Shymkent, Elshibek Batyr street b/n, Residential zone, West	Nitrogen oxide	0.0518	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0574	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.23	5	0.35	0.39	0.37	
25.	RK, Shymkent microdistrict Saule b/n, Residential zone, South	Nitrogen dioxide	0.0389	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0445	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0514	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.95	5	0.35	0.39	0.37	
26.	RK, Shymkent microdistrict Saule b/n, Residential zone, North	Nitrogen dioxide	0.0367	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0483	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0522	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.82	5	0.35	0.39	0.37	
27.	RK, Shymkent microdistrict Saule b/n, Residential zone, East	Nitrogen dioxide	0.0415	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0458	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0554	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.16	5	0.35	0.39	0.37	
28.	RK, Shymkent microdistrict Saule b/n, Residential zone, West	Nitrogen dioxide	0.0392	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0491	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0481	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.84	5	0.35	0.39	0.37	

29.	RK, Shymkent microdistrict Otrar b/n, Residential zone, South	Nitrogen dioxide	0.0522	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0485	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0619	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.55	5	0.35	0.39	0.37	
30.	RK, Shymkent microdistrict Otrar b/n, Residential zone, North	Nitrogen dioxide	0.0453	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0367	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0663	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.43	5	0.35	0.39	0.37	
31.	RK, Shymkent microdistrict Otrar b/n, Residential zone, East	Nitrogen dioxide	0.0512	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0492	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0542	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.69	5	0.35	0.39	0.37	
32.	RK, Shymkent microdistrict Otrar b/n, Residential zone, West	Nitrogen dioxide	0,0485	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0518	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0577	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.14	5	0.35	0.39	0.37	
33.	RK, Shymkent st. Tverskaya b/n, Residential zone, South	Nitrogen dioxide	0,0476	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0517	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0618	0.5	0.09	0.01	0.02	

		Carbon monoxide	2.12	5	0.35	0.39	0.37	
34.	RK, Shymkent st. Tverskaya b/n, Residential zone, North	Nitrogen dioxide	0.0458	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0562	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0633	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.34	5	0.35	0.39	0.37	
35.	RK, Shymkent st. Tverskaya b/n, Residential zone, East	Nitrogen dioxide	0.0365	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0481	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0591	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.19	5	0.35	0.39	0.37	
36.	RK, Shymkent, Tverskaya street, Residential zone, West	Nitrogen dioxide	0.0397	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0553	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0545	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.78	5	0.35	0.39	0.37	
37.	RK, Shymkent microdistrict Vostok b/n, Residential zone, South	Nitrogen dioxide	0.0333	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.422	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0512	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.89	5	0.35	0.39	0.37	
38.	RK, Shymkent microdistrict Vostok b/n, Residential zone, North	Nitrogen dioxide	0,0411	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0375	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	

		Sulfur dioxide	0,0477	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.92	5	0.35	0.39	0.37	
39.	RK, Shymkent microdistrict Vostok b/n, Residential zone, East	Nitrogen dioxide	0.0385	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0461	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0524	0.5	0.09	0.01	0.02	
		Carbon monoxide	1.73	5	0.35	0.39	0.37	
40.	RK, Shymkent microdistrict Vostok b/n, Residential zone, West	Nitrogen dioxide	0.0423	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0548	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0455	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.07	5	0.35	0.39	0.37	
41.	RK, Shymkent, Baitursynov street 70, Residential zone, South	Nitrogen dioxide	0.0352	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0523	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0644	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.57	5	0.35	0.39	0.37	
42.	RK, Shymkent, Baitursynov street 70, Residential zone, North	Nitrogen dioxide	0.0346	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0487	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0595	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.64	5	0.35	0.39	0.37	
43.	RK, Shymkent, Baitursynov street 70, Residential zone, East	Nitrogen dioxide	0.0328	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0463	0.4	0.02	0.04	0.04	

		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0618	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.49	5	0.35	0.39	0.37	
44.	RK, Shymkent, Baitursynov street 70, Residential zone, West	Nitrogen dioxide	0.0415	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0477	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0573	0.5	0.09	0.01	0.02	
		Carbon monoxide	2.34	5	0.35	0.39	0.37	
45.	RK, Shymkent city, Korotkiy microdistrict, Residential area, South	Nitrogen dioxide	0,0447	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.0377	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0658					
		Carbon monoxide	2.31	0.5	0.09	0.01	0.02	
46.	RK, Shymkent microdistrict Korotkiy, Residential zone, North	Nitrogen dioxide	0.0452	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0361	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0611					
		Carbon monoxide	2.26	0.5	0.09	0.01	0.02	
47.	RK, Shymkent city, Korotkiy microdistrict, Residential area, East	Nitrogen dioxide	0,0483	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0419	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025					
		Sulfur dioxide	0.0589	0.15	-	-	-	
		Carbon monoxide	2.45	0.5	0.09	0.01	0.02	
48.	RK, Shymkent microdistrict Korotkiy, Residential zone, West	Nitrogen dioxide	0.0425	0.2	0.05	0.05	0.04	

		Nitrogen oxide	0,0433	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025					
		Sulfur dioxide	0.0593	0.15	-	-	-	
		Carbon monoxide	2.18	0.5	0.09	0.01	0.02	
49.	RK, Shymkent 21 microdistrict, 57, Residential zone, South	Nitrogen dioxide	0.0329	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0,0449	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025					
		Sulfur dioxide	0.0523	0.15	-	-	-	
		Carbon monoxide	2.25	0.5	0.09	0.01	0.02	
50.	RK, Shymkent 21 microdistrict, 57, Residential zone, North	Nitrogen dioxide	0.0355	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.452	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025					
		Sulfur dioxide	0.0548	0.15	-	-	-	
		Carbon monoxide	2.34	0.5	0.09	0.01	0.02	
51	RK, Shymkent city, 21 microdistrict, 57, Residential area, East	Nitrogen dioxide	0.361	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.437	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025					
		Sulfur dioxide	0.496	0.15	-	-	-	
		Carbon monoxide	2.45	0.5	0.09	0.01	0.02	
52.	RK, Shymkent 21 microdistrict, 57, Residential zone, West	Nitrogen dioxide	0.0384	0.2	0.05	0.05	0.04	
		Nitrogen oxide	0.435	0.4	0.02	0.04	0.04	
		Carbon (soot)	<0.025					
		Sulfur dioxide	0.0518	0.15	-	-	-	
		Carbon monoxide	2.78	0.5	0.09	0.01	0.02	

Conclusion: based on the results of atmospheric air measurements, no exceedances of maximum permissible concentrations for 5 ingredients (pollutants) were detected.

5. CHARACTERISTICS OF BIODIVERSITY OF THE CITY OF SHYMKENT AND SOUTH KAZAKHSTAN REGION

Biodiversity is the sum of all living things and the ecosystems they inhabit. It is, first and foremost, the interaction between living organisms and the natural environment – a dynamic that is essential for the survival of the planet.

Fauna of the city of Shymkent and the South Kazakhstan region.

Shymkent is the administrative center of the South Kazakhstan region. Officially, the city is considered to be about 800 years old, but archaeological evidence has proven that people lived in these places as early as the 5th century AD. In ancient times, the northern branch of the Great Silk Road passed through Shymkent, and in the mid-19th century it was an important transit point connecting the European part of Russia and Western Siberia with Central Asia.

In the city itself, the sights include the remains of a medieval citadel, the Ethnographic Museum, the zoo and the arboretum. The most interesting are the environs of Shymkent.

Shymkent is located in a unique natural landscape zone.

In the eastern part of the horizon, a fairly extensive mountain landscape opens up to the view, which is part of the Western Tien Shan mountain system. In the southern part of the mountain range is Mount Kazygurt (peak height 1768 meters, length 20 km), located 40 km southeast of Shymkent. To the north of Mount Kazygurt, a view of the Karzhantau mountain range opens up (the highest point (Mingbulak peak) is 2823 m, the length of the chain is 90 km). Behind this mountain is the Ugam range (the highest point (Sairam peak) 4299 m, length 115 km), which extends further to the north, emerging from under the overlap of the Karzhantau range. Most of the year, the peaks are covered with snow. The Ugam and Karzhantau ranges are located on the territory of two countries - Kazakhstan and Uzbekistan. Since ancient times, Shymkent has been famous as a "garden city", a green city. The city's vegetation is characterized by extreme diversity. In addition to the above-mentioned oaks, elms and poplars, Canadian maple, willow, chestnut, acacia, ailanthus, thuja, pine, spruce and many others grow here. Among the garden crops, cherry, sweet cherry, apricot, dried apricot, plum, cherry plum, pomegranate, walnut, quince, various varieties of grapes, etc. are common. Bushes are mainly represented by ligustra (privet) and in some areas - blackberries. Among the wild herbs, dandelions, red poppies, cornflowers, shepherd's purse, clover, species of plants of the sedge and cereal families stand out. Petunias, calendula, rose bushes, tulips, daffodils are artificially grown along the central streets.

In the northern outskirts of the city, in 1980, on the site of a former landfill, an Arboretum was established. About half a million trees and shrubs, 1,360 different species, grow on the park's 150-hectare territory. Among them, a huge number of rare and exotic species are represented.

12 km east of Shymkent is the village of Sairam, on the site of which in the Middle Ages there was one of the largest centers of the Great Silk Road - Ispidzhab. It was first mentioned in Chinese manuscripts under the year 629. In the 13th century, it acquired a new name - Sairam. The village has preserved the remains of buildings from the 13th to

19th centuries. However, Sairam is famous not only for this, it is also known as the birthplace of the great poet and mystic of the 12th century - Khoja Ahmed Yassawi. Here are the mausoleums of the father and mother of Khoja Ahmed Yassawi: the mausoleum of Ibrahim-ata and the mausoleum of Karashash-ana.

Sairam-Ugam State National Nature Park is located to the east of Shymkent in the northern spurs of the Western Tien Shan on an area of 150 thousand hectares. The park has seven natural zones: from mountain-steppe to high-mountain. It is home to 59 species of mammals, including the Menzbier marmot endemic to the Western Tien Shan, and about 300 species of birds. The diverse flora and fauna of the park is complemented by unique mountain landscapes, rivers, waterfalls and mountain lakes.

Nearby is the Aksu-Dzhabagly State Nature Reserve. The reserve was created in 1926, its area is 74.4 thousand hectares. The name of the reserve comes from two rivers flowing in these places: Aksu and Dzhabagly. It is on the Aksu River that one of the most famous natural attractions of Kazakhstan is located - the Aksu Canyon. The depth of the canyon is 1800 m, this is one of the deepest canyons in Central Asia, which is often compared to the Grand Canyon in the USA. In addition to its beauty, this gorge is famous for its ancient petroglyphs. There are 1,737 species of plants in the Aksu-Dzhabagly Reserve, including the emblem of the reserve - a huge Greig tulip, the size of the petals of which reaches 15 cm. Common animals include bear, roe deer, maral, wild boar, badger, stone marten, weasel, ermine, long-tailed marmot, porcupine, tolai hare and muskrat. Rare snow leopard, Western Tien Shan species of Menzbier's marmot and argali are sometimes encountered. There are 267 species of birds in the reserve, and marinka and naked osman live in the rivers.

