«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 — A.B Balturin

Almaty, 2024 y.

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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).

JSC Kazakhtelecom (hereinafter referred to as the Company), in order to implement paragraph 17 of Section E of the above-mentioned roadmap, 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).

From July 28 to August 8, 2024, studies were conducted in the city of Almaty. 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 Almaty 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 118 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 - 28 points, for electromagnetic impact - 25 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.

Climate of Almaty – continental , characterized by the influence of pronounced mountain-valley circulation and altitudinal zonation, which is especially evident in the southern part of the city, located directly in the transition zone of the mountain slopes to the plain.

The city's temperature regime is generally much milder than the average for Kazakhstan due to relatively high temperatures in winter. The average long-term air temperature is +10°C, which is significantly higher than in Moscow and Astana . However, due to the high-altitude zonation and location in the heart of the continent, which quickly cools down in winter, Almaty's climate is cooler than that of Tbilisi , Sofia, Barcelona and other Mediterranean cities located on the same 43rd parallel . The average temperature of the coldest month (January) is -4.7°C, the warmest month (July) is +23.8°C. Frosts begin on average on October 14 and end on April 1. Steady frosts last an average of 67 days - from December 19 to February 23. Weather with temperatures above +30°C is observed on average 36 days a year. In the center of Almaty, as in any large city, there is a " heat island " - the contrast in average daily temperature between the northern and southern outskirts of the city is 3.8% and 0.8 ° C during the coldest and 2.2% and 2.6 ° C during the hottest five-day period. Therefore, frosts in the city center begin on average 7 days later and end 3 days earlier than on the northern outskirts. The maximum high air temperature was recorded in the city on July 31 1983 – +43°C.

On average, 600-650 mm of precipitation falls per year , the main maximum falls in April-May, the secondary maximum falls in October-November. The dry period falls in August. The average date of formation of stable snow cover is considered to be November 30, although the time of its appearance fluctuates from November 5 to December 21. The average date of snow melting is March 15 (fluctuates from February 26 to March 29). Fog is observed in the city and its environs 50-70 days a year [1].

Late May snowfalls and sharp but short-term cold snaps are not uncommon for Almaty. For example, over the past 70 years, such snowfalls were recorded on May 30, 1958, May 18, 1966, May 1, 1987, May 13, 1985, May 1, 1989, May 5, 1993, and May 18, 1998. The absolute record for late snowfall in Almaty was June 17. 1987. They usually occur as a result of a short-term nighttime cold spell, followed by an equally sudden warm spell. As a result, a large mass of sticky snow melts quickly, but manages to damage a large number of trees and cause damage to crops.

Most often, the Almaty GMO weather station registers a south-east wind (30%): its stability increases in summer (37%) and decreases in winter (19%). In the flat northern parts of the city, north-west winds are most frequent (22-28% per year). On average, strong winds of 15 m/s or more are observed for 15 days per year.

Table 2.1

Climate of Almaty

Indicator	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov .	Dec.	Year
Absolute maximum, °C	18.2	19.0	28.0	33.2	35.8	39.3	41.7	40.5	38.1	31.1	25.4	19.2	41.7
Average maximum, °C	0.7	2,2	8.7	17.3	22.4	27.5	30.0	29.4	24.2	16.3	8.2	2,3	15.8
Average temperature, °C	-4.7	-3	3.4	11.5	16.6	21.6	23.8	23.0	17.6	9.9	2.7	-2.8	10.0
Average minimum, °C	-8.4	-6.9	-1.1	5.9	11.0	15.8	18.0	16.9	11.5	4.6	-1.3	-6.4	5.0
Absolute minimum, °C	-30.1	-37.7	-24.8	-10.9	-7	2.0	7.3	4.7	-3	-11.9	-34.1	-31.8	-37.7
Precipitation rate, mm	34	43	75	107	106	57	47	30	27	60	56	42	684

Table 2.2

Climate of Astana (350m) over the last 10 years (2013 - 2023)

Indicator	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov .	Dec.	Year
Absolute maximum, °C	3.8	8.2	20.4	29.0	33.2	37.6	38.2	38.2	36.1	25.7	13.6	2.8	38.2
Average maximum, °C	0.3	1.5	10.5	17.9	23.2	28.0	30.9	29.7	24.4	16.6	7.2	1.4	16.0
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
Absolute minimum, °C	-38.2	-39.3	-28.6	-17.4	-2.1	2.5	6.1	2.9	-4	-13.9	-29.2	-40.6	-40.6

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:

- 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, about 37% of premature deaths associated with 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 policymakers 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 (NO) 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 – Almaty.

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 and in the air of the working area was carried out using the GANK-4 gas analyzer, which has a valid verification certificate. (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	**Almaty, Yesenova st. 23/7**	Residential area, South	33	26	756	0.0452	0.0155	<0.025	0,0741	2.89
2		Residential area, North	33	26	756	0.0435	0,0174	<0.025	0.0653	2.65
3		Residential area, East	33	26	756	0.0457	0,0159	<0.025	0.0548	3.07
4		Residential area, West	33	26	756	0.0428	0,0142	<0.025	0,0727	3.15
5	**Almaty, Yesenova st. 23/7**	Telecommunication equipment	33	26	756	0.0264	0,0125	<0.025	0.0548	1.98
6	**Almaty, Ermak st. 17**	Residential area, South	36	30	752	0.0382	0,0202	<0.025	0.0652	2.14
7		Residential area, North	36	30	752	0.0335	0,0194	<0.025	0.0587	2.63

8		Residential area, East	36	30	752	0,0405	0,0173	<0.025	0.0649	2.81
9		Residential area, West	36	30	752	0.0351	0.0215	<0.025	0.0554	2.45
10	**Almaty, Ermak st. 17**	Telecommunication equipment	36	30	752	0.0334	0,0167	<0.025	0.0431	2.17
11	**Almaty, Panfilov st., 129**	Residential area, South	33	26	756	0.0367	0.0255	<0.025	0.0552	3.15
12		Residential area, North	33	26	756	0,0421	0.0195	<0.025	0,0671	2.74
13		Residential area, East	33	26	756	0.0352	0.0214	<0.025	0.0623	2.46
14		Residential area, West	33	26	756	0.0391	0,0185	<0.025	0.0584	2.48
15	**Almaty, Panfilov st., 129**	DGA	33	26	756	0.0257	0.0215	<0.025	0,0412	2.12
16		Precision air conditioners	33	26	756	0.0253	0,0168	<0.025	0.0397	2.43
17		CDMA800	33	26	756	0,0241	0,0152	<0.025	0,0461	2.14
18	**Almaty, st. Tchaikovsky, 39-39A/113**	Residential area, South	36	30	752	0.0291	0.0195	<0.025	0.0415	1.95
19		Residential area, North	36	30	752	0.0253	0,0167	<0.025	0.0375	2.43
20		Residential area, East	36	30	752	0,0237	0,0172	<0.025	0,0419	2.11
21		Residential area, West	36	30	752	0.0255	0,0179	<0.025	0,0403	2.26
22	**Almaty, st. Tchaikovsky, 39-39A/113**	RAC6610 Room/study (3rd floor)	36	30	752	0,0211	0,0138	<0.025	0.0352	1.72
23	**Almaty, st. Furmanova, 240-A, B**	Residential area, South	36	30	752	0.0415	0.0294	<0.025	0.0588	2.13
24		Residential area, North	36	30	752	0.0422	0.0265	<0.025	0.061	2.56
25		Residential area, East	36	30	752	0.0367	0.0243	<0.025	0.0584	2.37
26		Residential area, West	36	30	752	0.0359	0,0841	<0.025	0.0572	2.29
27	**Almaty, st. Furmanova, 240-A, B**	Telecommunication equipment	36	30	752	0,0216	0,0185	<0.025	0.0337	1.95
28	**Almaty, st. Tchaikovsky, 39**	Residential area, South	36	30	752	0.0264	0,0185	<0.025	0,0412	1.92
29		Residential area, North	36	30	752	0,0237	0,0161	<0.025	0.0392	2.14
30		Residential area, East	36	30	752	0,0244	0,0168	<0.025	0,0401	2.05
31		Residential area, West	36	30	752	0.0232	0,0177	<0.025	0.0422	2.21
32	**Almaty, st. Tchaikovsky, 39**	RAC6610 Room/study (2nd floor)	36	30	752	0,0216	0,0143	<0.025	0,0317	1.85

33	**Almaty, Panfilov st. 72/74**	Residential area, South	33	26	756	0,0482	0.0291	<0.025	0.0752	2.45
34		Residential area, North	33	26	756	0,0476	0.0257	<0.025	0,0741	2.22
35		Residential area, East	33	26	756	0.0429	0.0266	<0.025	0.0773	2.19
36		Residential area, West	33	26	756	0.0455	0.0258	<0.025	0.0728	2.47
37	**Almaty, Panfilov st. 72/74**	Air conditioner Liebert Hirros HIMOD S17UA (4 pcs)	33	26	756	0,0212	0,0146	<0.025	0.0315	2.02
38		Diesel generator	33	26	756	0.0579	0.0455	0.0814	0.0588	3.49
39	**Almaty, Al-Farabi Ave., 134**	Residential area, South	36	30	752	0,0411	0.0364	<0.025	0.0715	2.44
40		Residential area, North	36	30	752	0.0385	0.0428	<0.025	0,0708	2.16
41		Residential area, East	36	30	752	0.0392	0,0406	<0.025	0.0685	2.83
42		Residential area, West	36	30	752	0.0359	0.0391	<0.025	0.0742	3.12
43	**Almaty, Al-Farabi Ave., 134**	Telecommunication equipment	36	30	752	0,0317	0,0196	<0.025	0,0472	1.83
44	**Almaty, Medeu district, st. Divaeva, 39**	Residential area, South	36	30	752	0,0437	0,0185	<0.025	0.0722	2.41
45		Residential area, North	36	30	752	0.0285	0,0194	<0.025	0.0684	2.35
46		Residential area, East	36	30	752	0.0363	0,0211	<0.025	0,0648	2.53
47		Residential area, West	36	30	752	0,0412	0,0173	<0.025	0.0725	2.18
48	**Almaty, Medeu district, st. Divaeva, 39**	Telecommunication equipment	36	30	752	0.0325	0,0144	<0.025	0,0611	1.85
49	**Almaty, microdistrict. Koktem 3, 21b**	Residential area, South	36	30	752	0.0531	0.0247	<0.025	0.0628	2.44
50		Residential area, North	36	30	752	0.0557	0.0251	<0.025	0.0681	2.39
51		Residential area, East	36	30	752	0.0582	0.0312	<0.025	0.0615	2.73
52		Residential area, West	36	30	752	0,0489	0.0346	<0.025	0.0633	2.19
53	**Almaty, microdistrict. Koktem 3, 21b**	Telecommunication equipment	36	30	752	0.0394	0,0158	<0.025	0,0418	1.92
54	**Almaty, st. 2nd Goncharnaya 145 A Base**	Residential area, South	33	26	756	0,0442	0.0255	<0.025	0.0492	2.18
55		Residential area, North	33	26	756	0,0403	0.0239	<0.025	0.0566	2.75
56		Residential area, East	33	26	756	0.0415	0.0247	<0.025	0.0514	2.18

