KAZAKHSTAN

KARAGANDA WWTP MODERNISATION PROJECT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

February 2024

LIST OF ACRONYMS AND ABBREVIATIONS

AAQD	Ambient Air Quality Directive
amsl	above mean sea level
AD	Anaerobic Digestor
BAT	Best Available Technologies
BLS	Bureau of Labour Statistics (USA)
BOD	Biological Oxygen Demand
CESMP	Contractor's Environmental and Social Management Plan
CHP	Combined Heat and Power (facility)
CREM	Committee for Regulation of Natural Monopolies (of the Ministry of National Economy)
E&S	Environmental and Social
EBRD	European Bank for Reconstruction and Development
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
END	Environmental Noise Directive
ESAP	Environmental and Social Action Plan
ESIA	Environmental and Social Impact Assessment
ESP	Environmental and Social Policy
ESMP	Environmental and Social Management Plan
ETS	Emission Trading Scheme
EU	European Union
EUR	Euro
FS	Feasibility Study
FU	Functional unit
GBVH	Gender-Based Violence and Harassment
GET	Green Economy Transition
GHG	Green House Gas
GIP	Good International Practice
GM	Grievance Mechanism
GoK	Government of Kazakhstan
HR	Human Resources
H&S	Health and Safety
IFC	International Finance Corporation
ILO	International Labour Organisation
ISO	International Organization for Standardisation
JSC	Joint Stock Company
KS	Karaganda Su
KazCenter	JSC Kazakhstani Center for the Modernization of Housing and Utilities Sector
KZT	Kazakhstani Tenge
LCU	Lifecycle assessment
MEGNR	Ministry of Ecology Geology and Natural Resources
MPP	Maximum permitted pollution
OHS	Occupational Health & Safety
PIP	Priority Investment Programme
PPE	Personal Protective Equipment
PR	Performance Requirements (EBRD)
PS	Pumping Station
p.e./P.E.	Population Equivalent
SEE	State Environmental Expertise
SEP	Stakeholder Engagement Plan
SPS	Sewage Pumping Stations
SPZ	Sanitary Protection Zone
ToR	Terms of Reference
WFD	Water Framework Directive
WS	Water Supply
WTP	Water Treatment Plant
WW	Wastewater
WWT	Wastewater Treatment

WWPS	Wastewater Pump Station
WWTP	Wastewater Treatment Plant

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1 EXECUTIVE SUMMARY

The Environmental and Social Impact Assessment (ESIA) has assessed the potential environmental and social (E&S) impacts of the proposed Project to construct a new EU-compliant Wastewater Treatment Plant (WWTP) to replace the existing WWTP in Karaganda City, which is operated by Karaganda Su (KS). The location of the site of the new WWTP, which overlaps with and is partially immediately adjacent to the existing WWTP, is considered appropriate as it allows for continued use of key inflow and outflow piping infrastructure. Furthermore, the new WWTP will be located >500m from the nearest residential area and does not require changes in the current sanitary protection zone (SPZ).

The overall impacts of the proposed WWTP Project are assessed to be positive. There are no significant negative impacts expected after successful implementation of mitigation measures included in the Environmental and Social Management Plan (ESMP) for the Project. This applies to both environmental and socio-economic aspects.

1.1 Environmental Aspects

1.1.1 Benefits

The existing WWTP effluents do not fully meet EU and national effluent requirements, and raw sludge is dried and treated in sludge ponds without prior stabilization. In particular, the sludge handling from the existing WWTP results in substantial odour problems, which are felt in residential areas located approx. 600m to the east from the WWTP.

Hence, the most significant impact of the Project will be improvements in treated effluent quality to meet EU and national standards, and the sludge treatment will be much improved with the introduction of anaerobic digestion (AD) to the WW treatment process. Both aspects are expected to significantly reduce or eliminate current odour problems. The improved WWTP sludge handling will also substantially reduce the Green House Gas (GHG) emissions associated with wastewater treatment (estimated reduction of 23,649 tons CO_{2e}/year), compared to the current situation (estimated 48,349 tons CO_{2e}/year), hence contributing to climate mitigation. The outcome of the proposed Project will create an opportunity to reuse both the effluents and sludge for agricultural and/or other land use purposes, which need to be further explored by the project owner (KS) to ensure implementation. Effluent reuse, if implemented, can be seen as important for increasing climate resilience in a country like Kazakhstan, where water is a scarce resource.

1.1.2 Adverse impacts

Potential negative environmental impacts of the Project are mostly typical for construction activities and operation of WWTPs of similar size and complexity. These include risks of contamination of soil, surface and groundwater through daily construction and operation activities, air quality and noise. Given the relatively low sensitivity of the affected receptors, and moderate distance to residential areas, such impacts are considered of minor to moderate significance if not adequately managed, but they can be effectively mitigated through the implementation of standard measures.
Effective mitigation requires implementation of a robust Environmental and Social (E&S) management system in line with international good practice management system standards. This will bring the negative environmental impacts of the Project to be minor or negligible.

In terms of climate resilience, climate change is not assessed to increase the risk of flooding at the WWTP site, hence regular good practice site drainage and stormwater solutions, dimensioned based on historical precipitation data and local surface water conditions, as well as emergency planning, are considered sufficient. An uplift in measures due to climate change is not considered necessary. Site drainage and stormwater solutions must be integrated in the detailed design of the WWTP in line with normal good practice.