South of Shymkent, on the border with Uzbekistan, is one of the most famous balneological resorts in Kazakhstan - Saryagash. Local mineral water sources were discovered in 1949 during the search for oil deposits. Saryagash mineral waters are of the sodium hydrocarbonate type and help in the treatment of gastrointestinal diseases. In 1995, a mineral plant was built here and now Saryagash mineral water can be seen on sale throughout the country. Many sanatoriums have been built in Saryagash, and most of them have a developed infrastructure and are distinguished by a high level of service.

Fig.5.1 Weasel

Fig.5.2 Roe deer

Shymkent itself has many green spaces, several large reservoirs, rivers, fields, which makes the city rich in bird species diversity. Despite this, there are not many people interested in the city's bird fauna; birdwatchers from Shymkent can be counted on the fingers of one hand.

Typical city birds nest in the city itself, such as the myna, rock pigeon, collared and little turtle dove, black swift, magpie and blackbird. In the parks and adjacent water bodies, there are birds of prey, waterfowl and near-water birds that are not typical for the central part of the city.

Fig.5.3. Myna

Fig.5.4. Rock dove

Flora of Shymkent and South Kazakhstan region

South Kazakhstan Region is the southernmost region of Kazakhstan. From north to south - 620 km, from west to east - 520 km. Two ridges border the Karatau region - 440 km. Karzhantau ridge of the Western Tien Shan system. The longest river is the Syr Darya - 2137 km - it begins in Kyrgyzstan and flows into the Aral Sea. Its tributaries are the Keles River - 236 km, the Arys - 339 km. The Arys takes in the Ak-Su 122 km, the Mashat River - 62 km, the Badam River - 137 km. There are: Chardara Reservoir - 5.6 billion cubic meters of water, Bugun Reservoir - 375 million cubic meters of water, Badam Reservoir - 2 million cubic meters of water.

The climate in the northern part of the region is closer to Siberian. The southern part is closer to Mediterranean. The sand in the desert heats up to 70 degrees. In winter there are windows of spring. 290 frost-free days.

In total, 3,000 species of flowering plants grow in the South Kazakhstan region. The diversity of species composition is explained by the variety of environmental factors.

The semi-desert zone is characterized by such plants as: santonica wormwood, psoralia drupes - honey plant (ak kurai), anabasis aphyllum - it is harvested for the needs of the chemical and pharmaceutical plant. Anabasine sulfate, anabazodust is exported to 60 countries for sale. Sophora foxtail from legumes is a quarantine weed. Comb (kaz. zhytsgyl) - tamarisk - a very beautiful shrub with purple paniculate flowers.

5.1. BRIEF DESCRIPTION OF TECHNOLOGICAL EQUIPMENT AS A SOURCE OF INFLUENCE ON FLORA

In 2024, objects with telecommunications equipment located in the city of Shymkent were selected for the assessment of the impact on flora.

The city of Shymkent is a dynamically developing city with a population of more than 1 million people.

Shymkent is rightfully considered one of the greenest cities in the country. The size of the green belt in Shymkent is 2235 hectares. The area of the reserve, which is considered the lungs of the environment, reaches 752 hectares. In 2024, the total volume of the green belt near the city increased to 13 thousand hectares. Large-scale measures are being taken within the framework of the national project "Green Kazakhstan". This is facilitated by the municipal state institution "Green Belt" of the Shymkent city department of natural resources and environmental management. According to the specialists of the institution, tree seedlings planted along the green belt of the city begin from the northeast and then continue west to Turkestan and Tashkent. These areas are the main directions of the wind towards the city. The width of the green belt in different places ranges from 100 meters to two kilometers, depending on the terrain, wind direction, transport logistics and the location of settlements. Ash, maple, poplar, elm are planted in the green belt of Shymkent. All these types of trees take root quickly. However, to create flora and fauna, various trees are planted, in particular, wild apple, apricot, silver and even almond trees. Now pheasants, various birds, rabbits, hedgehogs and other creatures live in the green forest zone. The equipment of the municipal state institution "Green Belt" is replenished and updated annually. The green belt was created to improve the atmospheric climate of the city and protect it from storms and dusty winds. It also improves the quality of air in the environment.

Objects with telecommunication equipment are located in administrative buildings, special premises in the anthropogenic environment. The adjacent territory is expressed by city sidewalks, parks with green plantings, flowers, cultivated lawns. With significant interference in the natural environment of the plant world, assessing the impact of telecommunication equipment is impossible.

Taking into account that the indicators of emissions of pollutants into the atmospheric air do not exceed the maximum permissible concentrations, it follows that telecommunications equipment does not have a negative impact on the flora of the city of Shymkent in places where it is present.

5.2. BRIEF DESCRIPTION OF TECHNOLOGICAL EQUIPMENT FROM THE POINT OF VIEW OF IMPACT ON FAUNA

Monitoring of wildlife in the area of influence of the Company's activities is carried out for the purpose of timely identification, prevention and elimination of the consequences of negative processes and phenomena for the preservation of biological diversity.

In the vicinity of the city of Shymkent, in the mountains of the Turkestan region, there is a wide variety of fauna: 7 snow leopards, 604 argali, 155 Bukhara deer, 2658 mountain goats. In the mountains to the south of the Zaisan Basin (Saur, Tarbagatai, Dzungarian Alatau) live the maral, roe deer, Siberian ibex, lynx. Of the birds in the mountains of southeastern Kazakhstan, the Himalayan snowcock, alpine chough, red-bellied redstart are typical. In the rivers of the Dzungarian Alatau, there is the Semirechye newt - salamander.

In order to increase the wildlife, a special nursery currently operates in the region in the Baidibek district, where 1,000 hectares are used for artificial breeding of bustards imported from the United Arab Emirates.

The state forest fund of the Turkestan region is more than 3 million hectares. In total, forestry institutions of the region carried out forest restoration work on an area of 7720.6 hectares. Of these, 7000 hectares were sown with saxaul seeds, and tree seedlings were planted on 720.6 hectares. The total area of hunting grounds in the region is about 7 million hectares. In order to preserve the diversity of the fauna of the region, the capture of animals listed in the Red Book of Kazakhstan is prohibited by law.

At the same time, the region also supports the aquatic fauna. The number of fishery reservoirs is 11 units. Two of them are the Shardara Reservoir and the Syrdarya River, the rest are of local importance.

Shymkent is located in a very favorable place for observing and studying birds - at the junction of a desert plain and high mountains. Not far from the city is the Shakpak Pass, through which many migrating birds fly; the only stationary bird ringing center in Kazakhstan and all of Central Asia is located there.

Shymkent itself has many green spaces, several large reservoirs, rivers, fields, which makes the city rich in bird species diversity. Despite this, there are not many people interested in the city's bird fauna; birdwatchers from Shymkent can be counted on the fingers of one hand.

Typical city birds nest in the city itself, such as the myna, rock pigeon, collared and little turtle dove, black swift, magpie and blackbird. In the parks and adjacent water bodies, there are birds of prey, waterfowl and near-water birds that are not typical for the central part of the city.

You can also see rare bird species here, such as the black whinchat, a rare species that used to nest only in the Syr Darya floodplain. The Turkestan tjuvik nests in the Arboretum, also a rare species that nests only in the southern half of the country. During migrations and wintering, the city is home to many birds, including some truly rare species listed in the Red Book. For example, bustards winter in the fields within the city limits, bluebirds on the banks of the Badam River, and eagles are also found. The main places in Shymkent for bird watching are listed below.

The most accessible place for bird watching in Shymkent is located not far from the center, on Baidibek bi Avenue - "Dendropark".

The arboretum is a huge forest area where many coniferous and deciduous trees grow. There are also areas without trees. All routes have sidewalks, gazebos and benches. The arboretum is very popular among city residents, and therefore quite crowded, especially on weekends and holidays. However, this will not prevent you from seeing interesting birds - here they are more patient with people than outside the park. In total, the arboretum's avifauna includes about 50 species of birds.

In summer, common urban species such as the ringed hawk nest here. turtle dove, magpie, blackbird and not quite ordinary pheasant, sparrowhawk, Turkestan scaly-winged owl, long-eared owl, wood pigeon, white-winged woodpecker, Bukhara tit . It is interesting that there is nothing at all *on* the territory of the park Myna, the most common and numerous bird in the city, is not found . Almost all nesting birds, with the exception of the tjuvik and the wood pigeon, are sedentary, that is, they live here throughout the year. In one walk, you can easily count 15 species.

The fauna of the dendopark looks completely different during the bird migration, in the spring and autumn period. In addition to the above-mentioned nesting birds, you can meet the black-throated accentor, black and gray crows, robin, red-backed redstart, warblers, finches. Sometimes you can even meet predators - steppe eagle, imperial eagle, marsh harrier, black kite. At this time, an experienced birdwatcher can see up to 30 species.

Some birds stay or fly to the park for the winter. For example, mallard, sparrowhawk, long-legged buzzard, eastern buzzard, black-throated accentor, black-throated thrush, mistle thrush, robin, red-backed redstart, wren, brambling, linnet, common bunting. Sometimes you can see white-tailed eagle, steppe eagle, goshawk, woodcock, grosbeak, long-legged scaly-sided finch. During one winter walk you can see from 15 to 30 species, depending on the availability of binoculars and observation experience.

The Borzharsky (Buryzharsky) reservoir is located within the city limits, the distance from the Dendopark is about 10 km in a straight line. It is a fairly large reservoir, changing its size depending on the season: in winter, the volume of water decreases. The reservoir attracts many waterfowl and near-water birds. The spillway structure of the dam and the canal after it are also an ideal place for observation. Below the dam there are several small reservoirs fed by filtration waters, along the canal grow fairly dense bushes and reeds, there are tree plantations. In total, the avifauna of the reservoir has about 130 species.

Many birds nest here - night heron, great white and grey heron, rail, coot, moorhen, marsh harrier, long-legged buzzard, hobby, wood pigeon, hoopoe, golden bee-eater, roller, red-rumped swallow, pink starling, black chat, etc. Of the interesting ones, sometimes you can see glossy ibis, black-winged stilt and avocet, greenshank, ruff, pale sand martin. If everything goes well, you can see 50-60 species during the trip.

The Borzharsky storage pond is rich in birds during migration. In spring and autumn, there are many species of ducks, as well as the little grebe, great and little cormorants, mute swan, ruddy shelduck, shelduck, white-tailed eagle, steppe eagle, lapwing, little owl, black-throated accentor, common penduline tit, red-bellied and reed buntings and others. Occasionally, you can meet the "Red Book" white-headed duck, black and white stork, imperial eagle, short-toed eagle, peregrine falcon, common cranes, black-bellied sandgrouse. In one day, birdwatchers can see 80-100 species, and beginners will definitely count at least 25.