57	**"Almatykomplekt"**	Residential area, West	33	26	756	0.0431	0,0209	<0.025	0.0529	2.43
58	**Almaty, st. 2nd Goncharnaya 145 A Base "Almatykomplekt"**	Telecommunication equipment	33	26	756	0.0319	0,0172	<0.025	0,0446	2.16
59	**Almaty, Dzhumaliev st., 108**	Residential area, South	36	30	752	0.0364	0,0203	<0.025	0.0386	1.84
60		Residential area, North	36	30	752	0.0335	0,0212	<0.025	0.0415	1.96
61		Residential area, East	36	30	752	0.0347	0.0226	<0.025	0.0375	2.08
62		Residential area, West	36	30	752	0.0349	0,0204	<0.025	0,0403	2.16
63	**Almaty, st. Dzhumalieva, 108**	RAC6610 Room/study (3rd floor)	36	30	752	0.0353	0,0186	<0.025	0.0255	1.67
64	**Almaty, st. Beisebaeva 47**	Residential area, South	36	30	752	0.0415	0,0194	<0.025	0.0518	2.15
65		Residential area, North	36	30	752	0,0402	0,0172	<0.025	0.0544	2.46
66		Residential area, East	36	30	752	0.0394	0,0212	<0.025	0.0511	2.05
67		Residential area, West	36	30	752	0.0388	0,0203	<0.025	0,0486	2.43
68	**Almaty, st. Beisebaeva 47**	CDMA800 Container	36	30	752	0.0321	0,0196	<0.025	0.0345	1.85
69	**Almaty, Shemyakin st. 55**	Residential area, South	33	26	756	0.0469	0,0194	<0.025	0.0621	2.34
70		Residential area, North	33	26	756	0.0391	0,0173	<0.025	0.0594	2.59
71		Residential area, East	33	26	756	0.0457	0,0185	<0.025	0.0615	2.41
72		Residential area, West	33	26	756	0.0452	0,0169	<0.025	0.0638	2.25
73	**Almaty, Shemyakin st. 55**	CDMA800 Room/office (1st floor)	33	26	756	0,0306	0.0153	<0.025	0.0322	1.79
74	**Almaty, Kyzybaeva st. 9**	Residential area, South	33	26	756	0,0472	0.0264	<0.025	0.0618	2.15
75		Residential area, North	33	26	756	0,0489	0.0228	<0.025	0,0627	2.44
76		Residential area, East	33	26	756	0.0521	0.0275	<0.025	0.0634	2.38
77		Residential area, West	33	26	756	0.0547	0.0249	<0.025	0.0551	1.94
78	**Almaty, Kyzybaeva st. 9**	Telecommunication equipment	33	26	756	0.0395	0.0224	<0.025	0.0318	1.62
79		Residential area, South	33	26	756	0,0442	0.0225	<0.025	0.0567	2.11

80	**Almaty, Ahan Sulfur St. 150a**	Residential area, North	33	26	756	0.0518	0.0264	<0.025	0.0553	2.32
81		Residential area, East	33	26	756	0.0493	0.0271	<0.025	0.0549	2.17
82		Residential area, West	33	26	756	0.0456	0.0228	<0.025	0.0582	2.19
83	**Almaty, Ahan Sulfur St. 150a**	Telecommunication equipment	33	26	756	0.0326	0,0204	<0.025	0.0371	1.83
84	**Almaty, Ospanova st. 160**	Residential area, South	33	26	756	0,0441	0.0223	<0.025	0.0518	1.85
85		Residential area, North	33	26	756	0,0449	0.0215	<0.025	0.0512	1.95
86		Residential area, East	33	26	756	0,04,62	0.0248	<0.025	0.0522	1.79
87		Residential area, West	33	26	756	0.0433	0.0261	<0.025	0.0546	2.05
88	**Almaty, st. Ospanova 160**	Telecommunication equipment	33	26	756	0.0425	0,0178	<0.025	0.0429	1.65
89	**Almaty, microdistrict. Taugul 19**	Residential area, South	36	30	752	0.0392	0,0142	<0.025	0.0415	2.36
90		Residential area, North	36	30	752	0.0355	0,0156	<0.025	0,0443	2.51
91		Residential area, East	36	30	752	0,0361	0,0159	<0.025	0.0451	248
92		Residential area, West	36	30	752	0.0348	0,0164	<0.025	0.0397	2.11
93	**Almaty, microdistrict. Taugul 19**	Digital TV room (part of the first floor) - Telecommunication equipment	36	30	752	0.0349	0,0183	<0.025	0.0323	1.74
94	**Almaty, Kazakhfilm microdistrict, bldg.37, room 45**	Residential area, South	33	26	756	0.0399	0.0221	<0.025	0.0518	2.26
95		Residential area, North	33	26	756	0.0385	0,0217	<0.025	0.0556	2.43
96		Residential area, East	33	26	756	0.0387	0.0219	<0.025	0.0543	2.57
97		Residential area, West	33	26	756	0.0394	0.0233	<0.025	0.0525	2.19
98	**Almaty, Kazakhfilm microdistrict, bldg.37, room 45**	Telecommunication equipment	33	26	756	0.0452	0,0185	<0.025	0.0511	1.73
99	**Almaty, Alatau village, Kayipov st., 5**	Residential area, South	36	30	752	0.0385	0.0154	<0.025	0.0511	1.86
100		Residential area, North	36	30	752	0,0401	0,0129	<0.025	0,0482	1.92
101		Residential area, East	36	30	752	0,0409	0,0183	<0.025	0.0479	1.78
102		Residential area, West	36	30	752	0.0392	0,0172	<0.025	0,0505	1.85
103	**Almaty, Alatau**	Telecommunication equipment	36	30	752	0.0333	0.0199	<0.025	0.0374	1.65

	village, Kayipov st., 5									
104	**Almaty, Bostandyk district, st. Bayzakova, 303**	Residential area, South	36	30	752	0,0482	0.0195	<0.025	0.0572	2.19
105		Residential area, North	36	30	752	0.0435	0,0186	<0.025	0.0556	2.27
106		Residential area, East	36	30	752	0.0469	0,0175	<0.025	0.0549	2.34
107		Residential area, West	36	30	752	0.0392	0,0207	<0.025	0.0528	2.22
108	**Almaty, Bostandyk district, st. Bayzakova, 303**	5G Antennas	36	30	752	0.0351	0,0186	<0.025	0.0415	1.95
109	**Almaty, Medeu district, Abay Ave., 4**	Residential area, South	36	30	752	0.0552	0.0225	<0.025	0,0467	2.42
110		Residential area, North	36	30	752	0.0573	0,0237	<0.025	0.0502	1.95
111		Residential area, East	36	30	752	0.0556	0.0233	<0.025	0,0507	2.23
112		Residential area, West	36	30	752	0.0544	0,0241	<0.025	0.0511	2.19
113	**Almaty, Medeu district, Abay Ave., 4**	5G Antennas	36	30	752	0,0317	0,0173	<0.025	0.0368	1.85
114	**Almaty, Almaly district, st. Kurmangazy, 48A**	Residential area, South	36	30	752	0.0332	0,0185	<0.025	0.0591	1.87
115		Residential area, North	36	30	752	0.0339	0,0189	<0.025	0.0625	1.59
116		Residential area, East	36	30	752	0.0334	0,0194	<0.025	0,0611	1.74
117		Residential area, West	36	30	752	0.0348	0,0193	<0.025	0.0584	1.96
118	**Almaty, Almaly district, st. Kurmangazy, 48A**	5G Antennas	36	30	752	0.0288	0,0145	<0.025	0.0389	1.73

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.
Almaty , Yesenova street 23/7

Photo 4.2.
Almaty, st. Furmanova, 240-A, B

Table 4.1.