Additionally, construction and operation of the Project is associated with risks for worker health and safety, which are typical to construction and WWTP treatment activities. For this, KS and the involved contractors must adopt strict H&S management procedures. Hence, a prerequisite for successful Project implementation is that E&S (incl. Health and Safety) management is fully adopted, led, and supervised by KS, and integrated in all works conducted by contractors involved in the Project. To enable this, training, and capacity building in E&S management amongst KS staff and its partners needs to be organised throughout the Project lifecycle.

1.2 Socio Economic Aspects

1.2.1 Benefits

The Project will through improvement of the wastewater treatment have a positive effect on the prevalence of water and sanitation related diseases in the Project area. This will, together with the significant reduction in odour, which is mentioned by communities as a significant annoyance, substantially improve the health and wellbeing of the population in the Project area.

The construction of the WWTP will require around 100 workers during the 36-month construction phase which will create temporary employment opportunities for the population in the nearby settlements and in Karaganda City and Region in general. As construction workers are expected to be hired locally there will be no significant influx of workers.

1.2.2 Adverse Impacts

The Project will have few negative socio-economic impacts. Due to the WWTP site's location in an industrial area with no communities in the proximity, the Project impacts on community health and safety due to construction influence on air quality and noise are of moderate significance and will with adequate mitigation and management be reduced to minor significance. Increased traffic and transport are moderate during construction if not adequately managed, but they can be effectively mitigated through the implementation of the indicated measures. The risk of communicable diseases and the risk of gender-based violence and harassment are assessed to be minor after mitigation as influx of construction workers is not foreseen.

While some employment opportunities will be created during construction, there will be a reduction of WWTP staff in the operation phase, as the current WWTP staffing is considered excessive for the operation of the new WWTP. Efforts will be made to avoid collective dismissals by redistributing staff to other workplaces within the company. In case this is not possible, the process will be carried out in line with national and EBRD requirements on collective dismissals and retrenchment.

The Project may lead to increased wastewater tariffs which could have negative impacts for vulnerable groups in Karaganda City. This needs to be monitored during operations to ensure that such impacts are adequately mitigated and managed by KS.

Other social aspects such as impacts on land use and cultural heritage are considered negligible after the implementation of mitigation measures.

2 INTRODUCTION

2.1 Context

The European Bank for Reconstruction and Development (the "EBRD" or the "Bank") is considering providing finance to Karaganda Su ("KS" or the "Company"), a city-owned company providing water supply, and wastewater management in Karaganda City. The finance will be used for construction of a new wastewater treatment plant (WWTP) and associated infrastructure (the "Project").

Karaganda City is located in the north-eastern part of Kazakhstan and is the administrative centre of the Karaganda Region.

Figure 2.1: Location of Karaganda City in Kazakhstan

A consultancy team from Sweco Danmark and the Kazakhstani company EcoSocio Analysis (the "Consultant") was engaged by EBRD to conduct a scoping process to identify key environmental and social issues related to the proposed Project and carry out the subsequent Environmental and Social Impact Assessment (ESIA) of the proposed Project.

2.2 Scoping process

The scoping process, which was conducted in February-March 2023 and reviewed again in August 2023 when the Project Description was available, involved initial identification of key environmental and social issues related to the Project. It also scoped out issues that are of lesser or no concern. The scoping process for the Project in Karaganda involved contact to, and consultation with, representatives of several regional and city authorities and a few households close to the existing WWTP, in addition to several discussions with KS.

The outcomes of the scoping process are shown in matrices illustrating interfaces between key Project activities and products and environmental and social receptors. These matrices are presented in the Scoping Report submitted to EBRD and are also included in Annex 3 to this ESIA Report.

2.3 Objectives and key stages of the ESIA process

The ESIA, which builds on the findings during the scoping phase, has the following objectives:

- Assessing any potentially significant future adverse environmental and social impacts associated with the proposed Project.
- Determining measures needed to prevent, minimise, mitigate, and compensate adverse impacts.
- Identifying potential environmental and social opportunities, including those that would improve the environmental and social sustainability of the Project.

The ESIA process is divided into the following key stages:

- Baseline analysis, including analysis of existing data and Consultant's own studies
- Impact assessment
- Mitigation management planning.

Consultations with stakeholders started during the scoping process and continued during the ESIA. There will be further stakeholder consultations during the public disclosure of this ESIA Report and other documents developed during the ESIA process. The public disclosure process as well as the stakeholder engagement and consultations for the detailed design and construction phases are explained in a separate Stakeholder Engagement Plan.

3 PROJECT DESCRIPTION

3.1 Project overview and location

The **Project** involves the construction of a new Wastewater Treatment Plant (WWTP) for the city of Karaganda located *approx.* 200km to the south of the national capital of Astana. A Feasibility Study (FS) (June 2023) with a preliminary design of the new WWTP was prepared by the local design agency Aquarem. The proposed new WWTP is to serve a population of nominally 500,000.

The Project comprises the following key infrastructure components:

- Construction of a new WWTP based on activated sludge technology and with design capacity of 100,000 m^3/day average flow and 130,000 m^3/day peak daily flow (500,000 P.E.) compliant with national and EU standards for urban wastewater treatment.
- Anaerobic Digestor (AD) line capacity to treat sludge from the WWTP process via primary and secondary digestion resulting in on average 22,000 m^3 biogas/day and output of approx. 100 t/day dewatered digested sludge for further drying (Aquarem estimate). Following drying, resulting in an estimated final treated and dried sludge quantity of approx. 50 tons/day (at 50% dry solids), which can be used as fertilizer or other land rehabilitation.
- A combined heat and power (CHP) facility to produce heat and electricity from biogas generated by the AD facility, with estimated *approx*. 66,000 kWh/day thermal energy and 50,140 kWh/day electric energy. The power generated by the CHP will be used at the WWTP site. (Aquarem estimate).