Many ducks, herons, cormorants, eagles, eagles, harriers, owls, rails, lapwings, gulls, as well as black-throated accentor, wren, mistle thrush, greenfinch stay here for the winter. Common merganser, woodcock, great snipe, great grey shrike fly here for the winter. Rarely you can meet great bittern, white-winged lark or black-headed penduline tit. During one trip you can meet from 25 to 60 species.

This reservoir is at least three times larger than Borzharsky Pond, and the distance from the Dendropark is about 20 km in a straight line. The reservoir is located on the outskirts, on the border of the city and Tolebiysky District, far from the settlement. The reservoir itself is unremarkable, almost the entire coast is empty, only along its border there are forest plantations.

In winter, ducks, seagulls, herons, eagles, sparrowhawks, long-legged buzzards, and crows can be found here. You can also see goshawks, upland buzzards, imperial eagles, red-winged wallcreepers, goldcrests, and grey-headed goldfinches. In total, up to 25–30 species can be found in winter.

The Badam River flows from east to west through the southern half of the city. Some of its sections are landscaped, so it is convenient to walk there. Here we consider the sections from the Republic Avenue. In summer, the great white and grey herons, black-winged stilts, common sandpipers, common terns, red-rumped swallows, up to 20 species in total, can nest here.

In winter, you can see herons, black-headed gulls, black-headed gulls, and rock pipits here. Of interest, we can note the chukar, red-winged wallcreeper, and bluebird. In total, there are 15–20 species.

There is insufficient data to draw specific conclusions about how the bird population has changed in recent years. However, the climate characteristics of the region contribute to the development and preservation of bird diversity. This is also facilitated by the cessation of the operation of many industrial facilities that, in the course of their activities, emitted and discharged pollutants.

During the fauna monitoring studies in June-July 2024, for an objective assessment of the Company's impact, birds were selected as indicators as a representative of the fauna that is more common in the urban environment than representatives of ungulates and terrestrial vertebrates. Observations were carried out in places of possible bird nesting: on auxiliary equipment (diesel generator sets), antenna mast structures, roofs of administrative buildings near wireless communication antennas.

5.3. PHYSICAL IMPACT OF TELECOMMUNICATION EQUIPMENT ON FLORA, FAUNA, POPULATION

Noise and vibrations of varying intensity and spectrum are created during the operation of various mechanisms, units, passing vehicles and other devices.

The operation of any power equipment is accompanied by the release of thermal, noise, and vibration pollution of the environment.

Noise is a combination of sounds of different frequencies and amplitudes. Noise interferes with the perception of useful sounds (human speech, signals, etc.), disturbs the silence and has a harmful effect on the environment and the human body. Noise creates a significant load on the human nervous system, exerting a psychological effect on it. Noise can increase the content of stress hormones such as cortisol, adrenaline and noradrenaline in the blood - even during sleep. The longer these hormones are present in the circulatory system, the higher the likelihood that they will lead to life-threatening physiological problems.

The population living in these areas in conditions of significant excess established noise standards, notes a deterioration in health, headaches, sleep disturbances, cardiovascular and gastrointestinal tract functions.

To combat noise and vibration and ensure regulated noise levels in the working area of enterprises and in the environment, it is necessary to carry out a whole range of engineering and technical measures. Of great importance is the planning of methods for combating noise and vibration, which is preceded by an analysis of production conditions to identify the most harmful production areas. A promising direction for reducing noise is the creation of low-noise machines, equipment and transport. Even at the stage of designing technological processes and industrial buildings, the creation of measures to reduce noise to levels regulated by sanitary standards is an important indicator of quality. This path is quite complex and does not always bring the expected result. Therefore, an important place in the fight against noise and vibration is occupied by methods that reduce these unfavorable factors of the production environment along the path of their propagation. Sound insulation and sound absorption are very widely used for noise protection in workshops and other premises. Soundproofing uses physical spatial barriers that prevent the spread of noise, while sound absorption uses coatings applied to reflective surfaces (ceilings or walls) or individual absorbers placed in the space of the room.

Sound insulation is used to reduce noise emanating from noisy rooms through indirect sound propagation paths (windows, doorways, gates), as well as from power equipment housings located outdoors.

The enclosing structures of production facilities must have the required sound insulation. The estimated noise characteristics from technological, electrical, sanitary equipment, as well as external noise (in cities, towns) are determined in each specific case during the development of a working project, within the framework of which the possible impact of the planned activity on the environment and the population is considered.

Further research involves conducting physical monitoring (noise measurements) of an already operating facility (equipment in operation).

Physical monitoring is a system of observations of the impact of physical processes and phenomena on the environment and on the biodiversity of ecosystems.

The purpose of monitoring physical impacts is to assess the level of physical factors affecting telecommunications equipment and the Company’s facilities and determine whether they comply with established standards and recommendations.

In the course of the Company’s activities, it is the impact of physical factors that is the most likely source of impact on bioecosystems, since it is telecommunications equipment that is a potential source of electromagnetic, vibro-acoustic and radiological impacts.

During the monitoring period in the summer of 2024, noise level measurements were carried out with the ВШВ-003-М3 device (passport and verification certificate are presented in Appendix 5, 6).

The process of monitoring the effects of physical parameters includes the following steps:

A) Preparation for measurements: Check mechanical serviceability, remove the cover from the rear compartment of the meter, remove the power source and insert the batteries.

B) Installation of the equipment: Install the meter in the working position (horizontal or vertical) and set the arrow to 0 on the 0-1 scale with a mechanical zero corrector

C) Measurement of noise levels: Measurements are carried out periodically for 5-10 minutes to establish average values.

D) Processing of measurement results: After the measurement is completed, the data obtained is entered into the log.

Photo 6.3.1.
Shymkent st. Beibitshilik no #

Photo 6.3.2.
st. Baitursynov 70

Table 5.3.1

No.	**Address**	**Measuring point**	**Actual noise measurement results, dB**	**Norm according to ND**
1	**2**	**3**	**4**	**5**
1	RK, Shymkent, Beibitshilik street	Telecommunication equipment	57	75
2	RK, Shymkent, Kazybek bi st. 16A	DGA	61	75
3		Acid batteries	42	75
4		precision air conditioners	57	75
5		RRL (4 radiating antennas on AMS)	46	75
6	RK, Shymkent, Kazybek bi st. 24	DGA	59	75
7		Acid batteries	47	75
8		precision air conditioners	55	75
9	RK, Shymkent, Tynybaev St. 4	DGA	59	75
10		Acid batteries	44	75
11		precision air conditioners	51	75
12		RRL (12 radiating antennas on AMS)	49	75
13	RK, Shymkent, Republic Ave. 25g	DGA	60	75

14		Acid batteries	42	75
15		precision air conditioners	51	75
16	RK, Shymkent st. Elshibek Batyr b/n	DGA	62	75
17		Acid batteries	45	75
18		precision air conditioners	55	75
19	RK, Shymkent microdistrict Saule b/n	DGA	58	75
20		Acid batteries	44	75
21		precision air conditioners	50	75
22	RK, Shymkent microdistrict Otrar b/n	Acid batteries	47	75
23		precision air conditioners	54	75
24	RK, Shymkent, Tverskaya street b/n	Acid batteries	41	75
25		precision air conditioners	55	75
26	RK, Shymkent microdistrict Vostok w/n	Acid batteries	43	75
27		precision air conditioners	52	75
28	RK, Shymkent, Baitursynov St. 70	DGA	45	75
29		precision air conditioners	53	75
30	RK, Shymkent microdistrict Korotkiy	DGA	63	75
31		Acid batteries	46	75
32	RK, Shymkent 21 microdistrict, 57	Telecommunication equipment	59	75

According to table 5.3.1 and the results of noise measurements near telecommunications equipment, no exceedances of the maximum permissible level were found.

In order to prevent the negative impact of noise on the environment and the population, it is necessary to carry out a number of measures for the technical maintenance of equipment, repair equipment, modernize and replace equipment with high energy efficiency and noise suppression.

5.4. ELECTROMAGNETIC FIELD (RADIATION) FROM TELECOMMUNICATION EQUIPMENT AND ITS IMPACT ON FLORA, FAUNA AND POPULATION

Electromagnetic fields play a significant role in all processes occurring on Earth. Being the primary periodic ecological factor, the natural magnetic field (MF) of the Earth has constantly affected and affects the formation, state and dynamics of ecosystems for billions of years. In the course of evolutionary development, the structural and functional organization of ecosystems has adapted to the natural background of the MF. At the current stage of development of scientific and technological progress, man significantly transforms the natural magnetic field, often sharply increasing its intensity and giving it new parameters.

The impact of man-made electromagnetic fields on natural biocomplexes is comparable to natural ones, and in some cases exceeds them. Power plants create electromagnetic fields of industrial frequencies (50 Hz) significantly higher than the average level of natural fields.

The approach to the interaction of electromagnetic radiation with biosystems of various hierarchies dictates the consideration of this impact as a complex man-made ecological factor that has multiple multidirectional (environmentally transforming, biocidal and stimulating) effects on ecosystem components.

Consequently, the need to study the impact of this factor on biological systems at all levels of their organization is highly relevant. To date, researchers have obtained a wealth of data on the impact, primarily of magnetic fields, on the condition of humans and animals. At the same time, the impact of the electromagnetic factor on the functioning of biosystems at various levels of organization remains poorly addressed by research. The same situation persists with respect to the mechanisms of the impact of electromagnetic field components of different frequencies and intensities on living organisms.

One of the consequences of civilization is the filling of the environment with electromagnetic fields of different frequencies and amplitudes. Electromagnetic pollution is associated with adverse changes in the biosphere and its saturation with energy. In the form of energy, the environment is polluted with heat and electromagnetic fields (EMF). From an ecological point of view, EMF is one of the types of energy pollution of the environment, which is a global factor in changing the biosphere .

Electromagnetic energy is also emitted by many technical means whose main functions are not connected with the intentional process of radiation, for example, power plants, electrified transport, power lines, etc. Various types of electromagnetic and corpuscular radiation are the most important tool for understanding living matter.

Artificial electromagnetic and magnetic fields, close in amplitude and frequency range to natural fields, also have an effect on biological objects.

Electromagnetic fields (EMF) of industrial frequency (IF) are part of the ultra-low frequency range. They are widely used in industrial conditions and everyday life. With the development of electric power engineering, radio and television technology, a large number of various EMF sources have appeared. EMF near generators should be considered as induction fields, and not as a flux of radio wave radiation. Induction fields quickly weaken with distance from the source, and beyond the vicinity of a radius of several wavelengths, the EMF intensity is already an insignificant fraction of their initial values. EMF of industrial frequency occurs near power lines, transformers, etc. In the immediate vicinity of these sources, the EMF intensity can be quite significant.

The biological influence of electric and magnetic fields on biosystems of various hierarchies has been studied quite extensively. However, the effects of this type of influence on living organisms are still unclear and difficult to determine. The effect of EMF exposure is very diverse and can be both negative and positive. EMFs of different frequencies and intensities can cause both an inhibitory effect and stimulation of life processes (hormesis).