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

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
1.	Almaty , Yesenova street 23/7 (Residential zone, South)	Nitrogen dioxide	0.0452	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0155	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	<0.025	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.89	5	0.47	0.66	0.779	
2.	Almaty , Yesenova street 23/7 (Residential zone, North)	Nitrogen dioxide	0.0435	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0174	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0653	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.65	5	0.47	0.66	0.779	
3.	Almaty , Yesenova street 23/7 (Residential zone, East)	Nitrogen dioxide	0.0457	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0159	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0548	0.5	0.03	0.05	0.02	
		Carbon monoxide	3.07	5	0.47	0.66	0.779	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
4.	Almaty , Yesenova street 23/7 (Residential zone, West)	Nitrogen dioxide	0.0428	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0142	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0727	0.5	0.03	0.05	0.02	
		Carbon monoxide	3.15	5	0.47	0.66	0.779	
5.	Almaty , Yesenova st. 23/7 (Telecommunication equipment)	Nitrogen dioxide	0.0264	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0125	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0548	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.98	5	0.47	0.66	0.779	
6.	Almaty , Ermak street 17 (Residential area, South)	Nitrogen dioxide	0.0382	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0202	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0652	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.14	5	0.47	0.66	0.779	
7.	Almaty , st. Ermaka 17 (Residential zone, North)	Nitrogen dioxide	0.0335	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0194	0.4	0.04	0.05	0.027	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0587	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.63	5	0.47	0.66	0.779	
8.	Almaty , Ermak street 17 (Residential area, East)	Nitrogen dioxide	0,0405	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0173	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0649	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.81	5	0.47	0.66	0.779	
9.	Almaty , Ermak street 17 (Residential area, West)	Nitrogen dioxide	0.0351	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0215	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0554	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.45	5	0.47	0.66	0.779	
10.	Almaty , Ermak st. 17 (Telecommunication equipment)	Nitrogen dioxide	0.0334	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0167	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0431	0.5	0.03	0.05	0.02	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon monoxide	2.17	5	0.47	0.66	0.779	
11.	Almaty , Panfilov St. , 129 (Residential zone, South)	Nitrogen dioxide	0.0367	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0255	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0552	0.5	0.03	0.05	0.02	
		Carbon monoxide	3.15	5	0.47	0.66	0.779	
12.	Almaty , Panfilov St. , 129 (Residential zone, North)	Nitrogen dioxide	0,0421	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0195	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0671	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.74	5	0.47	0.66	0.779	
13.	Almaty , Panfilov St. , 129 (Residential zone, East)	Nitrogen dioxide	0.0352	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0214	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0623	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.46	5	0.47	0.66	0.779	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
14.	Almaty , Panfilov St. , 129 (Residential zone, West)	Nitrogen dioxide	0.0391	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0185	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0584	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.48	5	0.47	0.66	0.779	
15.	Almaty , Panfilov St. , 129 (DGA)	Nitrogen dioxide	0.0257	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0215	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0412	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.12	5	0.47	0.66	0.779	
16.	Almaty , Panfilov st. , 129 (Precision air conditioners)	Nitrogen dioxide	0.0253	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0168	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0397	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.43	5	0.47	0.66	0.779	
17.	Almaty , Panfilov St. , 129 (CDMA800)	Nitrogen dioxide	0,0241	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0152	0.4	0.04	0.05	0.027	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0461	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.14	5	0.47	0.66	0.779	
18.	Almaty, st. Tchaikovsky, building 39-39A/113 (Residential zone, South)	Nitrogen dioxide	0.0291	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0195	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0415	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.95	5	0.47	0.66	0.779	
19.	Almaty, st. Tchaikovsky, house 39-39A/113 (Residential zone, North)	Nitrogen dioxide	0.0253	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0167	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0375	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.43	5	0.47	0.66	0.779	
20.	Almaty, st. Tchaikovsky, building 39-39A/113 (Residential zone, East)	Nitrogen dioxide	0,0237	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0172	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0419	0.5	0.03	0.05	0.02	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon monoxide	2.11	5	0.47	0.66	0.779	
21.	Almaty, Tchaikovsky street, house 39-39A/113 (Residential area, West)	Nitrogen dioxide	0.0255	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0179	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0403	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.26	5	0.47	0.66	0.779	
22.	Almaty, st. Tchaikovsky, building 39-39A/113 (RAC6610 Room/office (3rd floor))	Nitrogen dioxide	0,0211	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0138	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0352	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.72	5	0.47	0.66	0.779	
23.	Almaty, st. Furmanova, 240-A, B (Residential zone, South)	Nitrogen dioxide	0.0415	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0294	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0588	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.13	5	0.47	0.66	0.779	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
24.	Almaty, st. Furmanova, 240-A, B (Residential zone, North)	Nitrogen dioxide	0.0422	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0265	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.061	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.56	5	0.47	0.66	0.779	
25.	Almaty, st. Furmanova, 240-A, B (Residential zone, East)	Nitrogen dioxide	0.0367	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0243	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0584	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.37	5	0.47	0.66	0.779	
26.	Almaty, st. Furmanova, 240-A, B (Residential zone, West)	Nitrogen dioxide	0.0359	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0841	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0572	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.29	5	0.47	0.66	0.779	
27.	RK, Almaty, Furmanov st., 240-A, B	Nitrogen dioxide	0,0216	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0185	0.4	0.04	0.05	0.027	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
	(Telecommunication equipment)	Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0337	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.95	5	0.47	0.66	0.779	
28.	Almaty, st. Tchaikovskogo, building 39 (Residential zone, South)	Nitrogen dioxide	0.0264	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0185	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0412	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.92	5	0.47	0.66	0.779	
29.	Almaty, st. Tchaikovskogo, building 39 (Residential zone, North)	Nitrogen dioxide	0,0237	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0161	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0392	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.14	5	0.47	0.66	0.779	
30.	Almaty, st. Tchaikovsky, building 39 (Residential zone, East)	Nitrogen dioxide	0,0244	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0168	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0401	0.5	0.03	0.05	0.02	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon monoxide	2.05	5	0.47	0.66	0.779	
31.	Almaty, st. Tchaikovskogo, building 39 (Residential zone, North)	Nitrogen dioxide	0.0232	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0177	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0422	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.21	5	0.47	0.66	0.779	
32.	RK, Almaty, st. Tchaikovsky, building 39 (RAC6610 Room/office (2nd floor))	Nitrogen dioxide	0,0216	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0143	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0317	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.85	5	0.47	0.66	0.779	
33.	Almaty , Panfilov street 72/74 (Residential zone, South)	Nitrogen dioxide	0,0482	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0291	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0752	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.45	5	0.47	0.66	0.779	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
34.	Almaty , Panfilov street 72/74 (Residential zone, North)	Nitrogen dioxide	0,0476	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0257	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0741	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.22	5	0.47	0.66	0.779	
35.	Almaty , Panfilov street 72/74 (Residential zone, East)	Nitrogen dioxide	0.0429	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0266	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0773	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.19	5	0.47	0.66	0.779	
36.	Almaty , Panfilov street 72/74 (Residential zone, West)	Nitrogen dioxide	0.0455	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0258	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0728	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.47	5	0.47	0.66	0.779	
37.	Almaty , Panfilov st. 72/74 (Air conditioner Liebert	Nitrogen dioxide	0,0212	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0146	0.4	0.04	0.05	0.027	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
	Hirros HIMOD S17UA (4 pcs))	Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0315	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.02	5	0.47	0.66	0.779	
38.	Almaty , Panfilov St. 72/74 (Diesel generator)	Nitrogen dioxide	0.0579	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0455	0.4	0.04	0.05	0.027	
		Carbon (soot)	0.0814	0.15	-	-	-	
		Sulfur dioxide	0.0588	0.5	0.03	0.05	0.02	
		Carbon monoxide	3.49	5	0.47	0.66	0.779	
39.	Almaty , Al-Farabi Ave., 134 (Residential zone, South)	Nitrogen dioxide	0,0411	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0364	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0715	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.44	5	0.47	0.66	0.779	
40.	Almaty , Al-Farabi Ave., 134 (Residential zone, North)	Nitrogen dioxide	0.0385	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0428	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0708	0.5	0.03	0.05	0.02	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon monoxide	2.16	5	0.47	0.66	0.779	
41.	Almaty , Al-Farabi Ave., 134 (Residential zone, East)	Nitrogen dioxide	0.0392	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0406	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0685	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.83	5	0.47	0.66	0.779	
42.	Almaty , Al-Farabi Ave., 134 (Residential zone, West)	Nitrogen dioxide	0.0359	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0391	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0742	0.5	0.03	0.05	0.02	
		Carbon monoxide	3.12	5	0.47	0.66	0.779	
43.	Almaty , Al-Farabi Ave., 134 (Telecommunication equipment)	Nitrogen dioxide	0,0317	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0196	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0472	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.83	5	0.47	0.66	0.779	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
44.	Almaty, Medeu district, st. Divaeva , 39 (Residential zone, South)	Nitrogen dioxide	0,0437	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0185	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0722	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.41	5	0.47	0.66	0.779	
45.	Almaty, Medeu district, st. Divaeva , 39 (Residential zone, North)	Nitrogen dioxide	0.0285	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0194	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0684	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.35	5	0.47	0.66	0.779	
46.	Almaty, Medeu district, st. Divaeva , 39 (Residential zone, East)	Nitrogen dioxide	0.0363	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0211	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0648	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.53	5	0.47	0.66	0.779	
47.		Nitrogen dioxide	0,0412	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0173	0.4	0.04	0.05	0.027	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
	Almaty, Medeu district, st. Divaeva , 39 (Residential zone, West)	Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0725	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.18	5	0.47	0.66	0.779	
48.	Almaty, Medeu district, Divaeva street , 39 (Telecommunication equipment)	Nitrogen dioxide	0.0325	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0144	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0611	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.85	5	0.47	0.66	0.779	
49.	Almaty, microdistrict . Koktem 3, building 21b (Residential zone, South)	Nitrogen dioxide	0.0531	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0247	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0628	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.44	5	0.47	0.66	0.779	
50.	Almaty, microdistrict . Koktem 3, building 21b (Residential zone, North)	Nitrogen dioxide	0.0557	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0251	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0681	0.5	0.03	0.05	0.02	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon monoxide	2.39	5	0.47	0.66	0.779	
51.	Almaty, microdistrict . Koktem 3, building 21b (Residential zone, East)	Nitrogen dioxide	0.0582	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0312	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0615	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.73	5	0.47	0.66	0.779	
52.	Almaty, microdistrict . Koktem 3, building 21b (Residential zone, West)	Nitrogen dioxide	0,0489	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0346	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0633	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.19	5	0.47	0.66	0.779	
53.	Almaty, microdistrict Koktem 3, house 21b (Telecommunication equipment)	Nitrogen dioxide	0.0394	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0158	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0418	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.92	5	0.47	0.66	0.779	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
54.	Almaty, st. 2nd Goncharnaya 145 A Base " Almatykomplekt " (Residential zone, South)	Nitrogen dioxide	0,0442	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0255	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0492	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.18	5	0.47	0.66	0.779	
55.	Almaty, st. 2nd Goncharnaya 145 A Base " Almatykomplekt " (Residential zone, North)	Nitrogen dioxide	0,0403	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0239	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0566	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.75	5	0.47	0.66	0.779	
56.	Almaty, st. 2nd Goncharnaya 145 A Base " Almatykomplekt " (Residential zone, East)	Nitrogen dioxide	0.0415	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0247	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0514	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.18	5	0.47	0.66	0.779	
57.	Almaty, st. 2nd Goncharnaya 145 A Base	Nitrogen dioxide	0.0431	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0209	0.4	0.04	0.05	0.027	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
	" Almatykomplekt " (Residential zone, West)	Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0529	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.43	5	0.47	0.66	0.779	
58.	Almaty, 2-ya Goncharnaya st. 145 A Base " Almatykomplekt " (Telecommunication equipment)	Nitrogen dioxide	0.0319	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0172	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0446	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.16	5	0.47	0.66	0.779	