The Project will be implemented in line with the national and EU standards for wastewater treatment, EU requirements for sewage sludge management, EU BAT requirements for such facilities and EU taxonomy. Once implemented, the Project will also lead to a reduced level of odour.

Relocation of parts of the existing 35kV and 6kV overhead power lines that are located on the proposed land extension (12.75ha) for the new WWTP will also be required. The overhead lines are planned to be relocated along the perimeter of the new WWTP (further information is included in section 3.3.5 below) and consists of both overhead powerlines and underground cables. It is understood that this component will be implemented by the regional electric company that manages the power grid (not known how costs will be shared) and is considered an ‘associated facility’ of the proposed Project.

The existing WWTP site has an area of 49 ha in the southern part of the city, *approx.* 5km from the city centre at an elevation of 546m above sea level, hence the winters are harsh (Figure 3.1). There is a 500m sanitary protection zone. The new WWTP will be located partly within the existing WWTP site and partly within a 12.75 ha extension of the site towards the east from the existing site (Figure 3.2).

Figure 3.1 Location of the existing Karaganda WWTP in Karaganda (Source: Google Earth)

Figure 3.2: The site of the proposed new WWTP to the east of the existing WWTP (Map source: Google Earth)

Selected characteristics of the project in terms of timing and scope are summarised in Table 3.1: below.

Table 3.1: Summary of key project characteristics

Key project characteristics	
Project proponent	Karaganda Su (KS)
Estimated investment cost (CAPEX)	USD 175.7 million (KZT 78,559,378,638), *incl.* VAT. *Exchange rate as in May 2023: 447 KZT = 1 USD.*
Design capacity for WW treatment	500,000 PE, 100,000 m^3/day average and 130,000 m^3/day peak
Start and duration of construction phase	Planned construction start in June 2024. Duration of construction 36 months.
Estimated commission date of new WWTP	June 2027
Design lifetime of new WWTP	50 years (Civil works) 15 years (Mechanical works)
Number of staff during construction	100
Number of staff during operation	50
Estimated gross power consumption at normal operation capacity (MWh/year)	16,900

3.1.1 Project location alternatives

The Feasibility Study (2023) by Aquarem and the Sweco Feasibility Study (2021) do not consider alternative Project locations. The Project location adjacent to the existing WWTP site is proposed due to different reasons:

- Land adjacent to the existing WWTP site available for construction.
- Location with 5 km distance to Karaganda City centre, nearest residential area is over 600m from the location of the proposed new WWTP, which is adjacent to the railways.

3.2 Existing WWTP and justification of the need for the Project

3.2.1 Description of the existing WWTP

Karaganda has a centralized sewerage system in which domestic wastewater and industrial wastewater produced in the city is collected in the sewer collectors and transported by gravity to the existing WWTP. The WWTP is a mechanical-biological plant constructed in 1979. The actual wastewater flowrate to the existing Karaganda (WWTP) has been reported as *approx.* 95,000 m^3/day average flowrate, and a maximum wet weather flowrate of 169,000m^3/day likely based on water consumption as there is no flowmeter.

The existing Karaganda WWTP (49 ha) is located *approx.* 5 km south-west of the city at an elevation of 546m above sea level (masl) and which suffers harsh winters (-8.7 to -17.1^{O}C in winter, to 14.3 to 26.8^{O}C in summer). It is located in the territory of 11 industrial sites. The existing WWTP facilities were put into operation in 1979 and was designed for a maximum hydraulic capacity of 232,000 m^3/day. The nearest residential area is *approx.* 600m to the East adjacent to the railways.

The final recipient of effluent standards from the WWTP is the Sokyr river which is a small stream adjacent (south) to the WWTP. It does not support drinking water extraction. Due to the small size, the Sokyr river flow is very low and flows to the Intumak Dam which is also fed by the upstream Nura River. After the dam, the Nura River flows to the Lake Tengiz. As the river is small compared to the WWTP effluent flow, and the fact that it discharges to the Intumak Dam, it should be considered a “sensitive” receiving waters, as defined in the Urban Waste Water Treatment Directive.

The existing Karaganda WWTP utilises a Conventional Activated Sludge treatment process; however, the anaerobic digestion system was discontinued immediately after the WWTP was commissioned. The WWTP has all standard components, *viz.*: screens, grit removal, primary and secondary sedimentation tanks, aeration basins with Activated sludge, sludge beds and sludge storage area.

The existing plant includes:

- Mechanical treatment unit: (1 receiving chamber with volume of 130.4 m^3)
- Screens compartment of the main pumping station: (3 units with the gap width 16mm)
- Submersible type main pumping station: (3 units)
- Sand traps: (10 units of circular configuration with 6m *dia.* and 4.5 m depth)
- Sand drying beds: (3 units, 17x40m)
- Primary treatment (4 units of circular configuration)
- Raw sludge pumping station: (6 units)
- Aeration tanks: (4 units, each Volume = 20 500m^3)
- Blower and pumping station: (5 units)
- Secondary sedimentation tanks: (4 units, 40 m *dia.*)
- Pumping station for technical water
- Sludge ponds: (21 units with 1.5m depth)
- Bio-ponds (4 trains each of 3 ponds)

The treatment process is Conventional Activated Sludge where the raw wastewater is initially treated in the preliminary treatment process which includes screening and grit removal. Wastewater flows to primary settling tanks where the sludge is separated by gravity and transported to 21 sludge ponds located on the site area. Originally, the sludge was sent to anaerobic digesters; however, this was discontinued; they are not in use and should be demolished.