The hormesis effect has found its greatest application in plant growing, in particular in pre-sowing irradiation of seeds, which does not exclude its use in other industries.

It has been established that whole organisms have the highest sensitivity to EMF, isolated organs and cells have a lower sensitivity, and solutions of molecules have an even lower sensitivity (Presman, 1968).

The biological effect of EMR depends on the wavelength (or frequency of radiation), the generation mode (continuous, pulsed), and the conditions of impact on the body (constant, intermittent; general, local; intensity; duration). The biological activity of EMR decreases with increasing wavelength (or decreasing frequency) of radiation, therefore the most active are the centimeter, decimeter and meter ranges of radio waves. Electromagnetic radiation characterized by pulsed generation has greater biological activity than radiation with continuous generation.

The impact of electromagnetic fields on biological objects is determined by the magnitude of the induction of internal fields and electric currents and their distribution in the body of humans and animals. This depends on the size, shape, anatomical structure of the body, electrical and magnetic properties of tissues, the orientation of the object relative to the polarization of the body, as well as on the characteristics of the EMF (frequency, intensity, modulation, etc.). The absorption and distribution of absorbed energy inside the body also depends significantly on the shape and size of the irradiated object, on the ratio of these sizes to the wavelength of the radiation.

Electromagnetic waves are only partially absorbed by the tissues of a biological object. Part of the electromagnetic energy goes into space, and the rest is dissipated (absorbed) by the environment (Spodobaev, 2000). Therefore, the biological effect depends on the physical parameters of the EMF. The degree of energy absorption by tissues depends on their ability to reflect it.

All biological reactions to non-ionizing EMR are based on two types of interaction - thermal and non-thermal, the latter is called informative. In 1953, American scientist G. Schwan proposed to consider the maximum permissible energy flux density for humans equal to 100 mW/cm. This value is called the thermal threshold (Spodobaev, 2000). Values equal to or lesser increase the temperature of the irradiated object or area by no more than 1°C and cause effects comparable to those occurring in the body during natural physiological processes (Mikhailov, 2011). When the energy flux density values exceed the thermal threshold, the thermoregulation system cannot cope with the removal of the generated heat and the human body overheats. Thus, a thermal effect occurs.

Its level depends on the intensity of irradiation. The biological effect of thermal exposure is caused by EMF energy, which is absorbed and utilized by the biological object. When EMF affects a biological object, the electromagnetic energy of the external field is converted into thermal energy, which is accompanied by an increase in body temperature or local selective heating of tissues, organs, cells, especially those with poor thermoregulation (crystalline lens, vitreous body, testicles, etc.).

When exposed to EMF, the temperature does not increase in the environment or on the surface of the body, but directly in the animal's body. The heating of animal body tissues and the general increase in body temperature under the influence of EMF depend on the amount of electromagnetic energy converted into heat (Presman, 1968). Thermal effects are comparable to the energy exchange of the animal's body.

In the case of non-thermal (informational) action, the biological reaction is not caused by the EMI energy; it is only an initiating signal for the body’s own energy resources.

In the body of an animal or a human, when in an external electric, magnetic or electromagnetic field, currents are induced that overlap with the body’s own biocurrents, as a result of which natural processes may change or new phenomena may arise.

Constant external electric fields cannot cause currents in the body. The only consequence of the impact of such fields can be the occurrence of electric charges on the surface of the body. Constant magnetic fields penetrate into the body without change, since there are no ferro- or diamagnetic formations in the body.

High-frequency electromagnetic fields are also capable of inducing currents in the body. The appearance of these currents is certainly a new factor influencing processes in the body, since high-frequency currents are absent in the body under natural conditions.

As studies have shown, an alternating electric field affects many organisms in the same way as a constant one. However, it has been shown that with the same field strength, the reaction of fruit flies to an alternating field is 1.5-2 times higher than to a constant one. The increase in reaction may be due to the occurrence of vibration of the limbs, especially the antennae in an alternating field. The frequency of field changes that causes the maximum reaction of the insect coincides with the resonant frequency of oscillations of the antennae of insects of a given species.

Depending on the frequency, the impact of EMF on organisms varies greatly. Let's consider them in more detail.

The most common industrial frequencies are ultra-low (50 Hz).

Electromagnetic fields created by electromagnets have an exciting effect on some leaf beetles. These fields also affect the fertility of insects. On the aphids AcyMosgronic caraganae Clyulosk., especially at the beginning of summer, constant exposure to the field led to an increase in fertility by 30% (Chernyshev, 1996).

There are few works devoted to the effects of EMF against the background of changing environmental factors. All this leads to the lack of a unified opinion on the mechanisms of the influence of EMF on living systems.

The greatest success in this area has been achieved by the school of Professor E.K. Eskov. In the process of conducting fundamental research using a comprehensive assessment of the results of EMF influence, a methodological approach to studying this factor was developed. It is based on complex studies of behavioral and physiological reactions of living systems of varying complexity to this factor. This allowed Professor E.K. Eskov and his students (Eskov, 1974, 1975, 1976, 1979, 1981, 1986, 1990, 1990a, 19906, 1990b, 1992, 1995, 2003; Zolotov, 2004) to develop a theory of the mechanisms of EMF perception by insects, determine the ranges and thresholds of their sensitivity to EMF, discover the organ that perceives the influence of this factor and study the ontogenetic aspects of this influence in insects.

As a result of these studies, a destabilizing effect of EP on the microclimate of the home of red forest ants was discovered. It was established that EP causes defensive reactions in them and leads to the formation of mutual aggression and the death of insects (Chernyshev, 1996).

Electromagnetic fields cause group reactions in insects. Increased aggressiveness of individual individuals is caused by induced currents and static charges of the body surface created by EP. During mutual contacts of individuals, these factors create electrical discharges that are perceived as acts of mutual aggression. This leads to the formation of inadequate behavior, expressed in mutual aggression and mass death of individuals (Grefner, 1998).

Bee colonies living in hives located near electrical equipment become weaker and have low productivity (Yeskov, 1990).

EF stimulates an increase in the intensity of metabolic processes in insects, affects the reduction of their lifespan at the pupal and imago stages. The effectiveness of EF at frequencies in the range of maximum perception depends on its intensity. In all studied animal species (from protozoa to insects), EF has a repellent effect and can be considered a negative irritant. Most likely, this is associated with the effect of EF power transmission lines on changes in the density of earthworms under the line (Zolotov, 2004).

In the work of N. M. Grefner, the development of grass frog larvae (Rana temporaria L.) in an electromagnetic field was studied. An industrial frequency generator was used as an electromagnetic wave generator. Experimental data show that electromagnetic radiation has an ambiguous effect on the growth and development of Rana temporaria tadpoles: it slightly accelerates the growth of tadpoles, but slows down the rate of development and increases embryonic mortality, causing changes in the blood (Grefner, 1998).

The impact of industrial frequency EM on the human body is widely covered in the literature. An increase in the incidence of cancer has been found in people who have been exposed to IF EMF for a long time. At the same time, the data is contradictory and it is believed that industrial radiation, which most people in cities encounter on a daily basis, does not pose a serious danger as a source of leukemia.

The literature contains information on changes in the cardiovascular and neuroendocrine systems, immunity, metabolic processes, as well as on the inducing effect of IF EMF on carcinogenesis processes. When studying the health status of individuals exposed to industrial effects of EMF during servicing substations and overhead power lines with a voltage of 220-500 kV, complaints of a neurological nature were noted (headache, increased irritability, fatigue, lethargy, drowsiness). At the same time, there were complaints about disruption of the cardiovascular system and gastrointestinal tract. The noted complaints were accompanied by some functional dysfunctions of the nervous and cardiovascular systems in the form of autonomic dysfunction (tachycardia or bradycardia), arterial hypertension or hypotension, pulse lability, hyperhidrosis. Neurological disorders were manifested by increased tendon reflexes, tremors of the eyelids and fingers, decreased corneal reflexes and asymmetry of skin temperature, decreased memory and attention (Kholodov, 1982; Grigoriev, 2000).

The most exposed group of the population to the effects of IF EMF are people working with the source of these radiations; a slowdown in the pulse rate was noted in fitters and volunteers exposed to EFs with a strength of up to 21 kV/m, which may indicate an increased risk of developing vegetative-dependent cardiovascular diseases. However, a number of foreign authors, having conducted a thorough examination of people in EFs, did not reveal any differences in the state of the cardiovascular system compared to the control group.

There are a large number of studies on the impact of EMF on the generative function, often contradictory, from strong influence to complete absence. Several large reviews (Holzel, Lamprecht, 1994; Knave, 1994) have collected a large amount of contradictory data on these issues.

Reliable changes in the nervous system indices (passive sympathy, tension, stereotypy) were revealed in baboons exposed to EFs with a strength of 60 kV/m for 12 hours a day for a week. After the end of the exposure, all indices returned to normal.

The human and animal organisms are very sensitive to the effects of RF EMI. The nervous system, gonads, eyes, and hematopoietic system are most sensitive to the effects (Kholodov, 1982).

The effect of radiofrequency EMF on the central nervous system is observed at an energy flux density (EFD) of more than 1 mW/cm. Changes in the blood are usually observed at an EFD above 10 mW/cm. At lower levels of exposure, phase changes in the number of leukocytes, erythrocytes and hemoglobin are observed (most often leukocytosis, an increase in erythrocytes and hemoglobin). With prolonged exposure to EMF, physiological adaptation or weakening of immunological reactions occurs (Life Safety, 2006). Normal functioning of human cells is associated with metabolism through membranes. The exchange is carried out by opening channels in the membrane through which sodium, calcium, chlorine and other element ions pass. The opening of the channels occurs due to electrostatic forces acting on the protein molecules of the membrane, with changes in the voltage between the membrane walls due to differences in ion concentrations inside and outside the cell (Kholodov, 1982; Grigoriev, 2000). In a calm state, the voltage is approximately 80 mV. In order for the membrane channels to be transparent to sodium ions, it is sufficient to reduce the voltage by 20 mV. Taking into account the electrical conductivity and structure of nerve tissue, this state corresponds to an average electric field strength in the human body of 40 V/m and a current density of 4 A/m. If the specified field or current density is artificially created inside the human body, the natural processes of organ functioning will be disrupted, for example, paralysis of nerve tissue will occur or the rhythm of heart muscle contractions will be disrupted. Thus, the specified values of field strength or current density are certainly dangerous (Life Safety, 2006).

Much attention in recent years has been paid to the study of the possible development of a carcinogenic (leukogenic) effect when exposed to low-intensity industrial and non-industrial EMF. According to currently available information, the main danger is the effect of induced electric current on the excitable structures of the body (nervous, muscular) (Kholodov, 1982; Grigoriev, 2000).