59.	Almaty , Dzhumaliev St. , 108 (Residential zone, South)	Nitrogen dioxide	0.0364	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0203	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0386	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.84	5	0.47	0.66	0.779	
60.	Almaty , Dzhumaliev St. , 108 (Residential zone, North)	Nitrogen dioxide	0.0335	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0212	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0415	0.5	0.03	0.05	0.02	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon monoxide	1.96	5	0.47	0.66	0.779	
61.	Almaty , Dzhumaliev St. , 108 (Residential zone, East)	Nitrogen dioxide	0.0347	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0226	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0375	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.08	5	0.47	0.66	0.779	
62.	Almaty , Dzhumaliev St. , 108 (Residential zone, West)	Nitrogen dioxide	0.0349	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0204	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0403	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.16	5	0.47	0.66	0.779	
63.	Almaty , st. Dzhumalieva , 108 (RAC6610 Room/office (3rd floor))	Nitrogen dioxide	0.0353	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0186	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0255	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.67	5	0.47	0.66	0.779	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
64.	Almaty , st. Beisebaeva 47 (Residential zone, South)	Nitrogen dioxide	0.0415	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0194	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0518	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.15	5	0.47	0.66	0.779	
65.	Almaty , st. Beisebaeva 47 (Residential zone, North)	Nitrogen dioxide	0,0402	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0172	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0544	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.46	5	0.47	0.66	0.779	
66.	Almaty , st. Beisebaeva 47 (Residential zone, East)	Nitrogen dioxide	0.0394	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0212	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0511	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.05	5	0.47	0.66	0.779	
67.	Almaty , st. Beisebaeva 47 (Residential zone, West)	Nitrogen dioxide	0.0388	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0203	0.4	0.04	0.05	0.027	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0486	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.43	5	0.47	0.66	0.779	
68.	Almaty , st. Beisebaeva 47 (CDMA800 Container)	Nitrogen dioxide	0.0321	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0196	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0345	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.85	5	0.47	0.66	0.779	
69.	Almaty , Shemyakin st. 55 (Residential zone, South)	Nitrogen dioxide	0.0469	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0194	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0621	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.34	5	0.47	0.66	0.779	
70.	Almaty , Shemyakin st. 55 (Residential zone, North)	Nitrogen dioxide	0.0391	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0173	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0594	0.5	0.03	0.05	0.02	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon monoxide	2.59	5	0.47	0.66	0.779	
71.	Almaty , Shemyakin st. 55 (Residential zone, East)	Nitrogen dioxide	0.0457	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0185	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0615	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.41	5	0.47	0.66	0.779	
72.	Almaty , Shemyakin st. 55 (Residential zone, West)	Nitrogen dioxide	0.0452	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0169	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0638	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.25	5	0.47	0.66	0.779	
73.	Almaty , Shemyakin st. 55 (CDMA800 Room/office (1st floor))	Nitrogen dioxide	0,0306	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0153	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0322	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.79	5	0.47	0.66	0.779	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
74.	Almaty , Kyzybaeva st. 9 (Residential zone, South)	Nitrogen dioxide	0,0472	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0264	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0618	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.15	5	0.47	0.66	0.779	
75.	Almaty , Kyzybaeva st. 9 (Residential zone, North)	Nitrogen dioxide	0,0489	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0228	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0627	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.44	5	0.47	0.66	0.779	
76.	Almaty , Kyzybaeva st. 9 (Residential zone, East)	Nitrogen dioxide	0.0521	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0275	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0634	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.38	5	0.47	0.66	0.779	
77.	Almaty , Kyzybaeva st. 9 (Residential zone, West)	Nitrogen dioxide	0.0547	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0249	0.4	0.04	0.05	0.027	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0551	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.94	5	0.47	0.66	0.779	
78.	Almaty , Kyzybaeva st. 9 (Telecommunication equipment)	Nitrogen dioxide	0.0395	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0224	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0318	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.62	5	0.47	0.66	0.779	
79.	Almaty , Ahan Sery St. 150a (Residential zone, South)	Nitrogen dioxide	0,0442	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0225	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0567	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.11	5	0.47	0.66	0.779	
80.	Almaty , Ahan Sery St. 150a (Residential zone, North)	Nitrogen dioxide	0.0518	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0264	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0553	0.5	0.03	0.05	0.02	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon monoxide	2.32	5	0.47	0.66	0.779	
81.	Almaty , Ahan Sery St. 150a (Residential zone, East)	Nitrogen dioxide	0.0493	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0271	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0549	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.17	5	0.47	0.66	0.779	
82.	Almaty , Ahan Sery St. 150a (Residential zone, West)	Nitrogen dioxide	0.0456	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0228	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0582	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.19	5	0.47	0.66	0.779	
83.	Almaty , Akhan Sery St. 150a (Telecommunication equipment)	Nitrogen dioxide	0.0326	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0204	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0371	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.83	5	0.47	0.66	0.779	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
84.	Almaty , Ospanova str. 160 (Residential zone, South)	Nitrogen dioxide	0,0441	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0223	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0518	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.85	5	0.47	0.66	0.779	
85.	Almaty , Ospanova street 160 (Residential zone, North)	Nitrogen dioxide	0,0449	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0215	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0512	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.95	5	0.47	0.66	0.779	
86.	Almaty , Ospanova str. 160 (Residential zone, East)	Nitrogen dioxide	0,0462	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0248	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0522	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.79	5	0.47	0.66	0.779	
87.	Almaty , Ospanova str. 160 (Residential zone, West)	Nitrogen dioxide	0.0433	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0261	0.4	0.04	0.05	0.027	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0546	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.05	5	0.47	0.66	0.779	
88.	Almaty , Ospanova st. 160 (Telecommunication equipment)	Nitrogen dioxide	0.0425	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0178	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0429	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.65	5	0.47	0.66	0.779	
89.	Almaty, microdistrict . Taugul 19 (Residential zone, South)	Nitrogen dioxide	0.0392	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0142	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0415	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.36	5	0.47	0.66	0.779	
90.	Almaty, microdistrict . Taugul 19 (Residential zone, North)	Nitrogen dioxide	0.0355	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0156	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0443	0.5	0.03	0.05	0.02	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon monoxide	2.51	5	0.47	0.66	0.779	
91.	Almaty, microdistrict . Taugul 19 (Residential zone, East)	Nitrogen dioxide	0,0361	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0159	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0451	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.48	5	0.47	0.66	0.779	
92.	Almaty, microdistrict . Taugul 19 (Residential zone, West)	Nitrogen dioxide	0.0348	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0164	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0397	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.11	5	0.47	0.66	0.779	
93.	Almaty, Taugul microdistrict , 19 (Digital premises) tv (part of the first floor) - Telecommunication equipment)	Nitrogen dioxide	0.0349	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0183	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0323	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.74	5	0.47	0.66	0.779	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
94.	Almaty , Kazakhfilm microdistrict , building 37, office 45 (Residential area, South)	Nitrogen dioxide	0.0399	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0221	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0518	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.26	5	0.47	0.66	0.779	
95.	Almaty , microdistrict Kazakhfilm , no. 37, room 45 (Residential zone, North)	Nitrogen dioxide	0.0385	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0217	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0556	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.43	5	0.47	0.66	0.779	
96.	Almaty , Kazakhfilm microdistrict , building 37, office 45 (Residential area, East)	Nitrogen dioxide	0.0387	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0219	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0543	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.57	5	0.47	0.66	0.779	
97.	Almaty , Kazakhfilm microdistrict , building 37,	Nitrogen dioxide	0.0394	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0233	0.4	0.04	0.05	0.027	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
	office 45 (Residential area, West)	Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0525	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.19	5	0.47	0.66	0.779	
98.	Almaty , Kazakhfilm microdistrict , bldg.37, pom.45 (Telecommunication equipment)	Nitrogen dioxide	0.0452	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0185	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0511	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.73	5	0.47	0.66	0.779	
99.	Almaty , Alatau village , Kayipov st. , 5 (Residential zone, South)	Nitrogen dioxide	0.0385	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0154	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0511	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.86	5	0.47	0.66	0.779	
100.	Almaty , Alatau village , Kayipov st. , 5 (Residential zone, North)	Nitrogen dioxide	0,0401	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0129	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0482	0.5	0.03	0.05	0.02	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon monoxide	1.92	5	0.47	0.66	0.779	
101.	Almaty , Alatau village , Kayipov st. , 5 (Residential zone, East)	Nitrogen dioxide	0,0409	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0183	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0479	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.78	5	0.47	0.66	0.779	
102.	Almaty , Alatau village , Kayipov st. , 5 (Residential zone, West)	Nitrogen dioxide	0.0392	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0172	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0505	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.85	5	0.47	0.66	0.779	
103.	Almaty, Alatau , Kaiypova St. , 5 (Telecommunication equipment)	Nitrogen dioxide	0.0333	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0199	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0374	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.65	5	0.47	0.66	0.779	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
104.	Almaty, Bostandyk district, st. Baizakova , 303 (Residential zone, South)	Nitrogen dioxide	0,0482	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0195	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0572	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.19	5	0.47	0.66	0.779	
105.	Almaty, Bostandyk district, st. Baizakova , 303 (Residential zone, North)	Nitrogen dioxide	0.0435	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0186	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0556	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.27	5	0.47	0.66	0.779	
106.	Almaty, Bostandyk district, st. Baizakova , 303 (Residential zone, East)	Nitrogen dioxide	0.0469	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0175	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0549	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.34	5	0.47	0.66	0.779	
107.	Almaty, Bostandyk district, st. Baizakova ,	Nitrogen dioxide	0.0392	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0207	0.4	0.04	0.05	0.027	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
	303 (Residential zone, West)	Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0528	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.22	5	0.47	0.66	0.779	
108.	Almaty, Bostandyk district, st. Bayzakova , 303 (Antennas 5 G)	Nitrogen dioxide	0.0351	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0186	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0415	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.95	5	0.47	0.66	0.779	
109.	Almaty, Medeu district, Abay Ave., 4 (Residential zone, South)	Nitrogen dioxide	0.0552	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0225	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0467	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.42	5	0.47	0.66	0.779	
110.	Almaty, Medeu district, Abay Ave., 4 (Residential zone, North)	Nitrogen dioxide	0.0573	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0237	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0502	0.5	0.03	0.05	0.02	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon monoxide	1.95	5	0.47	0.66	0.779	
111.	Almaty, Medeu district, Abay Ave., 4 (Residential zone, East)	Nitrogen dioxide	0.0556	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0.0233	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0507	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.23	5	0.47	0.66	0.779	
112.	Almaty, Medeu district, Abay Ave., 4 (Residential zone, West)	Nitrogen dioxide	0.0544	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0241	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0511	0.5	0.03	0.05	0.02	
		Carbon monoxide	2.19	5	0.47	0.66	0.779	
113.	Almaty, Medeu district, Abay Ave., 4 (Antennas 5 G)	Nitrogen dioxide	0,0317	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0173	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0368	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.85	5	0.47	0.66	0.779	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
114.	Almaty, Almaly district, st. Kurmangazy, 48A (Residential zone, South)	Nitrogen dioxide	0.0332	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0185	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0591	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.87	5	0.47	0.66	0.779	
115.	Almaty, Almaly district, st. Kurmangazy, 48A (Residential zone, North)	Nitrogen dioxide	0.0339	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0189	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0625	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.59	5	0.47	0.66	0.779	
116.	Almaty, Almaly district, st. Kurmangazy, 48A (Residential zone, East)	Nitrogen dioxide	0.0334	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0194	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0,0611	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.74	5	0.47	0.66	0.779	
117.	Almaty, Almaly district, st. Kurmangazy, 48A (Residential zone, West)	Nitrogen dioxide	0.0348	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0193	0.4	0.04	0.05	0.027	