Primary treated wastewater flows to the aeration tanks for biological treatment using diffused air aeration. The mixture of purified water and activated sludge (Mixed Liquor) flows to the distribution chamber of the secondary sedimentation tanks where activated sludge is separated by gravity from the treated wastewater. The separated sludge is returned to the aeration tanks via the Return Sludge Pump Station, and excess sludge is transported to the sludge beds via the excess sludge pump station. The sludge has been stored in the adjacent territory since 1979.

From the secondary sedimentation tanks, effluent water from the WWTP is discharged to bio-ponds, which act as a form of tertiary treatment of the effluent water. There are four trains of 3 ponds (stages) each, in total 12 ponds. Each pond has an approximate size of 34,000 m^2 and the total bio-pond area is approx. 40 ha. Effluents from the WWTP are discharged to two trains of bio-ponds at each time, with rotation every 2-3 years. In this period, the two trains of bio-ponds not in use mostly dry out. Water from the bio-ponds flows via a discharge channel to the Sokyr river. An aerial photo showing the bio-ponds during winter is shown in Figure 3.33-3.

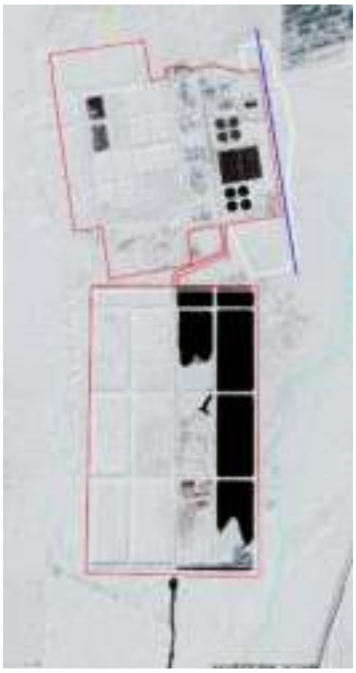

Figure 3.3 The WWTP site in January 2017, indicating which parts of the sludge ponds and the bioponds were in use at the time (image: Google Earth)

An existing road provides access from the north serving industries and local village (Ulitso Petrovskogo) to the existing Karaganda WWTP site. The road is a gravel road in a moderate condition and is considered suitable to support construction and operations for the new Karaganda WWTP.

3.2.2 Need for the new WWTP Project

The city is *approx.* 93% covered by sewerage networks and is expected to increase to up to almost 100% coverage by the design horizon of 2040. The need for the new WWTP is due to the poor quality of the existing civil works which have received limited maintenance. Additionally, the mechanical and electrical equipment of the existing Karaganda WWTP is in poor condition and does not treat wastewater fully to required levels. The existing treatment plant has four treatment lines in parallel, with three lines of biological treatment in a state of disrepair due to the wear of prefabricated reinforced concrete structures of partitions and walls. The original design was to utilise anaerobic digestion and biogas production however this has been discontinued. The digested sludge was to be dried in sludge ponds, however the existing treatment plant transports raw sludge to the sludge ponds for drying, where anaerobic digestion occurs and hence sludge removal attracts foul odours. Instead, the existing sludge beds should be replaced with mechanical dewatering devices such as a centrifuge or a belt filter press.

Karaganda is located within the Nura River basin (60,800km^2). The treated effluent from the Karaganda WWTP is discharged via a channel to the Sokyr River which flows westwards to the Intumak Dam/Reservoir on the Nura River – see maps below. The Nura River flows westwards for *approx.* 1000km, flowing to the north of Karaganda, then near the national capital and the Irtysh River, and eventually to Lake Tengiz (and the Kurgaldzhino wetlands). Note that the Karaganda region is noted for its lack of water resources, hence there is an incentive/opportunity for effluent re-use. Plantations appear to be located *approx.* 2km to the west from the WWTP site.