The parameter determining the degree of impact is the density of the eddy current induced in the body. In this case, electric fields of the frequency range under consideration are characterized by weak penetration into the human body, while magnetic fields make the body virtually transparent (Bolshakov AM, 2002). It was noted that a magnetic field with an induction of 20 mT increases the motor activity of sticklebacks (Kholodov, 1982). Experiments were also conducted on passerine birds. In 68% of cases, an increase in motor activity by 100-430% was noted compared to the control. Later, T. Ryskanov in experiments on 20 rats was exposed to magnetic induction from 2.20 to 200 mT, and an increase in motor activity was observed in 70% of cases. The magnitude of the effect increased with increasing induction (Kholodov, 1982).

A potentially dangerous and harmful factor affecting the biosphere is the impact of electromagnetic fields (EMF), the sources of which are radio transmitting devices.

Wireless communication is a widespread technology that uses radio frequencies (RF) and electromagnetic fields (EMF) to transmit information between users. Wildlife can be exposed to these waves, which partially penetrate biological tissue. These internal fields can have biological effects. The effects of RF EMF and the interactions between them and organisms will depend on the frequency of the waves. Fifth-generation (5G) wireless telecommunications networks operate in part on new frequencies that are not as common in the environment.

As described above, no excess emissions of pollutants from auxiliary and technological equipment near the facility were detected. Accordingly, the studies were aimed at studying the impact on birds.

The most common form of using fixed objects, as well as buildings and various structures, by birds is nesting in them. Usually, for example, rock pigeons Columba livia, jackdaws Corvus monedula, starlings Sturnus vulgaris nest in holes, niches, crevices of buildings and structures. In most cases, the species stereotype of nesting behavior of birds in natural conditions is preserved: the height of the nest from the ground, the diameter of the hole or the size of the niche. Starlings, nesting in tree hollows in natural conditions, when nesting in buildings, choose holes of a suitable diameter not only at the optimal nesting height, but also closer to the edge of the structure.

Relatively numerous and common are cases of nesting on antennas (in beams and emitters) and waveguide terminals of powerful radars of starlings and sparrows. For these purposes, starlings choose holes and voids of a suitable size, usually not lower than 2.5 m from the ground and close to the edge of the structure. For example, in antenna beams they occupy only edge holes. Birds have from 6 hours to one day for the first stage of nest construction in a fixed installation. Despite such powerful radiation at a wavelength of 10 cm, the birds successfully raised chicks. When feeding the chicks, the parents flew into the nest without any difficulties. It should also be noted that even the noise and radiation of nearby equipment did not frighten the birds starting to build a nest. There is evidence that the same place was occupied in subsequent years, but it is unknown whether it was the same pair of birds, since ringing was not carried out.

During the monitoring period in the summer of 2024, measurements of the electromagnetic field level were carried out near telecommunications equipment and in places where wireless antennas were located in order to identify excesses of standards for the electrical component, kV/m, V/m and for the magnetic component, if any.

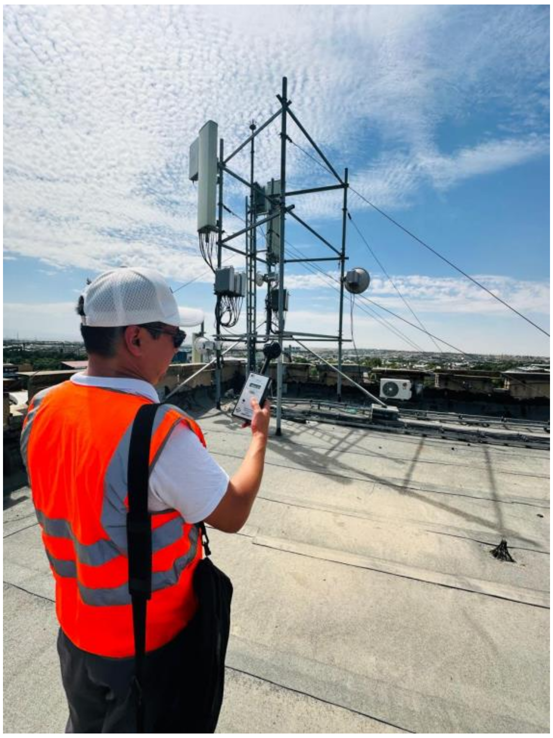


Photo 5.4.1 st. Kazybek bi 16A

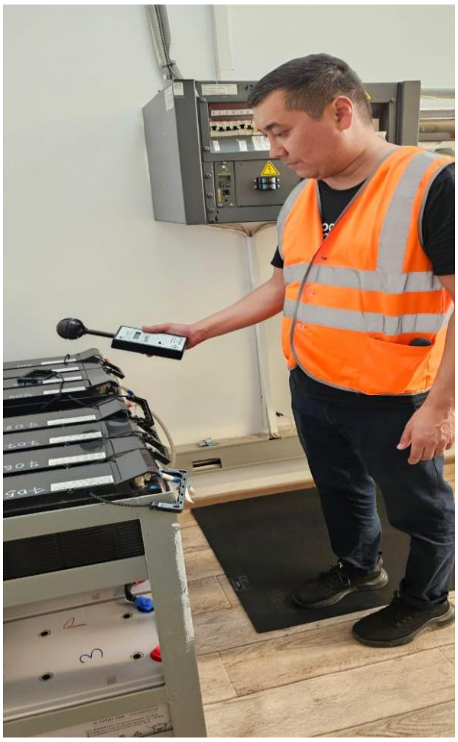


Photo 5.4.2 st. Tynybaeva 4

Table 5.4.1

Results of measurements of the level of electromagnetic fields in the locations of telecommunications equipment of JSC Kazakhtelecom

Date of measurement	Test protocol	Item No.	Sampling location	Sampling point	Distance from source in meters	Height from the floor in meters	EMF intensity			
							By magnetic component, μT		By electrical component, V/m	
							Measurement results	Norm according to ND	Measurement results	Norm according to ND
05.08.2024	19.08.2024	1	RK, Shymkent city, Beibitshilik street	Telecommunication equipment	0.7	1	4.56	25	--	--
							5.28	25	--	--
							5.17	25	--	--
05.08.2024	19.08.2024	2	RK, Shymkent st.Kazibek bi 16A	DGA	0.7	1	2.57	25	--	--
							2.84	25	--	--
							3.13	25	--	--
		3		Acid batteries	0.7	1	5.48	25	--	--
							5.36	25	--	--
							5.42	25	--	--
		4		Precision air conditioners	0.7	1	5.77	25	--	--
							5.83	25	--	--
							6.71	25	--	--
		5		RRL (4 radiating antennas on AMS)	0.7	1	5.41	25	--	--
							4.33	25	--	--

							4.85	25	--	--
05.08.2024	19.08.2024	6	RK, Shymkent, Kazybek bi st. 24	DGA	0.7	1	4.15	25	--	--
							3.28	25	--	--
							3.17	25	--	--
		7		Acid batteries	0.7	1	5.64	25	--	--
							5.39	25	--	--
							5.47	25	--	--
		8		Precision air conditioners	0.7	1	6.18	25	--	--
							5.48	25	--	--
							7.29	25	--	--
05.08.2024	19.08.2024	9	RK, Shymkent, Tynybaev St. 4	DGA	0.7	1	4.62	25	--	--
							4.85	25	--	--
							5.16	25	--	--
		10		Acid batteries	0.7	1	5.21	25	--	--
							4.79	25	--	--
							4.52	25	--	--
		11		Precision air conditioners	0.7	1	5.14	25	--	--
							4.72	25	--	--
							6.25	25	--	--
		12		RRL (12 radiating antennas on AMS)	0.7	1	5.28	25	--	--
							4.91	25	--	--
							5.13	25	--	--
05.08.2024	19.08.2024	13	RK,Shymkent, Republic Ave. 25g	DGA	0.7	1	5.16	25	--	--
							5.28	25	--	--
							4.93	25	--	--
				Acid batteries	0.7	1	6.25	25	--	--

		14					6.43	25	--	--
							6.11	25	--	--
		15		Precision air conditioners	0.7	1	5.78	25	--	--
							8.91	25	--	--
							7.64	25	--	--
05.08.2024	19.08.2024	16	RK, Shymkent st. Elshibek Batyr b/n	DGA	0.7	1	3.68	25	--	--
							5.73	25	--	--
							5.14	25	--	--
		17		Acid batteries	0.7	1	8.64	25	--	--
							8.71	25	--	--
							8.45	25	--	--
		18		Precision air conditioners	0.7	1	8.14	25	--	--
							7.92	25	--	--
							7.88	25	--	--
05.08.2024	19.08.2024	19	RK, Shymkent microdistrict Saule b/n	DGA	0.7	1	4.58	25	--	--
							4.69	25	--	--
							4.52	25	--	--
		20		Acid batteries	0.7	1	5.79	25	--	--
							5.16	25	--	--
							5.84	25	--	--
		21		Precision air conditioners	0.7	1	6.28	25	--	--
							5.74	25	--	--
							7.18	25	--	--
05.08.2024	19.08.2024	22		Acid batteries	0.7	1	5.62	25	--	--
							6.74	25	--	--

		23	RK, Shymkent microdistrict Otrar b/n				5.55	25	--	--
				Precision air conditioners	0.7	1	7.81	25	--	--
							7.33	25	--	--
							7.48	25	--	--
05.08.2024	19.08.2024	24	RK, Shymkent, Tverskaya street b/n	Acid batteries	0.7	1	4.72	25	--	--
							6.31	25	--	--
							5.64	25	--	--
		25		Precision air conditioners	0.7	1	5.28	25	--	--
							6.33	25	--	--
							5.86	25	--	--
05.08.2024	19.08.2024	26	RK, Shymkent microdistrict Vostok w/n	Acid batteries	0.7	1	5.26	25	--	--
							5.47	25	--	--
							4.91	25	--	--
		27		Precision air conditioners	0.7	1	6.25	25	--	--
							5.45	25	--	--
							6.18	25	--	--
05.08.2024	19.08.2024	28	RK, Shymkent, Baitursynov St. 70	DGA	0.7	1	3.65	25	--	--
							3.78	25	--	--
							3.52	25	--	--
		29		Precision air conditioners	0.7	1	6.81	25	--	--
							6.76	25	--	--
							7.15	25	--	--
05.08.2024	19.08.2024	30	RK, Shymkent microdistrict. Short	DGA	0.7	1	4.15	25	--	--
							4.05	25	--	--
							3.97	25	--	--
				Acid batteries	0.7	1	5.26	25	--	--

		31					5.17	25	--	--
							5.38	25	--	--
05.08.2024	19.08.2024	32	RK, Shymkent 21 microdistrict, 57	Telecommunication equipment	0.7	1	5.29	25	--	--
							7.48	25	--	--
							6.22	25	--	--
05.08.2024	19.08.2024	33	RK, Shymkent, Al-Farabi district, st. Akpan batyr, 111	Antennas – 5G	0.7	1	5.27	25	--	--
							5.17	25	--	--
							5.34	25	--	--
05.08.2024	19.08.2024	34	RK, Shymkent, Turansky district, st. Zheltlksan, 20B	Antennas – 5G	0.7	1	4.92	25	--	--
							5.14	25	--	--
							4.76	25	--	--
05.08.2024	19.08.2024	35	RK, Shymkent, Al-Farabi district, st. Divaeva, 12	Antennas – 5G	0.7	1	6.47	25	--	--
							5.99	25	--	--
							6.34	25	--	--

Conclusion:

According to the measurement results presented in Table 5.4.1, it is clear that the actual level of electromagnetic radiation is significantly lower than the approved standards.