No.	Sample collection location	Indicators	Actual data for 2024	MPC	Background concentration values			Notes
					2024	2023	2022	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0584	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.96	5	0.47	0.66	0.779	
118.	Almaty, Almaly district, st. Kurmangazy, 48A (5 G Antennas)	Nitrogen dioxide	0.0288	0.2	0.05	0.06	0.04	
		Nitrogen oxide	0,0145	0.4	0.04	0.05	0.027	
		Carbon (soot)	<0.025	0.15	-	-	-	
		Sulfur dioxide	0.0389	0.5	0.03	0.05	0.02	
		Carbon monoxide	1.73	5	0.47	0.66	0.779	

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 AMATA AND ALMATY 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 Almaty and Almaty region.

Let's immediately leave out pigeons, tits, Afghan starlings, magpies, crows and sparrows.

Although we are wrong about sparrows. In recent years, they have not been seen very often in Almaty, so they can already be classified as rare species. But Almaty residents can see blackbirds with the naked eye. There are quite a lot of them in the city this winter and spring.

But let's move on to rarer species. If you take places below Al-Farabi Avenue, you can watch birds:

The Botanical Garden is particularly noteworthy.

There you can also see wild Semirechensk pheasants. There are a lot of them there, and they walk around quite leisurely.

In the park areas of the city you can meet scops owls . Especially in the Park of 28 Panfilov Guardsmen. Let us recall that in 2024 scops owls became the birds of the year in Kazakhstan.

Picture. 5.1. Scops owl

They spend the winter in the region of the Southern Sahara, and return to our region for the summer. They arrive in mid-April. It is difficult to see them - they are nocturnal animals. But they can be heard and recognized by their characteristic sound, which is sometimes compared to a creaking swing.

Sometimes you don't even have to go to the parks to see unusual birds.

And six months in advance, you can list the birds that fly to Almaty for the winter: accentor, common grosbeak, juniper grosbeak.

Picture. 5.2. White heron

Animal world. To begin with, let us recall a simple rule: animals are all living things, starting with worms, beasts are mammals. It is about beasts that we will talk. Without going into the parks in the evenings, Almaty residents can see bats - they are already awake.

The most common bat we see is the pygmy pipistrelle. It is a kind of city bat. They can be seen right in the city center. Sometimes the red noctule bat is found, but less often. It is more likely to be seen in the private sector.

There are always a lot of squirrels in the First President's Park, and you can feed them right from your hands.


Picture. 5.3. Squirrel in Baum's Grove

If you head towards the mountains, the animal biodiversity becomes more noticeable. For example, in the area of the visitor center " Ayusay " you can meet wild boars.

In the Prokhodny Gorge you can meet Siberian mountain goats. That is if you go up a little higher. And lower down you can meet the elik - that is the Kazakh name for the Siberian roe deer.

Picture. 5.4. Siberian ibex

Well, it's not for nothing that the Ayusay Gorge got its name. There really are bears there. At least, during the quarantine, they were recorded in that direction by camera traps

In the camera traps installed in the mountains. The device captured it in the Shymbulak area . But, as photographers say, capturing a snow leopard on camera is a great success, because it is a very cautious animal.

In principle, animals are afraid of humans. But the same boars can also attack in self-defense. For example, if you try to pick up a piglet or throw something at them, then, defending them, the boar can pounce. Animals are more active in the dark. So if you are outdoors in the dark, you can simply make sounds, and they will move away themselves. Animals get scared and run away from any rustle.

If you want to take part in a photo hunt and photograph animals in their natural environment, you can go outside of Almaty to the Altyn- Emel National Park .

There is an observation tower built there, and in the mornings you can watch the kulans from there - these are wild donkeys. You can also see a goitered gazelle there. And various birds too.

You can also meet wolves not far from Almaty.

Reptiles . Well, since we've already left Almaty, it's worth talking about reptiles.

Let's start with the dangerous ones. There are only two species of them in the Almaty area. Of course, we are talking about snakes - the copperhead and the viper. You can meet them both in the mountains - less often, and in the steppe - more often.

But they themselves will never attack either. Only if, say, you step on them. Or provoke them somehow.

In the direction of Konaev , you can meet the lizard agama. Small, but cute. There are also sand lizards.

And there is also such a rare reptile as the frogtooth. It is found only in the Zhetysu Alatau. Those who want to see it can go to the Tekeli region and see it there.

And, of course, in the vicinity of Almaty, old, sometimes really old, good turtles crawl around.

If you meet them, you will have plenty of time to take this reptile down from all sides. She will definitely not care about you.

Flora of the city of Almaty and Almaty region.

In Almaty, a city of republican significance in the Republic of Kazakhstan with a long history, no targeted study of urban herbaceous flora has been conducted before.

Almaty is located at the foot of the Zailiyskiy Alatau Mountains in the extreme southeast of the republic with a fairly mild climate. Almaty has a continental climate and is characterized by the influence of mountain-valley circulation, which is especially evident in the northern part of the city, located directly in the transition zone of the mountain slopes to the plain. The structure of the soil cover of Almaty is completely determined by the vertical zonality of the Zailiyskiy Alatau, where with a change in altitude, both natural and climatic zones and belts change, and, accordingly, the soil and vegetation cover. The upper part - the Medeo tract is located in the meadow-forest-steppe zone with leached chernozems, dark gray forest-steppe and mountain forest-meadow soils. Below, at an altitude of 1000 to 1200-1400 m above sea level . There is a steppe foothill zone with the following belts (subzones): a belt of high foothills (counters) with chernozems and a belt of foothill dark chestnut soils, which start from 750 to 1000 m. It should be noted that the study of herbaceous plants in urbanized areas is complicated by the fact that the soils of Almaty have been subjected to long-term anthropogenic impact. Natural soil horizons in cities are covered with imported soils, isolated from the atmospheric air by various hard surfaces, such as asphalt, concrete, paving stones, etc. It is known that urban soils absorb chemical pollutants from the air. The rate of self-purification of the soil is significantly lower than that of mobile media - water and air, and substances that have once entered it can harm plants for long periods of time. Under the influence of exhaust gases, the lead content in herbaceous plants increases by 50-100 times.

But in spite of everything, wild plants try to populate every patch of open soil – and if they are not trampled or rolled over by wheels, then without any watering they cover the ground, remove dust and make the city cleaner, more pleasing to the eye and more comfortable to live in.

Some of the wild plants that are found in the city as such: Roof brome, Tall ryegrass, French ryegrass, Viviparous bulbous bluegrass, Meadow bluegrass, Orchard grass , Yarrow, Wormwood, Caspian thistle, Leucanthemum vulgare…

Roof fire. Annuals herbaceous plants . Stems are several in number, erect or geniculate-ascending in the lower part, in the upper part, together with the branches of the inflorescence, short and thinly pubescent, 20-50, rarely up to 60 cm high. Leaves are linear, gradually but not long pointed, 1.5-4, rarely up to 5 mm wide, covered together with the sheaths with short thin hairs. The ligule is 2-3 mm long, split.

Picture. 5.5. Roof fire

Tall ryegrass. A herbaceous plant , a species of the genus Ryegrass (*Arrhenatherum*) of *the* family Poaceae . It is widespread in Eurasia and North Africa, and is also found as an alien plant in other regions. It is cultivated.

A perennial grass growing in dense tussocks and developing tall (up to 1 m) smooth stems with flat, linear along the edge, sharply rough, folded leaves ; the ligule is short and ciliate.

Ppanicle after flowering , with sharply rough branches. The spikelets are small, slightly compressed, two-flowered ; the lower flower is male, the upper one is bisexual. Spikelet scales are equal to floral scales, of which the lower one has one vein, and the upper one has three; the lower floral scale has 5-7 veins and in the bisexual flower with a long, geniculate, twisted at the bottom awn , extending from the base of the scale; in the male flower the awn is short, straight, extending below the top of the scale.

The grain is oblong, without a groove. The seeds remain in the flower films when ripening, awned, very difficult to sow. The weight of 1000 seeds is 2-4 grams.

Picture.5.6. Tall ryegrass

Hedgehog team. Perennial species herbaceous plants of the genus *Dactylis* of the *family Poaceae* . It is one of the best forage grasses .

Perennial herbaceous plant with loose turf . The rhizome is short, creeping, rather thick, with abundant fibrous thin roots . Stems (25)35-130(150) cm high and 1.5-3 mm thick, straight or rising at the base, with long internodes , bare, smooth or slightly rough under the inflorescence .

Leaves (3)5-12(20) mm wide, greyish-green, linear or broadly linear, often flat or folded lengthwise, soft, acutely rough or acutely spiny along the edges, rough along the veins, finely pointed. Sheaths are usually shorter than internodes, strongly flattened, closed for ½-¾ of the length from the base, rough, less often smooth or shortly hairy . Ligules (2.5)4-7(10) mm long, membranous, oblong- ovate, obtuse, split, fringed-torn at the top, usually bare and smooth.

Inflorescence is a greyish-green, dense, thick, laterally compressed, one-sided, lobed, usually triangular in outline panicle (at first narrow and dense; during flowering broadly lanceolate, with deflected and spreading branches of the first order; later compressed), (3)7-15(20) cm long and (2)3-5(7) cm wide, with an acute triangular axis and rough, long, especially lower, branches of the first order extending from the nodes on one or both sides of the panicle, on which directly or on separate branches of the second order are located one-sided, oblong-elliptical, capitate bundles of closely crowded spikelets.

Spikelets (2)3-5(6)-flowered, (4)6-8(10) mm long, on short peduncles, strongly compressed laterally, oblong-obovate, greyish-green, often with a violet tint; axis with articulation under each flower, rough, sometimes with scattered short hairs. Glumes nearly identical, keeled , lanceolate or lanceolate-oblong, rigid, leathery-membranous, ciliate along the keel, with 1-3 indistinct veins, very sharp, with awn-like points, shorter than the spikelet and lemmas; lower glume (2)3.5-5(6.5) mm long, upper glume 3-5.5(7) mm long. Floral scales are not uniform. Lower floral scale (3)5-6.5(7) mm long, oblong, oblong-lanceolate or lanceolate, with 5 thin veins, sharply keeled , rigidly ciliated along the keel at the top , short-ciliated along the edge, sometimes completely naked, with a point or awn 1-2(2.5) mm long at the apex. Callus naked, very short. Upper floral scale slightly shorter than lower, lanceolate-elliptic, membranous, flattened, with 2 keels, rough or short-ciliated along the keels , narrowed towards the top, bidentate at the apex. Floral films bidentate or bilobed. Stamens 3, anthers up to (1.5)2-4.5(5) mm long. The style of the pistil is elongated, the stigma is pinnate.