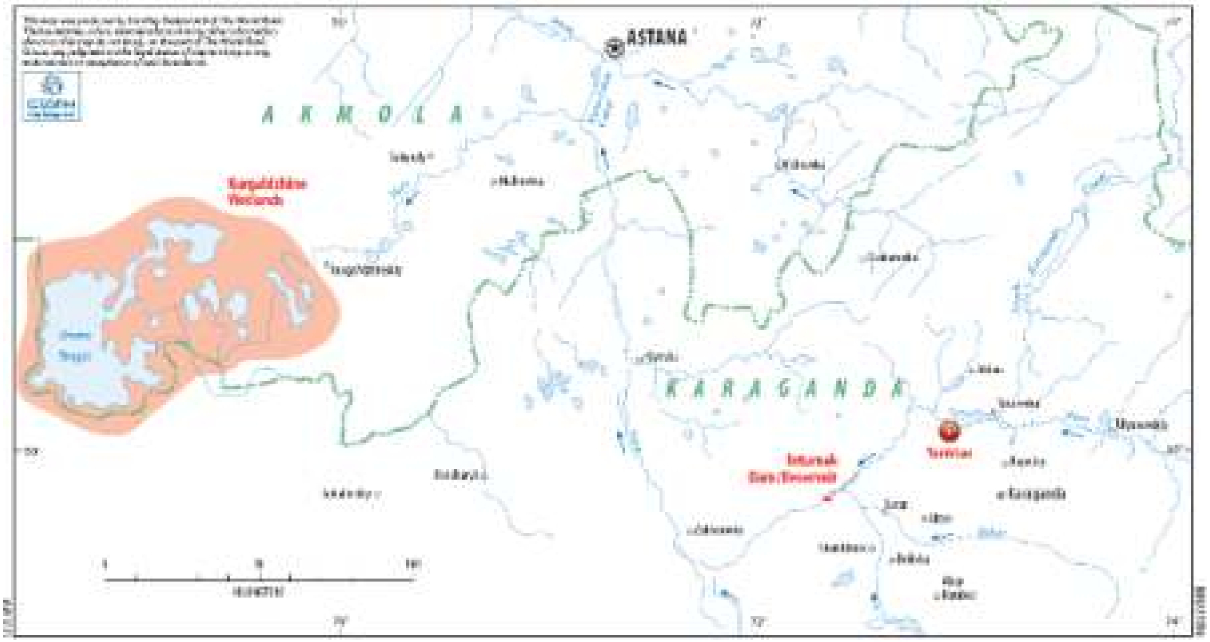

Figure 3.4: Location of Karaganda in the Nura River basin
Source: World Bank, 2013

Hence, there is a need for a new modern WWTP that can treat current and future volumes of wastewater from the city to meet strict effluent quality standards and improve the sanitary and epidemiological well-being of the city's population.

3.3 Proposed New Karaganda WWTP (The Project)

3.3.1 Introduction

A local Feasibility Study (FS) by Aquarem was presented in June 2023, proposing the construction of new WWT works serving a population of nominally 500,000. The object of the local Feasibility Study was the construction of a new wastewater treatment plant with an average influent wastewater capacity of 100,000 m^3/day, and a maximum daily capacity of 130,000 m^3/day for the city of Karaganda.

The Feasibility Study (2023) proposes:

- The use of modern energy-saving technologies and more advanced equipment for wastewater treatment.
- Implementation of the Project would significantly reduce the amount of wastewater pollution and improve the quality of wastewater suitable for irrigation.
- Improvement of the sanitary and epidemiological well-being of the city's population.

The following table summarises the design parameters of the new Karaganda WWTP works, as reflected in the local Feasibility Study (Aquarem, 2023):

Table 3.2: Design parameters for the construction of new WWTP

Design parameters	Unit	Values
Average daily consumption	m^3/day	100,000
Average hourly consumption	m^3/hour	4,167
Average second consumption	m^3/s	1.157
Maximum daily consumption	m^3/day	130,000
Maximum hourly consumption (K=1.47)	m^3/hour	6,125
Maximum consumption	m^3/s	1.7

3.3.2 Inflow characteristics and effluent discharge standards

The influent wastewater parameters have been estimated according to the rate of water consumption and the unit rates of pollution according to SN RK 4.01-03-2011:

Table 3.3: Estimated influent parameters for new Karaganda WWTP

No.	Parameter	Unit pollution rate (g/day*person)	Estimated concentrations Pollution (mg/L)	Actual performance (av./min.)
1	Suspended Solids	65	325	188.6/91.0
2	BOD $_{\text{ultimate (20 days)}}$	75	375	-
3	BOD_5	60	300	266.4/101.1
4	Ammonia Nitrogen, N	8	40	34.4/13.6
5	Phosphates, P_2O_5	3.3	16.5	11.0/5.6
6	Detergents	1.6	8	-
7	Chlorides, Cl	9	45	264.3/190.5
8	Surfactants (surfactants)	2.5	12.5	1.8/0.3

These estimated parameters are compared to those actually measured by KS, as tabled above. The new works for the Karaganda WWTP are to be constructed adjacent to the existing works. Based on the estimated values and actual measured values as tabled above, the following table assigns the designed d influent wastewater characteristics and effluent discharge standards proposed for the treatment plant:

Table 3.4: Summary of influent wastewater characteristics

The name of indicators	Unit measurements	Assigned values
Estimated values		
Maximum daily	m^3/day	130,000
Maximum hourly	m^3/hour	6,120
Qualitative characteristics of incoming wastewater:		
Suspended solids	mg/L	263
BOD ultimate (20 days)	mgO_2/L	439.2
BOD_5	mgO_2/L	366
COD	mgO_2/L	514.5
Nitrogen ammonium salts	mg/L	42.68
Phosphates	mg/L	4.5
Surfactant	mg/L	4.6
Sulphates	mg/L	264.3
Chlorides	mg/L	236.4
Iron total	mg/L	0.15
Oil products	mg/L	2.3
Nitrogen nitrite	mg/L	0.2
Nitrate nitrogen	mg/L	0.2
Characteristics of treated wastewater:		
Suspended solids	mg/L	5.0
BOD_5	mgO_2/L	6.0 (according to BOD ult.)
COD	mgO_2/L	30

The name of indicators	Unit measurements	Assigned values
Nitrogen of ammonium salts (ammonium ion)	mg/L	2.0
Phosphates	mg/L	3.5
Surfactant	mg/L	0.5
Sulphates	mg/L	236.3
Chlorides	mg/L	264.3
Iron total	mg/L	0.3
Oil products	mg/L	0.3
Nitrogen nitrite	mg/L	1.0
Nitrate nitrogen	mg/L	10.2