The telecommunications equipment of JSC Kazakhtelecom does not have a negative electromagnetic impact on flora, fauna and the population.

5.5. ELECTROMAGNETIC FIELD (RADIATION) FROM TELECOMMUNICATION EQUIPMENT AND ITS INFLUENCE ON THE FAUNA OF WATER BODIES

The impact of the Company's auxiliary and telecommunications equipment on the fauna of water bodies was not assessed within the framework of this study, since the objects of the study were equipment located in administrative buildings and structures far from water bodies.

According to the assessment of the impact of fiber optic cable and antenna mast structures, carried out in 2023, no anomalies in the qualitative and quantitative composition of the fauna of water bodies were identified.

5.6. ASSESSMENT OF THE IMPACT OF 5G WIRELESS COMMUNICATION ANTENNAS ON BIODIVERSITY AND POPULATION

Telecommunication networks use radio frequency electromagnetic fields to provide wireless communication. These networks have evolved over time and have been introduced in successive generations. The fifth generation of telecommunications networks operate on frequencies that were not typically used in previous generations, which will change the extent to which these waves affect wildlife.

The fifth generation of mobile technology is called 5G. The fifth generation of wireless communication is much faster. If you put it in numbers, it is 1000 times faster than the current 4G. They have a bandwidth of 100 GB per second. Current gadgets do not occupy the frequency used by 5G. There is significant interference because 3G and 4G use the same frequency. Also, unlike 4G towers, 5G antennas are directional, which leads to less interference.

All wireless devices use radio waves in the electromagnetic spectrum to send data. For example, Wi-Fi routers use a frequency range of 900 MHz to 60 GHz. The higher the frequency, the better. The frequency spectrum below 6 GHz, which covers the range from 700 MHz to 2.7 GHz, is used by 4G and LTE. Users can expect faster speeds and greater capacity from 5G than from 4G or LTE.

The millimeter wave (mmWave) spectrum , which covers the high-frequency range from 24.25 GHz and above, is used in 5G infrastructure. Millimeter wave frequencies have never been used for communications before, and 5G standards like IMT-2020 define how they should be used. Cell towers and the tiny cells that transmit data and emit these frequencies are examples of 5G base stations. Mobile broadband infrastructure will support decarbonization efforts in the energy, industrial, and transportation sectors by enabling:

• Remote intelligence supported by cellular communications

• New ecosystems and platforms are driven by rapid change.

• New business models from the bottom up

The fifth generation of telecommunications technology, 5G, is critical to achieving the goal of providing seamless fifth-generation wireless connectivity to all urban areas, railways, and key highways. This can only be achieved by building a dense network of antennas and transmitters. In other words, the number of high-frequency base stations and other devices will increase rapidly.

5G can reduce energy consumption. The 5G network combined with the Internet of Things (IoT) will allow devices to turn on and off automatically when in use. Meanwhile, sensors in home appliances, transportation networks, buildings, factories, street lights, and homes can monitor and assess their energy needs and consumption in real time, allowing them to optimize energy use on the go.

5G networks have a variety of environmental impacts, the most important of which may be the reduction of greenhouse gas emissions. With the rollout of 5G networks around the world, video conferencing and other communications will become more fluid and real-time. And as we have seen, COVID-19 has forced major companies to implement their work-from-home (WFH) models. This has helped reduce overall carbon emissions as office spaces use less energy and fewer vehicles are used for transportation. Similarly, 5G may help in using less energy sources and less pollution from cars as we can hold real-time meetings via Zoom and other platforms while sitting on our couches at home.

In addition, 5G can also benefit the environment in the automotive sector. In a 5G network, sensors and cameras can use real-time data to keep traffic moving and change stop signals to avoid delays. Reducing traffic congestion and idling will lead to lower fuel consumption and vehicle emissions.

The influence of 5 G on living organisms is a direction that requires long-term and in-depth research.

Since wireless telecommunication systems have become widespread, many animals and plants are exposed to radio frequency radiation. There are many scenarios for exposure to radio frequency radiation. The type of scenario is classified depending on the parameters of the source and the exposed organism. In general, the source can be either inside the organism (e.g., an implant), in direct contact with the organism (e.g., high-frequency electrodes), or the source can be external to the organism (e.g., a base station antenna). Depending on the type and configuration of the source and the frequency of the RF-EMF, the exposure can be either whole-body, i.e., in an exposure scenario in which the entire organism is (uniformly) exposed to the RF-EMF, or localized exposure, i.e., in which only a part of the organism is irradiated. significant amount of RF-EMF. For an external source of RF-EMF, the exposure scenario is divided into several categories depending on the distance between the sources and the organism. In the far field, the distance between the RF-EMF source and the exposed organism is 2 DD 2/θ, where D is the maximum size of the source or organism and λ is the wavelength. When the source is closer to the organism, this is often referred to as near field exposure. Often, far field sources cause whole-body exposure, while near field sources cause localized exposure. However, this is not true for all scenarios and is expected to change in future wireless networks.

These radiofrequency EMFs can penetrate and be absorbed by biological environments (ICNIRP 2020).

This absorption can be quantified using the specific absorption rate (SAR in W/kg), which is the amount of energy absorbed by a given mass. This value is only meaningful when averaged over a given volume or mass. Whole-body average SAR is a commonly used value for assessing RF exposure when the entire body is exposed to RF radiation. This quantity is not always useful for local exposure. Therefore, a smaller average volume or mass is required to characterize local exposure. This volume or mass is often defined such that the SAR threshold value averaged over that volume or mass corresponds to the biological effect.

The field of science that studies SAR under various exposure conditions is called RF dosimetry. There are other quantities that can be used to quantify RF EMF exposure if RF EMF absorption is not of interest, and the magnitude of internal electric and magnetic fields and currents in biological tissue can also be determined.

It is often impossible to measure and/or quantify the electromagnetic fields inside the body. Therefore, exposure to radiofrequency radiation is often quantified by examining the radiofrequency fields that arise from exposure. These are the electromagnetic fields that would be present at the location of the body if the body were not there. These incident fields induce internal electromagnetic fields (and the absorption of these fields). This exposure can be quantified using the electric field strength (E in V/m), which is the amplitude of the electric field (E).

Alternatively, RF exposure can also be quantified using electromagnetic power density (W/m2).

In free space, i.e. without any interference or blocking from objects in the environment, both E and S decrease with distance from the radiating antenna (propagation loss). This is another important difference between near-field and far-field exposure. The SAR produced by the antenna and the power density S around the antenna depend linearly on the power supplied to the antenna.

The amplitude of the electric field strength varies quadratically with the input power. In the case of an internal source, a radio frequency source in direct contact with the body, or a near field source when exposed to an external RF EMF source, there is no fixed relationship between the RF EMF values, the power density and SAR or the internal field values. These exposure values must be assessed on a case-by-case basis. However, lower and upper exposure limits can often be specified. In the case of an external source in the far field of view of the body, there is a fixed relationship between the power density and the electric field strength (S=E2/377).

The literature on the effects of radiofrequency EMF on the general population distinguishes between users and non-users of telecommunications networks. Both categories are susceptible to environmental effects.

Radio frequency electromagnetic fields (RFEMs) emitted by telecommunications networks and other users into the environment.

These sources are often located in an area far from the subject of the photograph. However, users are also exposed to RF emissions emitted by their own devices in an area close to the subject of the photograph.

The aim of fifth-generation (5G) mobile networks is to enable significantly higher mobile broadband speeds and increased data usage. One of the technological changes that should contribute to achieving these goals is the use of additional (higher) frequency bands in the RF-EMF spectrum. The 5G frontier bands defined at EU level are the 700 MHz (694-790 MHz), 3.6 GHz (3.4-3.8 GHz) and 26 GHz (24.25-27.5 GHz) frequency bands (Pujol et al., 2020).

In today's networks, data is transmitted using a fixed wide beam that covers a sector of a cell. One of the goals of 5G networks is to simultaneously serve multiple users on the same carrier frequency using the same base station antenna. This requires improving the signal-to-noise ratio (SNR) and signal-to-interference ratio (SIR) at each user. To increase the SNR using a fixed beam, the total input power to the beam must be increased. This is undesirable and is not a solution to SIR. Therefore, 5G uses new ways to perform DL network transmissions. One of the main approaches that will be used to achieve this goal is the use of adaptive transmissions from base station antenna arrays to transmit DL data to users (Marzetta 2010). In its simplest form, this approach adjusts the phase and amplitude for each antenna array element to achieve the maximum received signal power at the user's device (SNR optimization). As the user moves through the network, these phases and amplitudes adapt to maintain a high SNR. In more complex cases, the phases and amplitudes at the base station elements are chosen to increase the fields at the intended user while simultaneously decreasing those at other users (optimizing SIR and SNR) (Marzetta 2010). When the user is in the line of sight (LOS) of the base station, such array precoding schemes result in a narrow beamforming towards the user (Thors et al., 2017).

When a user is in a low visibility (LOS) zone, this results in an increase in the field strength around the user device (Shikhantsov et al., 2020).

The vast majority of non-human wildlife, vertebrates, invertebrates, and plants do not use wireless technology or networks. Thus, in terms of RF exposure, they are all classified as non-users. In this category, the predominant sources of RF-EMF exposure are long-range sources.

When comparing the effects of RF-EMF on plants and animals, an obvious difference is that plants are stationary and therefore their orientation relative to the RF-EMF base station antennas that make up the network is constant. Plants use RF-EMF to carry out photosynthesis and many have a relatively high surface area to volume ratio to maximize the use of sunlight. This also obviously makes them efficient receptors for other long-range RF-EMF sources such as most RF-EMF sources (Alain Vian et al., 2007). Temporal variations in RF-EMF exposure (plant shutdowns) may occur due to temporary variations in the network and mobile RF users that may occur near the plant when the RF radiation is emitted.

Animal mobility will result in large temporal variations in their exposure to RF radiation, since RF radiation exposure to non-users is spatially variable.
addiction.

While most non-human vertebrates will experience negligible near-field exposure, there are a growing number of wireless technologies that create near-field RF exposure for non-human vertebrates. Radio tracking or radio telemetry is a widely used method for monitoring vertebrates in the wild (White and Garrott 2012; Godfrey 2003; Millspaugh and Marzluff 2001). Dedicated RF-enabled wireless networks have been deployed to track animals in the wild (Panicker, Azman, and Kashyap 2019). There are also a growing number of wireless technologies in agriculture (S. Benaissa et al. 2017; Dlodlo and Kaleji 2015; Said Benaissa et al. 2016).

There are some wireless applications that generate short-range radio frequency radiation on invertebrates.