The fruit is an oblong grain , grooved on the inside, 1.8-3 mm long; the scar is oval, 6-8 times shorter than the grain. The weight of 1000 seeds is 0.8-1.24 grams.

Flowering June-August, fruiting July-September.

Picture.5.7. Hedgehog assembly

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 Almaty were selected for the assessment of the impact on flora.

The city of Almaty is a city of national significance with a population of over 2.2 million people .

The flora of Almaty is represented by 360 species of vascular plants belonging to 201 genera and 70 families. Central Park of Culture and Recreation – 201 species; Park of 28 Panfilov Guardsmen – 111 species; Kok- Tobe Park – 110 species; Park of the First President of the Republic of Kazakhstan – 124 species; Friendship Park – 73 species; Yuzhny Park – 98 species; Gulder Park – 76 species ; Gandhi Park – 97 species, Seifulina Park – 74 species, Detsky Park – 76 species, Family Park – 142 species, Zheltoksan Park – 58 species. In terms of species composition, the flora of Almaty parks is dominated by the department of angiosperms, which accounts for 98.4%, and 1.6% refers to conifers, ferns, club mosses, and horsetails.

About 35 species of trees and shrubs were common to all parks, boulevards and squares. In the flora of all parks, the percentage of local aboriginal species is very low (1-3%). In the spectrum of life forms of the flora of parks, the main role is played by perennial grasses (46.1%) and trees and shrubs (54.0%). For the general flora of the city of Almaty, the prevalence of xeromesophytes and mesophytes is expressed.

When studying the vegetation cover of any territory, flora analysis carried out in various directions plays a significant role. This allows comparing the analyzed flora with floras of other territories from the standpoint of taxonomic composition, geography, biomorphology, ecology and phytocenology. The composition of the flora reflects the state of the vegetation cover and changes over time. A comprehensive analysis of the flora can be used to characterize the vegetation cover of various territories. An important characteristic of the natural environment is weather and climate. Weather is a set of values of meteorological elements and atmospheric phenomena observed at a certain point in time at a particular point in the ground atmosphere. Climate is the average weather regime over a long period of time (about several decades) of individual areas, formed depending on their geographical location and physical and geographical features.

Objects with telecommunications 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 telecommunications 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 Almaty 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.

Birds are one of the largest classes of vertebrates. Their species composition in Kazakhstan is well known. To date, more than 530 species have been registered in the republic. The lifestyle of most species has been studied in sufficient detail. There is extensive literature on the birds of Kazakhstan, including several works on the birds of Almaty. However, this literature remains inaccessible to the population, and many Almaty residents, as it turns out, know very little about the city's birds. Rooks are often considered black crows, mynahs are confused with common starlings, and the species names of tits and other small birds are unknown. Almost nothing is known about their lifestyle.

According to observations of local residents, such familiar birds as swallows, turtle doves, and sparrows have become much fewer. Most often, they can now be seen in the private sector or in the region. As explained by a research associate of the laboratory of ornithology - herpetology of the Institute of Zoology, there has been a reduction in the nesting of local bird species in Almaty. Due to the growth of cities, there are fewer "green zones". Due to the reduction of the private sector, which is moving beyond the city limits, the living conditions of the birds that move behind are also changing. It is there that there is a sufficient number of plants and insects - turtle doves, sparrows and swallows feed on them. Of the four species of turtle doves, the small and ringed turtle doves live in Almaty and its environs. They prefer to settle under the roofs or cornices of one-story buildings, nest in separate pairs, often several pairs live next to each other.

Swallows and common starlings have redistributed their nesting sites. This is due to changes in biotopes and conditions for their survival, and one of the reasons is the proximity to the myna. This species is displacing them from their nesting sites.

As ornithologists note, over the past five years, according to the data of the counts during the spring and autumn migration at the Chokpak Pass , which is located in the Western Tien Shan (the crossing point of the migration routes of many species of migratory birds in large numbers), the number of barn swallows has increased, which cannot be said about the Spanish (black-breasted) and Indian sparrows. At present, their numbers have decreased hundreds of times.

To determine the change in the number of sparrows, it is necessary to conduct comprehensive studies (international projects) that will allow a detailed approach to the problem.

Experts note that invasive bird species easily adapt to the growth of cities and the reduction of natural wild parks, but local birds do not tolerate these changes well. The fact that mynas are omnivorous also contributed to their adaptation to our area. In summer, the birds mainly feed on beetles, orthoptera and other insects, ticks. They eat grapes, cherries, sweet cherries, dzhigida and mulberries with pleasure.

But speaking about the importance of urban birds, it should be emphasized that there are no harmful species among them. On the contrary, they bring undoubted benefit, controlling the number of many insects, pests of trees and shrubs. To a certain extent, they perform the functions of city orderlies, using various food waste as food. As follows from the analysis, in order to preserve and increase the diversity of fauna, it is necessary to create appropriate conditions, or try to preserve some areas in the urban environment in their original form.

During the fauna monitoring studies in June-August 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 where noise levels significantly exceed established standards, notes a deterioration in health, headaches, sleep disturbances, and problems with the cardiovascular system and gastrointestinal tract.

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.

Soundproofing 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.

Table 5.3.1 shows the results of noise measurements at telecommunications equipment sites where there is noise pollution.

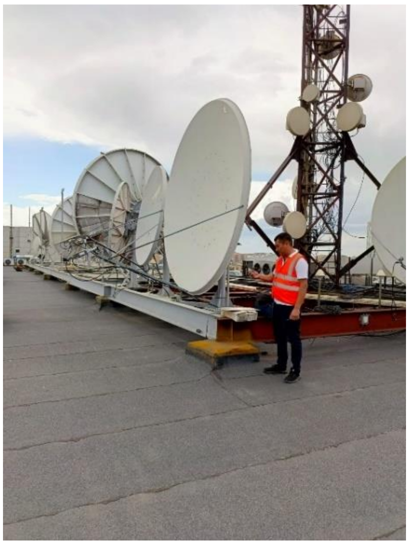

Photo 5.3.1.
Panfilova St., 129

Photo 5.3.2.
Al-Farabi Ave., 134

Table 5.3.1

No.	**Address**	**Measuring point**	**Actual noise measurement results, dB**	**Norm according to ND**
1	**2**	**3**	**4**	**5**
1	RK, Almaty, Yesenova st. 23/7	Telecommunication equipment	43	75
2	RK, Almaty, Ermak st. 17	Telecommunication equipment	43	75
3	Almaty, Panfilov st., 129	DGA	62	75
4		Precision air conditioners	58	75
5		CDMA800	54	75
6	RK, Almaty, st. Tchaikovsky, house 39-39A/113	RAC6610 Room/study (3rd floor)	50	75
7	RK, Almaty, st. Furmanova, 240-A, B	Telecommunication equipment	55	75
8	RK, Almaty, st. Tchaikovsky, house 39	RAC6610 Room/study (2nd floor)	48	75
9	RK, Almaty, Panfilov st. 72/74	Air conditioner Liebert Hirros HIMOD S17UA (4 pcs)	55	75
10		Diesel generator	103	75
11		Nazarbayev street, house 77, measurements in front of the entrance	72	75
12	RK, Almaty, Al-Farabi Ave., 134	Telecommunication equipment	43	75
13	RK, Almaty, Al-Farabi Ave., 118	Ubiquiti PowerBeam M5 400 radio bridge	52	75
14	RK, Almaty, Medeu district, st. Divaeva, 39	Telecommunication equipment	49	75
15	RK, Almaty, microdistrict. Koktem 3, building 21b	Telecommunication equipment	44	75
16	RK, Almaty, st. 2nd Goncharnaya 145 A Base "Almatykomplekt"	Telecommunication equipment	51	75
17	RK, Almaty, Dzhumaliev st., 108	Telecommunication equipment	47	75
18	RK, Almaty, st. Beisebaeva 47	CDMA800 Container	49	75
19	RK, Almaty, Shemyakin st. 55	CDMA800 Room/office (1st floor)	47	75
20	RK, Almaty, Kyzybaeva st. 9	Telecommunication equipment	45	75
21	RK, Almaty, Ahan Sulfur St. 150a	Telecommunication equipment	52	75
22	RK, Almaty, st. Ospanova 160	Telecommunication equipment	56	75

23	RK, Almaty, microdistrict. Taugul d.19	CDMA800 Container room Digital tv (part of the first floor) - Telecommunication equipment	45	75
24	RK, Almaty, Kazakhfilm microdistrict, house 37, office 45	Telecommunication equipment	48	75
25	RK, Almaty, Alatau village, Kayipov st., 5	Telecommunication equipment	61	75
26	RK, Almaty, Bostandyk district, st. Bayzakova, 303	5G Antennas	42	75
27	RK, Almaty, Medeu district, Abay Ave., 4	5G Antennas	45	75
28	RK, Almaty, Almaly district, st. Kurmangazy, 48A	5G Antennas	55	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).

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 centi- , deci- 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, the 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 aphids AsuMozgrkop caraganae С1ю1ос1к., 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 was studied (Rana temporaria L.) in an electromagnetic field. 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 tadpoles temporaria : it slightly accelerates the growth of tadpoles, but slows down the rate of development and increases embryonic mortality, causes 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 to the impact 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 exposed 20 rats to magnetic induction from 2.20 to 200 mT in experiments on 20 rats; 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 widely used 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 use by birds of stationary means, as well as buildings and various structures, is nesting in them. Typically, for example, nesting of rock pigeons Columba livia , Corvus jackdaw monedula , starlings Sturnus vulgaris 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 niches. 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.