The discharge standards based on the Unified System of Water quality classification are established for the water bodies for 2016, order of the Chairman of the Committee for Water Resources of the Ministry of Agriculture of the Republic of Kazakhstan dated 9 November 2016 #151. The following table summarises the design influent characteristics, the current (2017) and expected effluent quality, compared to the local discharge standards, as well as the EU discharge standards:

Table 3.5: Comparison of Influent Parameters with Discharge Standards

		Qualitative indicators (input/output)				
Indicators	**Units**	**Influent**	**Effluent (2017)**	**Effluent (expected)**	**Local Standards Treated Effluent**	**EU Standards**
Suspended Solids	mg/L	263	10.3	<1	$C_{background}$ +10,0	35
BOD ultimate (20 days)	mg/L	439.2		6	6.0	
BOD_5	mg/L	366.0	2.8	3		25
COD	mg/L	514.5		30	35.0	125
Nitrogen ammonium salts	mg/L	42.68	1.88	2	2.0	*10
Phosphorus total	mg/L	13.8		1		**1.0
Surfactant	mg/L	1.8	0.097	<0.5		
Sulphates	mg/L	299.2		<236	< 1500	
Chlorides	mg/L	264.3		<234	350	
Iron total	mg/L	0.90		<0.3	0.3	
Oil products	mg/L	0.90	0.05	<0.3	0.3	
nitrogen nitrite	mg/L	0.288		<1	5.0	
nitrogen nitrate	mg/L	0.2	0.85	<1	45.0	

*Total Nitrogen for discharges to sensitive water.
** Total Phosphorus for discharges to sensitive waters.

Note: The local discharge standards are very strict compared to those specified in EU Urban Wastewater Treatment Directive, hence the Project is aligned to the EU's wastewater treatment legislation. The capacity of the new Karaganda WWTP is designed to meet both the local and EU discharge standards for the future influent flowrate.

The discharge standards for the new Karaganda WWTP have been based on water quality standards in the receiving waters specified in accordance with the rules "Sanitary and epidemiological requirements for water sources, places of water intake for domestic and drinking purposes, domestic and drinking water supply and places of cultural and household water use and safety of water bodies" Order of the Minister of Health of the Republic of Kazakhstan dated February 20, 2023, #26. The following table summarises the water quality standards in the receiving waters.

Table 3.6: Water quality standards for receiving waters

No.	Indicators of the composition and properties of water body	For recreation of the population, as well as reservoirs within the boundaries of populated areas (Category II)
1	Suspended solids	The content of suspended solids should not increase by more than 0.25 milligrams per cubic decimetre[1] (hereinafter mg/dm^3), 0.75 mg/dm^3
2	Floating impurities (substances)	Floating films, stains of mineral oils and accumulations of other impurities should not be detected on the surface of the reservoir.
3	$BOD_{ultimate}$	Should not exceed (at 20 ^{O}C): 6.0 mgO_2/dm^3; for recreation areas 4.0 mgO_2/dm^3
4	COD	30 mgO_2/dm^3
5	Ammonia (for nitrogen)	2 mg/l
6	Nitrates (according to NO_3)	45 mg/l
7	Nitrites (according to NO_2)	3.3 mg/l
8	Polyphosphates (PO_4)	3.5 mg/l
9	Pathogens	Water should not contain pathogens.
10	Escherichia coli (LCP)	Within the boundaries of populated areas, no more than 5000 in dm^3, for boating and sailing 10000 dm^3, for swimming 1000 dm^3
11	Coliphages	No more than 100 in dm^3
12	Viable helminth eggs	Should not be contained in 1 dm^3
13	Chemical substances	Should not be contained in concentrations exceeding the MPC or MPC

3.3.3 Overall description of the WWTP Process and alternatives considered

The purpose of the new Karaganda wastewater treatment plant is:

I. To produce a treated effluent that is EU-compliant and meeting discharge standards for disposal to the receiving waters.
II. To produce a stabilized sludge suitable for reuse or final disposal.

Due to the sensitivity of the receiving waters (Sokyr River, Intumak dam and Nura River) and the strict discharge standards for the WWTP, the treatment process is designed for biological nutrient removal, with EU-compliant treatment of the entire flow of wastewater. The new WWTP should have at least two separate parallel processing lines to facilitate maintenance, and the main elements of the mechanical equipment must have redundant capacities.

Wastewater Treatment technology alternatives

The Feasibility Study (2023) compared a range of wastewater treatment processes for the production of a treated effluent suitable for disposal to the Sokyr River. Although the Activated Sludge process is a common industry standard, the secondary treatment process will also be designed for biological nutrient removal. The secondary treatment processes considered included:

- A2O process (Anaerobic-Anoxic-Oxic)
- Johannesburg process
- Modified UCT process

These secondary treatment processes considered are commonly used for the treatment of wastewater and for the biological removal of the nutrients, nitrogen, and phosphorus. Based on a qualitative assessment, the optimal process was considered to be the Modified UCT process, due to the advantages of lowest unit costs, high nutrient removal, extensive operating experience, knowledge of the ongoing processes and the proven efficiency of cleaning. For illustrative purposes, a sketch of the

[1] Note: In the Central Asia region, it is common for discharge standards to be specified in milligrams per cubic decimetre (mg/dm^3), in contrast to Europe where the standards are specified in the SI system as milligrams per litre (mg/L). The measures are the same ($1dm^3$ = 1 Litre).