Entomological radar is a technology that uses the scattering of electromagnetic fields by insects to detect them. In this radar method, a radar emits a pulse of radio frequency radiation in the direction of the insect.

The radiation is then partially reflected off the insect and these reflected fields are received by a radar station. Entomological radar is used to study insect behavior and dispersal (Chapman, Drake, & Reynolds, 2011; Glover et al., 1966; Riley, 1985). Wireless sensor networks exist for monitoring pollinating insects (Edwards-Murphy et al., 2016; Henry et al., 2019; Creedy, de Carvalho, & Gomes, 2016). Some insect telemetry studies are also being conducted (Daniel Kiessling, Pattemore, & Hagen, 2014). This is where the insect is tracked wirelessly by attaching a radio frequency tag to the animal, which sends information to a remote reader.

Wireless communication is a widespread technology that uses radio frequencies (RF) and electromagnetic fields (EMF) to transmit information between users. Wildlife may be exposed to these waves, which partially penetrate biological tissue. These internal fields may have biological effects. The effects of RF EMFs and the interactions between them and organisms will depend on the frequency of the waves. Fifth-generation (5G) wireless telecommunications networks operate in part at new frequencies that are not as common in the environment. These expected changes require a review of the existing literature on the effects of RF radiation on wildlife.

A search of the current literature database in this area revealed that it is divided based on two classifiers. The first is the target group under study: vertebrates, invertebrates, and non-human plants; the second is the frequency of the RF-EMF under study, which is divided into a lower (0.45-6 GHz) and a higher frequency range (6-300 GHz). The first frequency range includes the frequencies at which existing telecommunications networks operate, while the second is the range in which 5G will partially operate. As a result, six categories were identified, which are considered separately.

Dielectric heating due to RF EMF exposure of biological tissue is shown in all categories. This heating causes an increase in the internal temperature of organisms or cells, which in turn leads to biological effects such as the thermoregulatory response. This means that there is always a level of RF power density that causes biological effects called thermal effects.

Uncoupling effects caused by elevated temperatures and the presence of radiofrequency EMFs in biological tissues are major challenges in this area of research.

Many studies are aimed at demonstrating (the absence of) non-thermal effects. These are effects that are caused by exposure to RF EMF but are not related to any changes in temperature. Many other effects of RF EMF exposure are widely studied. However, in all six categories, no effect other than dielectric heating has been studied.

Lower frequency range (0.45-6 GHz)

Vertebrates

In the lower frequency range, in vitro studies on non-human vertebrate cells have shown mixed results regarding cellular genotoxicity and cellular transformation following exposure to RF radiation. Previous reviews on these topics suggest either that the evidence for such effects is weak or that the literature is inconclusive. Regarding non-genotoxic effects of RF EMF exposure, reports suggest that neuronal activity can be altered in vitro by RF EMF exposure. Other cellular effects are either unproven, disputed, or there are insufficient studies to draw any conclusions about such effects.

In vivo studies of RFEMF genotoxicity have shown conflicting results. There is some debate in the literature about whether RFEMF exposure can cause (temporary) changes in blood-brain barrier permeability.

It seems that the most recent studies have failed to demonstrate such effects. There are conflicting results regarding the effects of radiofrequency radiation on the nervous system in vivo. There seems to be a general consensus that animals can hear (pulsed) radiofrequency radiation above a certain threshold, so-called microwave hearing.

However, there is little evidence that telecommunication signals can cause this effect.

Ecological studies of RF EMF exposure and vertebrate behavior have focused primarily on animals: nesting, reproduction, orientation, and abundance near RF sources. There are a limited number of studies that conclude that RF exposure may affect behavior and reproductive function in birds and bats.

Invertebrates

The effects of HF-EMF on invertebrates in the low-frequency range have been studied by several authors.

In addition to heating the dielectric, particular attention is paid to the effects on development, genetics or behavior.

In vitro studies have shown increased neuronal activity in invertebrate neurons. In vivo studies on invertebrates have encountered a number of experimental problems and have yielded inconclusive results for a number of parameters examined. Additional studies of higher quality, in sham-exposed control groups, are needed. Of the limited number of studies that have examined non-insect invertebrates, all have found effects (in in vitro and in vivo). This calls for more research on this topic. Very limited ecological studies focus on invertebrates, and studies of non-insect invertebrates are also underrepresented. These topics require more research in the future.

Plants and mushrooms

It has been shown that dielectric heating of plants in the low frequency range can have a beneficial effect. Such heating can also cause plant mortality at a certain level. At lower levels of RF EMF, however, the literature on plants and fungi provides conflicting results and there are experimental shortcomings. The number of studies and plants studied, especially fungi, is limited compared to animal studies. More research is needed in this area, which should focus on improving the quality of unexposed controls and sham controls, temperature, and exposure monitoring and dosimetry.

Higher frequency range (6 to 300 GHz)

Vertebrates

At higher frequencies, in vitro studies of vertebrate and invertebrate neurons have shown effects of RF exposure on neural activity. In vivo studies in vertebrates have shown that RF exposure to the eye can cause corneal damage and cataracts. Effects on male fertility have also been demonstrated in rodents. There are mixed results on the effects of RF exposure on behavior and abundance in vertebrates. One group has shown that RF exposure can have a hypoallergenic effect in mice. These effects need to be replicated by other groups.

There is some evidence that high-frequency RF-EMF can be used to induce an anti-inflammatory response, up to a certain dose. A limited number of in vivo studies have shown that high-frequency RF-EMF can reduce tumor growth.

Invertebrates

In the same frequency range, neurostimulation in vitro and teratogenic effects in invertebrates have been demonstrated at relatively high frequencies and power densities in vivo. These effects require further study at lower power densities.

The literature on the effects of RF EMF on invertebrates in this frequency range is limited and requires further study.

Plants and mushrooms

The literature on fungi and plants in the high-frequency range is very limited, and at this point no conclusions can be drawn other than the fact of dielectric heating. Further research in this area is needed.

Due to the demand of the times and the rapid development of telecommunication technology, a detailed study of the impact of the fast-growing 5G technology over a long period of time to obtain a comparative analysis of "before" and "after".

The introduction of 5G entails the creation of a large volume of obsolete electronic equipment, the use of more energy. Full deployment of 5G means the construction of towers almost everywhere, including in mountains, forests, to ensure reliable connection. This process can lead to increased radiation for fragile participants in the ecosystem security.

We have birds that will most likely be affected by these towers, and studies have shown that they have produced deformed eggs due to 5G exposure in their habitats. In countries with high 5G coverage, birds are disrupted from breeding, nesting, and roosting by microwave radiation generated by cell towers. Similarly, wireless frequencies affect the rhythm of birds and the navigation system that helps birds during migration. This directly disrupts the ecosystem. Another study shows that the 5G spectrum and mid-band affect the behavior of insects, especially bees. As many telecom operators seek to expand their 5G network coverage to different countries around the world, millions of small towers will likely be installed in the future. The number of towers built per square kilometer will increase significantly to establish a powerful connection and ensure reliable and fast communication between devices. So we expect an unknown impact on the existing environment. The widespread millimeter wave will likely harm plants, vegetation, birds and insects of various species, leading to disruption of the ecosystem.

Despite many concerns about the safety of millimeter waves, telecommunications equipment does not emit destructive ionizing radiation that could damage DNA or affect the development of cancer cells.

Radiation of electromagnetic waves at high frequencies has a different effect on tissues, namely, it heats them up, using more energy on the surface compared to low-frequency waves, while practically not penetrating inside. Only excessive exposure to such radio waves can heat the human body to temperatures incompatible with life or cause local damage, for example, to the skin or eyes."

Also, according to many scientists, the higher the frequency, the less impact on the human body, since waves at high frequencies are reflected and do not penetrate inside.

Despite the lack of strong evidence of the dangers of new technology, it is certainly necessary to continue research into their impact on humans and animals and to support conclusions with strong scientific evidence.

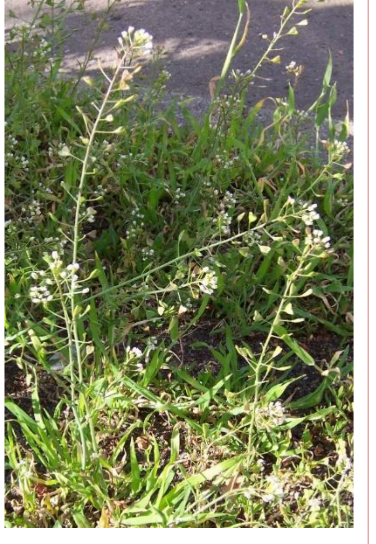
Every daily activity carries a risk, and the issue of electromagnetic radiation from any generation of mobile communications must be considered through the prism of whether we are ready to accept the identified risks.

Over many years of medical research into the effects of electromagnetic waves on humans, no negative factors have been identified, and the evidence presented had no scientific basis. Thus, based on the results of several studies, a conclusion was made about the existence of such a risk, however, when reproducing the study, the results were not confirmed. At the same time, the reproducibility of the results of the study is considered one of the most important criteria for the scientific nature of the conclusions.

There is general agreement that research into both the impact of new technologies and electromagnetic radiation needs to continue, but at this point there is no compelling reason to delay the introduction of these technologies.

Appendix A.

Table H.1 – Taxonomic composition of plant diversity

Latin (scientific name)	Name in the state language	Title in Russian	Known for this area (with indication) source of information)	Found (indication of the time frame for conducting the research)	Quantity	Photo
1	2	3	4	5	6	7
Shymkent city, Turkestan region						
Capsule-pastoral	Қарапайым шопанның сөмкесі	Пастушья сумка обыкновенная	The scientific Latin name is tautological: the generic name is Latin Capsella — a diminutive of capsa — a bag, which characterizes the shape of the fruit; the species epithet is bursa pastoris — literally a shepherd's bag. An annual plant 20-60 cm high with a thin spindle-shaped root. The entire plant is green, usually bare or slightly hairy, especially in the lower part. The hairs are simple and branched. The stem is single, erect, simple or branched. The basal leaves are petiolate, pinnately divided with acute triangular, entire or dentate lobes, string-shaped-notched or entire, collected in a rosette. The stem leaves are alternate, sessile, oblong-lanceolate, entire or notched-dentate, with auricles; the upper leaves are almost linear, with an arrow-	18.07.24 Found	More than 30	

			shaped base. Flowers are regular, four-membered, collected in a raceme, initially umbellate, then lengthening. Sepals are 0.25 cm long, petals are up to 0.35 cm long, obovate, white.			
Medicago sativa	Егістік жоңышқа	Люцерна посевная	Alfalfa grows all over the world as a weed, and is also widely grown as a valuable forage crop. Alfalfa hay contains many vitamins, phosphorus, calcium and up to 20% protein, which is not inferior in quality to the protein of chicken eggs. The plant is an excellent honey plant, its colorless nectar is almost half sugar. In the dark, a slight glow can be seen above the alfalfa fields - this is due to the high phosphorus content in the seeds. https://www.picturethisai.com/ru/wiki/Medicago_sativa.html	18.07.24 Found	More than 20	
Taraxacum officinale	Бақпақ	Одуванчик лекарственный	Dandelion is one of the most beloved plants in folk medicine. There are many ways to use it: medicinal decoctions, powders, salads, jams. It occupies a place of honor in the cultures of many countries. Dandelion drink was made famous by Ray Bradbury in his work "Dandelion Wine". In Rus' they used to say: "A dandelion squeezes a ball - it's	18.07.24 Found	More than 30	