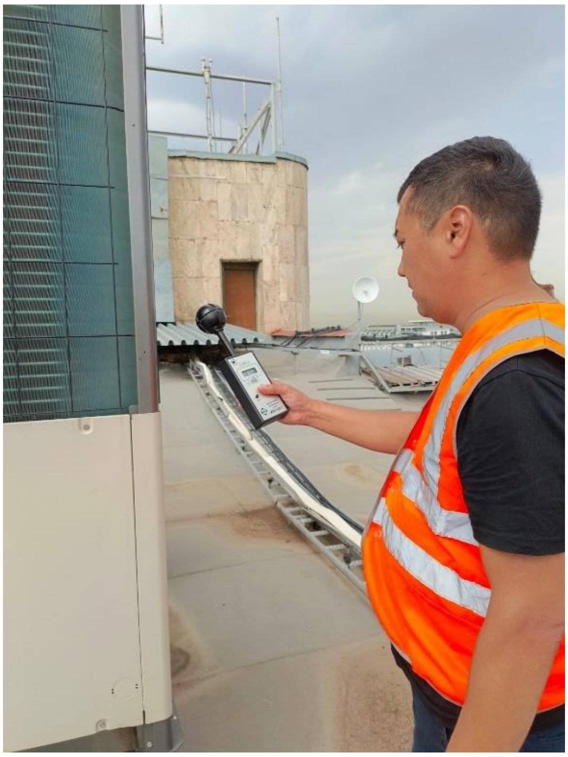

Photo 5.4.1
Almaty, Dzhumaliev st., 108

Photo 5.4.2
Almaty, st. Panfilova 72/74

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.

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	Pick-up point	Distance from source in meters	Height from the floor in meters	By magnetic component, μT		By electrical component, V/m	
							Measurement results	Norm according to ND	Measurement results	Norm according to ND
31.07.2024	*19.08.2024*	*1*	*RK, Almaty, Yesenova st. 23/7*	*Production and laboratory building - Telecommunication equipment*	*0.7*	*1*	*3.54*	*25*	--	--
							3.26	*25*	--	--
							2.44	*25*	--	--
31.07.2024	*19.08.2024*	*2*	*RK, Almaty, Ermak st. 17*	*Telecommunication equipment*	*0.7*	*1*	*2.47*	*25*	--	--
							5.88	*25*	--	--
							4.63	*25*	--	--
31.07.2024	*19.08.2024*	*3*	*Almaty, Panfilov st., 129*	*Precision air conditioners*	*0.7*	*1*	*4.35*	*25*	--	--
							4.72	25	--	--
							4.86	25	--	--
31.07.2024	*19.08.2024*	4		CDMA800	0.7	1	5.12	25	--	--
							5.16	25	--	--
							5.38	25	--	--
31.07.2024		5			0.7	1	4.16	25	--	--

	19.08.2024		RK, Almaty, st. Tchaikovsky, house 39-39A/113	RAC6610 Room/study (3rd floor)			4.52	25	--	--
							4.65	25	--	--
31.07.2024	*19.08.2024*	6	RK, Almaty, st. Furmanova, 240-A, B	Telecommunication equipment	0.7	1	4.36	25	--	--
							3.48	25	--	--
							4.65	25	--	--
31.07.2024	*19.08.2024*	7	RK, Almaty, st. Tchaikovsky, house 39	RAC6610 Room/study (2nd floor)	0.7	1	4.75	25	--	--
							3.86	25	--	--
							4.29	25	--	--
31.07.2024	*19.08.2024*	8	RK, Almaty, st. Panfilova 72/74	Air conditioner Liebert Hirros HIMOD S17UA (4 pcs)	0.7	1	3.28	25	--	--
							2.94	25	--	--
							3.61	25	--	--
31.07.2024	*19.08.2024*	9		Diesel generator	0.7	1	3.28	25	--	--
							2.95	25	--	--
							3.39	25	--	--
31.07.2024	*19.08.2024*	10	RK, Almaty, Al-Farabi Ave., 134	Telecommunication equipment	0.7	1	3.26	25	--	--
							3.41	25	--	--
							3.75	25	--	--
31.07.2024	*19.08.2024*	11	RK, Almaty, Al-Farabi Ave., 118	Ubiquiti PowerBeam M5 400 Radio Bridge	0.7	1	2.95	25	--	--
							3.26	25	--	--
							3.51	25	--	--
31.07.2024	*19.08.2024*	12	RK, Almaty, Medeu district, st. Divaeva, 39	Telecommunication equipment	0.7	1	3.29	25	--	--
							5.84	25	--	--
							4.95	25	--	--

31.07.2024	*19.08.2024*	13	RK, Almaty, microdistrict. Koktem 3, building 21b	Telecommunication equipment	0.7	1	7.65	25	--	--
							7.42	25	--	--
							7.29	25	--	--
31.07.2024	*19.08.2024*	14	RK, Almaty, st. 2nd Goncharnaya 145 A Base "Almatykomplekt"	Telecommunication equipment	0.7	1	6.49	25	--	--
							6.84	25	--	--
							6.37	25	--	--
31.07.2024	*19.08.2024*	15	RK, Almaty, Dzhumaliev st., 108	RAC6610 Room/study (3rd floor)	0.7	1	8.15	25	--	--
							7.54	25	--	--
							7.29	25	--	--
31.07.2024	*19.08.2024*	16	RK, Almaty, st. Beisebaeva 47	CDMA800 Container	0.7	1	5.68	25	--	--
							5.91	25	--	--
							5.29	25	--	--
31.07.2024	*19.08.2024*	17	RK, Almaty, Shemyakin st. 55	CDMA800 Room/office (1st floor)	0.7	1	5.17	25	--	--
							6.29	25	--	--
							6.82	25	--	--
31.07.2024	*19.08.2024*	18	RK, Almaty, Ahan Sulfur St. 150a	Telecommunication equipment	0.7	1	5.28	25	--	--
							4.79	25	--	--
							4.91	25	--	--
31.07.2024	*19.08.2024*	19	RK, Almaty, st. Ospanova 160	Telecommunication equipment	0.7	1	4.55	25	--	--
							5.13	25	--	--
							4.78	25	--	--
31.07.2024	*19.08.2024*	20	RK, Almaty, microdistrict. Taugul d.19	Digital TV room (part of the first floor) -	0.7	1	4.25	25	--	--
							5.23	25	--	--
							5.71	25	--	--

				Telecommunication equipment						
31.07.2024	*19.08.2024*	21	RK, Almaty, Kazakhfilm microdistrict, house 37, office 45	Telecommunication equipment	0.7	1	6.25	25	--	--
							5.84	25	--	--
							5.49	25	--	--
31.07.2024	*19.08.2024*	22	RK, Almaty, Alatau village, Kayipov st., 5	Telecommunication equipment	0.7	1	6.71	25	--	--
							5.29	25	--	--
							5.44	25	--	--
31.07.2024	*19.08.2024*	23	RK, Almaty, Bostandyk district, st. Bayzakova, 303	5G Antennas	0.7	1	5.44	25	--	--
							5.28	25	--	--
							6.15	25	--	--
31.07.2024	*19.08.2024*	24	RK, Almaty, Medeu district, Abay Ave., 4	5G Antennas	0.7	1	4.88	25	--	--
							5.23	25	--	--
							5.76	25	--	--
31.07.2024	*19.08.2024*	25	RK, Almaty, Almaly district, st. Kurmangazy, 48A	5G Antennas	0.7	1	5.12	25	--	--
							5.35	25	--	--
							5.27	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, transport 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 exposed to a 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 help achieve these goals is the use of additional (higher) frequency bands in the RF-EMF spectrum. The 5G frontier bands defined at EU level are 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 beam in the direction of the user (Thors et al ., 2017).

When a user is in a limited 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 all fall into the non-user category . 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, the 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 high-frequency EMF to carry out photosynthesis, and many have a relatively high surface area to volume ratio to maximize the use of sunlight. This obviously also makes them efficient receptors for other long-range EMF sources, such as most RF-EMF sources (Alain Vian et al ., 2007). Temporary variations in RF-EMF exposure (installation shutdown) may occur due to temporary changes in the RF power grid and mobile RF users that may occur near the installation when 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 , & Kashyap , 2019). There is also a growing number of wireless technologies in agriculture (S. Benaissa et al., 2017 ; Dlodlo & 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 from 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). There are also some insect telemetry studies 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 widely used 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 RFEMF frequency 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 those 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 of research in vitro studies on non-human vertebrate cells have shown mixed results regarding cellular genotoxicity and cellular transformation following exposure to radiofrequency radiation. Previous reviews on these topics have suggested either that the evidence for such effects is weak or that the literature is inconclusive. Regarding the non-genotoxic effects of radiofrequency EMF exposure, reports have suggested that neuronal activity may be altered in vitro by exposure to radiofrequency EMF. Other cellular effects are either unproven, disputed, or there are not enough studies to draw any conclusions about such effects.

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

It appears 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 general agreement that animals can hear (pulsed) radiofrequency emissions 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 performance 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.

Research in vitro studies have shown increased neuronal activity in invertebrate neurons. In vivo studies on invertebrates face a number of experimental problems and yield inconclusive results for a number of parameters examined. Additional studies of higher quality, sham-treated 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 beneficial effects. 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

In the higher frequency range, studies of neurons in vertebrates and invertebrates in vitro studies have shown the effects of radiofrequency radiation on neural activity. In In vivo studies in vertebrates have shown that ocular exposure to radiofrequency radiation can cause corneal damage and cataracts. Effects on male fertility have also been demonstrated in rodents. Controversial results have been obtained regarding the effects of radiofrequency radiation on behavior and abundance in vertebrates. One research group has demonstrated that exposure to radiofrequency radiation can have a hypoallergenic effect in mice. These effects need to be replicated by other research 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 studies in vivo showed that high-frequency RF-EMF can reduce tumor growth.