Modified UCT process is indicated below[2]:

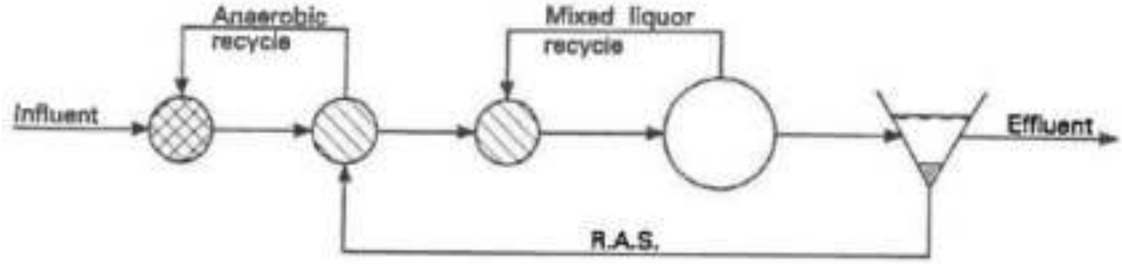

Figure 3.5: Sketch of Modified UCT process

Note: Whilst the conclusion and choice of treatment process is considered acceptable, Sweco recommends allowing tendering for a range of treatment processes which meet the discharge standards, with the lowest life-cycle cost tender meeting the administrative and technical criteria being suitable for implementation.

Sludge Treatment technology alternatives

The Aquarem Feasibility Study (2023) compared two sludge management systems:

I. Anaerobic sludge digestion with production of biogas for combustion in a Combined Heat and Power plant (CHP) for production of electricity.
II. Sludge dewatering, drying and combustion, however no biogas production for electricity generation.

Based on an economic assessment, the Feasibility Study (2023) selected the option of anaerobic digestion of the sludge with biogas production and combustion.

The proposal by Aquarem is to utilise the digested sludge from the WWTP as fertiliser. An area has been proposed for short-term storage of sludge within the WWTP site, prior to collection for land application. However, an actual plan to ensure sufficient offtake of the treated sludge has not been presented. Such a plan needs to be developed, including alternative disposal options in case of insufficient offtake capacity or interest by farms. This pre-construction action has been included in the ESMP for the project.

Sweco notes that for dealing with the digested sludge from the Anaerobic Digestion (AD) process, there are the following options (in order of preference):

1. Sludge re-use for agricultural purposes. This would be consistent with the EU Sewage Sludge Directive and management requirements and exploits the benefit of low-grade fertilizer value. The available land adjacent to the WWTP would be a long-term “sink” for sludge.
2. Sludge storage on-site (at the WWTP site) or at a long-term storage facility. This is feasible due to the excessive land available (especially if the sludge ponds are decommissioned), however provides no economic benefit. There might be opportunity for re-using some of the sludge for horticulture or land rehabilitation uses.
3. Long-term disposal at landfill. This has the disadvantage of reducing the municipal landfill lifetime and provides no economic benefits.

Sludge disposal via incineration is not considered a viable option due to high CAPEX and OPEX involved.

Note: The application of stabilized sludge via anaerobic digestion and heat treatment is consistent with the EU Sewage Sludge Directive, hence the Project is aligned to the EU’s sludge management

[2] In brief: The process includes an anaerobic zone for biological phosphorus removal, first and second anoxic zones (for nitrogen removal) and an aerobic zone (for oxidation of organic pollutants and ammonia), prior to separation of the effluent from the sludge in a sedimentation tanks. The treated effluent is discharged to the receiving waters and the sludge (RAS) is returned to the treatment process.

legislation. The Decommissioning Plan for the sludge ponds (except for a limited number of ponds for emergency requirements) is a requirement of the ESMP and ESAP.

3.3.4 Technical Description of the proposed new Karaganda WWTP Treatment Process

The new Karaganda WWTP is designed with a Modified UCT process to meet the effluent discharge standards, and with anaerobic digesters for sludge stabilization. The following drawing shows the proposed layout for the new Karaganda WW treatment plant (numbering of the Key Unit Processes in Figure 3.7 are based on Aquarem's detailed drawings):

Figure 3.6: Site layout for Karaganda WWTP

Figure 3.7 contains a detailed WWTP process diagram, and a description of the process steps is presented in the below diagram.

Key Unit Processes
2. Grit Channels
3. Primary Sedimentation
4. Biological tanks
5. Secondary Sedimentation
28/29. Anaerobic Digesters