			going to rain." https://www.picturethisai.com/ru/wiki/Taraxacum_officinale.html			
Cichórium	Шашыратқы	Цикорий	It has a long, strong taproot that penetrates deep into the soil. In the first year, a rosette of bright, oblong leaves with a clearly defined main vein appears. The leaves may be rounded at the end or narrowed. A rigid, vertical, deepened stem appears in the second summer. The flowers are ligulate, large, bisexual, usually blue, less often pinkish or white, located on a short individual stalk, extending from the upper part of the leaf. The flowers are in baskets with a double wrapper, the outer leaflets of the wrapper are short, bent, the inner ones are erect. The flowers open sequentially upwards, although in cloudy weather they are often closed. *Brockhaus and Efron Encyclopedic Dictionary : in 86 volumes*	18.07.24 Found	More than 10	
Centauréa	Гүлкекіре	Василёк	Cornflower, or blue cornflower (Centaurea cyanus), with web-like-woolly linear-lanceolate leaves and blue flowers, as a weed, is found mainly in winter grain crops, especially on sandy and loamy soils, and, as an annual plant,	18.07.24 Found	More than 20	

			reproduces by seeds, often sown together with grain crops, when the latter are poorly cleaned, and also found with the inflorescences of this plant in straw taken to the field together with manure. Measures for its destruction consist of liming the soil. *Great Soviet Encyclopedia : [in 30 volumes] / ch. ed. A. M. Prokhorov .*			
*Note: + - species detected; 0 - species not detected						

Table H.2 – Taxonomic composition of invertebrate diversity

Latin (scientific name)	Name in the state language	Title in Russian	Known for this area (with indication) source of information)	Found (indication of the time frame for conducting the research)	Quantity	
1	2	3	4	5	6	
Shymkent city, Turkestan region						
Muschampia cribrellum)	Торлы қалың бас	Толстоголовка решётчатая	The latticed fathead (lat. Muschampia cribrellum) is a butterfly from the fathead family. It develops in one generation per year. The flight time is observed from mid-May to early August. Butterflies fly in circles over areas of flowering vegetation, feeding on the nectar of herbaceous plants such as Veronica, Vicia, Thymus, etc. Males exhibit territorial behavior. Caterpillars feed on	Found	2	

			Potentilla , overwinter . *Czernay A. Verzeichniss der Lepidopteren des Charkowschen, Poltawschen und Ekaterinoslawschen gouvernements // Bull. Soc. Natur. - Moscow, 1854. - Issue. 27. - No. 7. - P. 212-225*			
Saga pedo (Pallas)	Дала кергісі	Дыбка степная	A steppe European-Kazakhstan species. It is widespread in Northern, Central, Southern and South-Eastern Kazakhstan, and the steppe zone of the European part of Russia. It lives in meadow areas, in the floodplains of rivers and streams. It reproduces parthenogenetically, i.e. without the participation of males. *Nurmuratov T.N., Azhbenov V.K., Kambulin V.E. et al. 2000. Locust pests of agricultural plants in Kazakhstan and recommendations for limiting their numbers. Almaty: Asia Publishing. 56 p.*	O discovered	5	
Mongoloraphidia Raphidiidae	Mongoloraphidia түйесі	Верблюдка Mongoloraphidia	A small group of medium-sized insects (15-20 mm) with complete metamorphosis. Camels got their name because of some resemblance in profile to a camel. Camels are moisture-loving, usually associated with woody and shrubby vegetation. Adults live openly on trees, are active in summer. They hunt for dipteran larvae, caterpillars, aphids, and bark beetle larvae. *Aspöck H. The biology of Raphidioptera: A*	Found	2	

			review of present knowledge (English) // Acta Zool. Acad. Sci. Hungaricae : journal. — 2002. — Vol. 48, no. suppl. 2. — P. 35–50. Archived October 27 , 2005 . Archived copy dated October 27 , 2005 on the Wayback Machine			
Красотел сетчатый	Торқанатты барылдауық қоңыз	*Calosoma reticulatum*	The beetle is 20-27 mm long. The head, pronotum and elytra are metallic green, bronze, rarely black with a bronze sheen. The mouth parts, antennae and legs are black. The pronotum and elytra are convex and wide. The pronotum is coarsely wrinkled and punctate. The spaces between the elytra form irregular tubercles, often merging transversely. The primary pits are distinct. *An essay on the reticulated krasotel on the Carabidae of the World website*	Not found		
*Note: + - species detected; 0 - species not detected						

Table H.3 – Taxonomic composition of the diversity of terrestrial vertebrates

Latin (scientific name)	Name in the state language	Title in Russian	Known for this area (with source indicated) information)	Found (indication of the time frame for conducting the research)	Quantity	Note
1	2	3	4	5	6	
Shymkent city, Turkestan region						

Erinaceus europaeus	Кірпі	Обыкнове́нный ёж	The common hedgehog is a small animal . The body length is from 20 to 30 centimeters. Weight is from 700 to 800 grams. The main distinguishing feature of the common hedgehog is the small spines that cover its back and sides. The color of the needles is striped, they grow at the same rate as hair. Adult hedgehogs have 5-6 thousand needles, young ones - about 3 thousand. Small ears are located on the hedgehog's head. Common hedgehogs that live in Cyprus have larger ears. The muzzle is elongated with a sharp and wet nose . The eyes are small, shiny, black. The hedgehog has 36 sharp small teeth. The hedgehog's paws are equipped with five fingers with claws, and the hind legs are longer than the front ones. *Brockhaus and Efron Encyclopedic Dictionary : in 86 volumes (82 volumes and 4 add.). — St. Petersburg, 1890-1907*	Found	More than 3	
Vulpes vulpes	Кәдімгі түлкі	Лиса обыкновенная	fox is a predatory mammal of the canine family, the largest species of the fox genus . The body length reaches almost one meter, the tail is 40-60 cm, and the weight is 6-10 kg. Females are slightly lighter and smaller than males. The fox has large eyes with a vertical pupil, the animal has excellent vision. The animal has forty-two teeth, which can	Not found		

			easily cope with almost any food. The ears of this predator are triangular in shape, slightly elongated and quite large. *<u>Brockhaus and Efron Encyclopedic Dictionary</u> : in 86 volumes (82 volumes and 4 add.). — St. Petersburg, 1890-1907*			
Chlidonias leucopterus	Аққанат қарқылдақ	Белокрылая крачка	In spring the body is black, the wings are light gray on top, and along the front edge from the base to the bend they are white, and this is the main difference from the black tern; from below in flying birds one more difference is visible - a contrasting two-color coloring of the wing. The tail and uppertail are white. The beak is reddish-black, the legs are bright red. The tail is with a shallow notch. In autumn adult birds are mostly white, with a gray bloom on the wings, body, a black spot behind the eye and a dark gray, with light speckles, nape. There are no dark spots on the sides of the chest, unlike the black tern. Young have generally the same coloring of the head, but the back is very dark and rather dark wings, the difference from young black terns is a very light, almost white tail, sharply contrasting with the dark back, the absence of dark spots on the sides of the chest. Weight 53-80 g, length 20-23, wing 20.0-22.4, wingspan 63-67 cm. *Delina, Hakan, Svensson, Lars. Der Kosmos-*	. Not found		

			Vogelatlas, übersetzt von Peter H. Barthel, ISBN 3-7632-4277-5 .			
Yellow-eyed Pigeon	Қоңыр көптер	Бурый голубь	The brown pigeon is a rare nesting migratory bird. It inhabits poplar groves and tugai thickets, or clay faults and old burial grounds on the plains. During migration, it is found in open spaces, mown fields and forest belts. In the spring, it appears in flocks of up to ten birds. At the Chokpak station, brown pigeons were caught during the spring migration from March 24 to May 19. It nests in separate pairs or loose colonies of up to 15-20 pairs. The nest is built in a tree or in a hole in a clay fault. A clutch of 2 eggs occurs from May to mid-July. *Gavrilov E. I. "Fauna and distribution of birds of Kazakhstan". Almaty, 1999.*	08.08.24 Found	More than 50	
*Note: + - species detected; 0 - species not detected						

Table H.4 – Taxonomic composition of the diversity of aquatic invertebrates and fish

Latin (scientific name)	Name in the state language	Title in Russian	Known for this area (with indication) source of information)	Found (indication of the time frame for conducting the research)	Quantity	Note
1	2	3	4	5	6	
Shymkent city, Turkestan region						

No studies have been conducted			
*Note: + - species detected; 0 - species not detected			

Appendix B

Table U.1 – Indicator species of trees and shrubs

Latin name	Kazakh name	Russian name of the species
1	2	3
Shymkent city, Turkestan region		
Quércus róbur.	Кәдімгі емен	Petiolate oak

Table U.2 – Indicator species of herbaceous plants

Latin name	Kazakh name	Russian name of the species
1	2	3
Shymkent city, Turkestan region		
Cichórium	Шашыратқы	Цикорий

Table U.3 – Phenological phases of trees and shrubs, according to observations in 2024 .

View	Date	Swelling of the buds	Bud break	Unfolding of leaves	Flowering, beginning	Flowering, mass	Blooming, end	Ripening, beginning	Ripening, complete	Autumn coloring, beginning	Autumn colours are in full swing	Leaf fall, beginning	Leaf fall, massive	November, the end
1	2	3	4	5	5	6	7	8	9	10	11	12	13	14
Silver birch	-	Mid April	End of April	End of April	End of April	End of April	End of May	**Recorded**	**Recorded**	Mid September	Mid September	Mid September	End of September	Mid October
Shymkent city, Turkestan region														
English oak	-	Mid May	Mid May	Mid May	End of May	End of May	End of May	End of May	End of May	**Recorded**	**Recorded**	Mid September	Mid September	Mid September

Table U.4. - Phenological phases of herbaceous plants, according to observations in 2024 .

View	Emergence of seedlings	Budding	Flowering, beginning	Massive flowering	Blooming, end	Seed maturation, beginning	Seed maturation, complete
1	2	3	4	5	6	7	8
Shymkent city, Turkestan region							
Chicory	Mid May	End of May	Beginning of June	Mid June	End of June	Beginning of July	End of July

Table U.5 – Productivity of trees and shrubs (in points), according to observations in 20-24 .

View	Inspectorate Section 1		Inspector's station 2	
	Yield in points on the phenological site	Yield in points on the plot as a whole	Yield in points on phenological site	Yield in points on the plot in in general
1	2	3	4	5
Shymkent city, Turkestan region				
English oak	2	4	-	-