Invertebrates

Neurostimulation has been demonstrated in the same frequency range in vitro and teratogenic effects on invertebrates at relatively high frequencies in vivo , power densities. 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
Almaty city						
Trifolium pratense	Шалғынды беде	Клевер луговой	Red clover - Taproot or taproot , heavily branched, penetrates the soil to a depth of 2 m. Lateral heavily branched fibrous roots are distributed in the arable soil layer. Stems are erect, ascending and creeping, 40-65 cm high (in grass mixtures and experimental crops 1 m, sometimes up to 2 m), thick or thin, bare or slightly pubescent. Depending on the type, variety, growing conditions, a bush has an average of 5-8 stems in dense crops and 30-70 in sparse ones. Leaves are trifoliate, with broadly ovate finely toothed lobes, leaflets along the edges are entire, with delicate cilia along the edges. https://tabigat.media/wildlife/Dikie-rastenia-almaty	30.07.24 Found	More than 20	

Crataegus Tourn . ex L	Долана	Боярышник	During germination, the cotyledons are carried above the ground; they are ovoid or elliptical, somewhat fleshy, bare, short-petiolate, 4-13 mm long. The hypocotyl part of the seedling is 1-6 cm long, bare, usually reddish. The first leaves alternate , close together, significantly smaller than normal and with a less deeply and intensively cut plate. During the first year or first two years, seedlings grow slowly; annual growth does not exceed 7-20 cm, then growth increases and reaches 30-40 (up to 60) cm per year, which continues until the age of 6-8 years; after this, growth slows down again. Flowering and fruiting occurs at the age of 10-15 years. Life expectancy is 200-300 (up to 400) years. *M. A. Nosal , I. M. Nosal . Medicinal plants and methods of their use among people / Ed. Academician of the Academy of Sciences of the Ukrainian SSR V. G. Drobotko . - Kiev: Gosmedizdat of the Ukrainian SSR, 1959.*	30.07.24 Found	More than 20	

Taraxacum officinal	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 going to rain." https://www.picturethisai.com/ru/wiki/Taraxacum_officinale.html	30.07.24 Found	More than 10	
Malus sievers	Сиверс алмасы	Яблоня Сиверса	Sievers apple is a deciduous tree , reaching a height of 5 to 12 meters in favorable conditions, and is very similar in appearance to many varieties of cultivated apple trees. The pollen is uneven in size, oval in shape when dry, and spherical when wet [. The fruits have the largest size among all types of wild apple trees and reach 7 cm in diameter, which is close to the size of the fruits of many varieties of domestic apple trees . Unlike cultivated apple trees, the leaves of most Sievers apple trees turn red in the fall. *Aghababyan Sh. M.* Forage plants of	30.07.24 Found	More than 10	

			hayfields and pastures of the USSR			
Achillea millefolium	Ақбасжусан	Тысячелистник	Yarrow is a large genus of plants in the Asteraceae family , including about 180 species . Most of the species are from Eurasia , several species are native to North America . Many species of yarrow, according to modern classification, have been moved to the closely related genus Tanacetum . Perennial rhizomatous herbs , less often subshrubs . The stem is erect or slightly curved at the soil surface. The leaves are serrated, incised or pinnately dissected, arranged in an alternate order. The inflorescences are small baskets , mostly collected in a common corymbose inflorescence. The fruit is an achene . *Great Soviet Encyclopedia : [in 30 volumes] / ch. ed. A. M. Prokhorov .*	30.07.24 Found	More than 10	
*Note: + - species detected; 0 - species not detected						

Table H.2 – Taxonomic composition of the diversity of terrestrial invertebrates

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	
			Almaty city			
Chrysolina P olita	Жапырақже гіш	Листоед	Leaf beetles are found everywhere except Antarctica and most of the Arctic zone. There are more than 1,500 species in the territory of the former USSR, and over 400 in Siberia alone. They inhabit almost all zoogeographic regions of the Earth, from water bodies to highlands, from deserts to polar islands. *A Guide to Insects of the USSR Far East. Vol. III. Coleoptera, or Beetles. Part 2 / edited by P. A. Lera . - L.: Nauka, 1992. - 704 p. - 1,400 copies. - ISBN 5-02-025623-4 .*	Not found		
Agrillus cuprescens	Зерқоңыз	Златка	Rose narrow-bodied borer, or currant narrow-bodied borer (lat. *Agrilus cuprescens*), - vidzhukov -zlatok. Damages roses, rose hips, blackberries and currants. Beetles fly in mid-to-late May; beetles feed on rose and rose hip leaves. *Alekseev A. V. Family Buprestidae — Zlatki. // Identifier of insects of the USSR Far East. Vol. III. Coleoptera, or beetles. Part 1 / edited by P. A. Lera . — L.: Nauka , 1989. — Pp. 463-489. — 572 p. — 3150 copies. — ISBN 5-02-025623-4 .*	Not found		

Mylabris quadripuncta ta	Mylabris қоңызы	Нарывник	They inhabit mainly steppes, steppe regions and savannas, and can also be found in deserts and semi-deserts. The lifestyle of all species is quite monotonous. Beetles feed on plant flowers. They are active only during the day, in sunny weather. Eggs are laid in the ground. *S.V. Kolov, V.L. Kazenas. Blister beetles (Type Arthropoda, Class Insects). Series "Animals of Kazakhstan in Photographs". - Almaty, 2013. - 110 p.*	Not found		
Calosoma sicophant	Хош иісті сұлу қоңыз	Красотел пахучий	It is distinguished by its golden-blue-green elytra and a pungent odor that the beetle emits in case of danger. A very active predator, it hunts during the day, feeds on the caterpillars of the gypsy moth and silkworms. During the summer period, one beetle destroys 200-300 caterpillars of the gypsy moth, and the larva - about 60 caterpillars and 15-20 pupae. *Striganova B. R. , Zakharov A. A. Five-language dictionary of animal names: Insects. Latin, Russian, English, German, French / edited by Dr. of Biological Sciences, Prof. B. R. Striganova . - M .: RUSSO, 2000. - P. 103. - 1060 copies. - ISBN 5-88721-162-8 .*	Not found		

Aporia crataeg	Долана көбелегі	Боярышница	The hawthorn is widespread throughout Europe, as well as in Northern and Central Asia to the western slopes of the mountains of Eastern Yakutia and Japan. It is extinct in England, where its last specimen was caught in 1925, and is absent from Sardinia and Corsica. It is most numerous in Northern Africa, Morocco and Algeria. *Striganova B. R., Zakharov A. A. Five-language dictionary of animal names: Insects. Latin, Russian, English, German, French / edited by Dr. of Biological Sciences, Professor B. R. Striganova . - M.: RUSSO, 2000. - P. 103. - 1060 copies. - ISBN 5-88721-162-8.*	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	
Almaty city						

Erinaceus europaeus	Кірпі	Обыкновенный 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*	Not found		
Ciconia ciconia	Ақ тырна	Белый аист	The white stork is the most famous of the storks. It is a white bird with black wingtips, a long neck, a long, thin, red beak and long reddish legs. When the stork's wings are folded, it seems that the entire back of the stork's body is black. Hence its Ukrainian name - chernoguz . Females are indistinguishable from males in color, but are	Not found		

			slightly smaller. The height of the white stork is 100-125 cm, the wingspan is 155-200 cm. The weight of an adult bird reaches 4-5 kg. The life expectancy of a white stork is on average 20 years. Weight 2.2-4.4 kg, length 100-115, wing 54.2-64.5, wingspan 195-215 cm. *Bejcek V., Stastny K. Birds. Illustrated Encyclopedia. - M.: Labyrinth-press, 2004. - 288 p.*			
Oenanthe isabella	Шыбжың тасшымшық	Каменка-плясунья	The Isabelline Wheatear is somewhat larger than the Common Wheatear, has longer legs, a larger head and a short tail. The coloration of the male and female is similar, light grayish-ocher. Males usually differ from females by a more distinct dark lore, but some females also have a rather dark lore. Seasonal changes in coloration are insignificant. Juveniles are darker than adults, they have dark and light-ocher speckles on top, a brownish scaly pattern on the chest, and are most reliably distinguished from young wheatears of other species by the pattern of the tail. The tail in all plumage has a wide dark-brown apical stripe, occupying about half the length of the tail. Manners are generally like other wheatears, when looking around, they often assume a vertical pose. Weight 22-38 g, length 15-18, wing 8.9-10.6, wingspan 28-32 cm.	Not found		

			Assessing the possible role of the Isabelline wheatear (Oenanthe isabellina) and other birds in the mechanism of enzootic plague / N.V. Popov, A.A. Sludsky , E.V. Zavyalov, A.I. Udovikov , V.G. Tabachishin , V.V. Anikin, N.P. Konnov // Volga Ecological Journal. 2007. No. 3. P. 215-226.			
Lanius excubitor	Үлкен тағанақ	Серый сорокопут	The throat, chest, abdomen, sides and undertail are whitish, gray or brownish-gray and in this case with a thin streaky transverse pattern. In adult females, the coloring is the same, but all the tones are duller and grayer, on the underside the brown streaky transverse pattern is always well expressed. There are females, apparently old, externally indistinguishable from males. Young ones are similar to females, but even grayer, their dark transverse pattern is more developed not only on the underside of the body, but also on the head and back. The beak and legs are black, the iris is brown-brown. Weight 54.5-88.6 grams, males wing - 102.0-123.0, tail 105.0-125.0, females - wing 104.0-115.5, tail 105.0-130.0. *Dementyev G.P., Gladkov N.A. Volume 6 // Birds of the Soviet Union. - Moscow: Soviet*	Not found		

			Science, 1954. - 754 p.			
Upupa epops	Бәбісек	Удод	The bird is slightly larger than a starling, with a very distinctive appearance. The head and body are brownish-ocher, on the head there is a lush red crest, which the bird can fold and fan out. The wings and tail are colored contrastingly in black and white stripes. The wings are wide, the flight is easy, with uneven flaps, a flying hoopoe looks like a large butterfly. The beak is long, tweezer-like . The male and female do not reliably differ, but the female is slightly smaller, she usually has a lighter throat and a browner chest. In autumn, the coloring is the same. Young ones look generally like adults, but duller, without a wine-pink shade on the chest, white stripes on the wings with a more pronounced reddish bloom, black ones - without shine, the beak is short and straighter. Weight 45-85 g, length 28-32, wing 14.2-15.3, wingspan 42-49 cm. *Candidate of biological sciences L. Semago. Hoopoe // Science and Life : magazine. - 1982. - No. 7. - P. 159-160.*	Not found		

Yellow-eyed Pigeon	Қоңыр кептер	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.*	30.07.24 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	
Almaty city						
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
Almaty region		
Acer rubrum	Қызыл үйеңкі	Клен красный

Table U.2 – Indicator species of herbaceous plants

Latin name	Kazakh name	Russian name of the species
1	2	3
Almaty region		
Crataegus Tourn . ex L	Долана	Боярышник

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
Almaty region														
Red maple	-	End of April	Beginning of May	Mid May	Mid May	End of May	End of May	**Recorded**	Mid September	Mid September	Mid September	Mid September	Mid September	End of September

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

View	Appearance shoots	Budding	Flowering, beginning	Massive flowering	Blooming, end	Maturation seeds , beginning	Seed maturation, complete
1	2	3	4	5	6	7	8
Almaty region							
Hawthorn	Start May	Middle May	End May	Start June	Start June	End June	Start July

Table U.5 – Productivity of trees and shrubs (in points), according to observations in 2024

View	Inspector's section 1		Inspector's section 2	
	Productivity in points at the phenological site	Yield in points on the site as a whole	Productivity in points at the phenological site	Yield in points on the plot in general
1	2	3	4	5
Almaty region				
Red maple	4	5	-	-