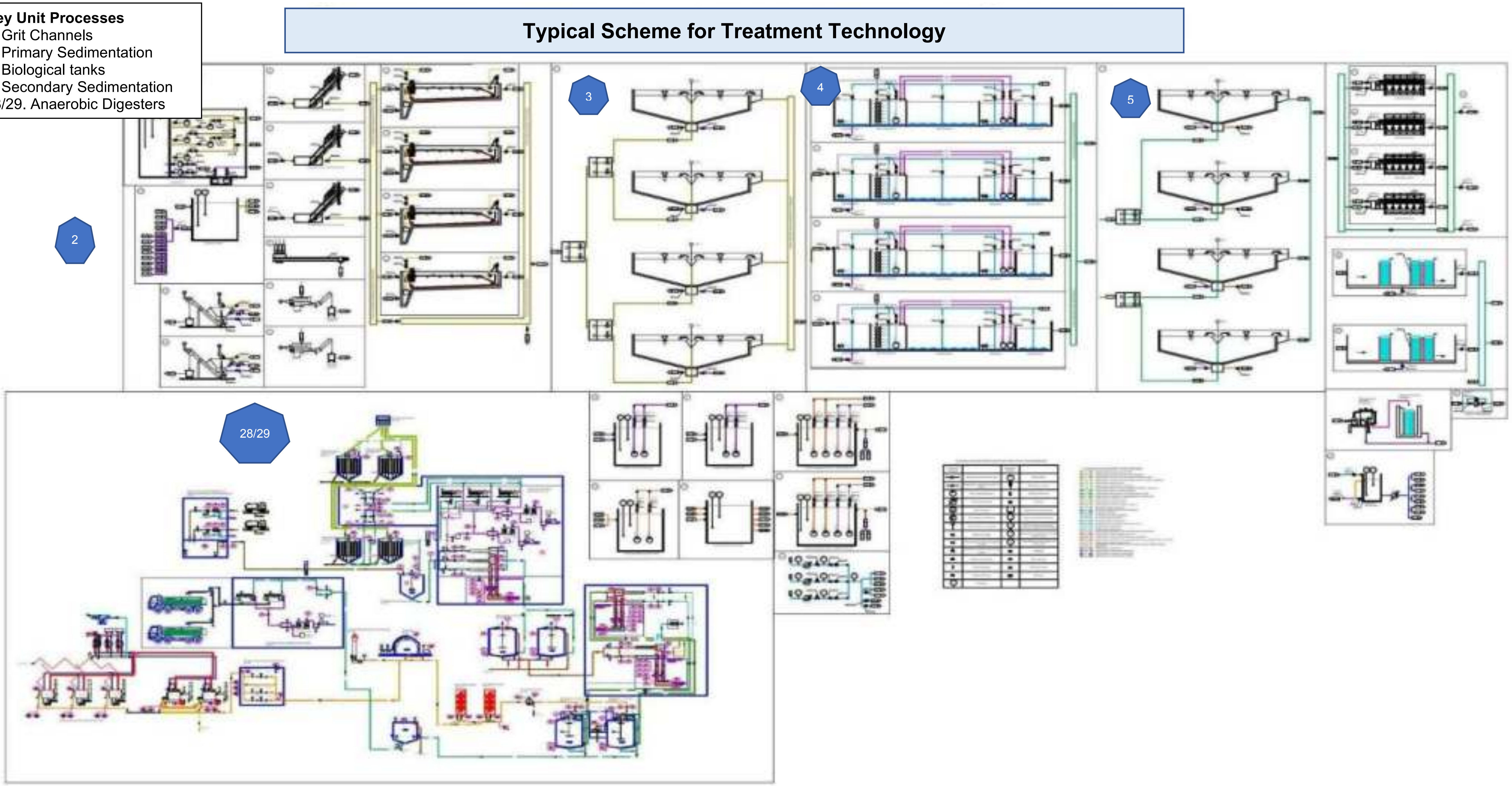

Figure 3.7: Proposed wastewater treatment process layout

The new Karaganda WWTP Process is described below and is based on the site layout in the above figures.

Domestic wastewater from the city and industrial enterprises enters the main sewage pumping station at the existing WWTP, from which the wastewater enters mechanical treatment which consists of fine screens, horizontal sand traps, washing and dewatering plant for waste from the screens and sand from the grit traps. Screenings retained on the screens is transferred via a hydro-chute to a screw washing press, from which they are then automatically dumped into a mobile trailer container-storage, with subsequent removal to landfill agreed with the city's sanitary service.

After the screens, wastewater is fed to horizontal sand traps (Item 2); the sediment from the sand traps is collected by a scraper mechanism and mixed in a pit, from where it is pumped by sand pumps to the building for sand separators and sand washing installation. Washed and dried sand is transported to the municipal solid waste site for disposal.

From the sand traps, wastewater is fed through a gravity pipeline to radial primary settling tanks (refer Item 3), where wastewater is partially treated by removal of settleable solids (primary sludge).

The sludge from the primary settling tanks is fed by gravity to the raw sludge pumping station, from where it is pumped to the sludge mixing tank, where it is combined with excess Activated Sludge from the secondary settling tanks through the circulating and excess sludge pumping station.

From the primary settling tanks, wastewater enters the biological tanks (refer Item 4). Each biological tank includes the following treatment zones separated by reinforced concrete partitions:

- Anaerobic zone (phosphorus removal), which is supplied with wastewater after mechanical treatment facilities and recirculation flow from the anoxic zone, by means of a recirculation pump. Fully anaerobic conditions are maintained in this zone (absence of dissolved oxygen and nitrates). To maintain the sludge mixture in suspension, submersible mechanical mixers are installed in the anaerobic zone.
- Anoxic zone (denitrification), which receives the mixture of the biomass and wastewater from the anaerobic zone, and the "nitrate recycle" sludge mixture from the end of the nitrification zone, and recirculated activated sludge. In this zone, it is necessary to maintain anoxic conditions (absence of dissolved oxygen, presence of nitrates). The concentration of dissolved oxygen in this zone is limited (not more than 0.5 mg/L). Submersible mechanical mixers are installed in the anoxic zone to keep the sludge mixture in suspension. From the end of the anoxic zone, it is planned to recirculate the nitrate-containing sludge mixture to the anaerobic zone (recycle) by mechanical propeller pumps.
- Aerobic zone (nitrification), in which aerobic conditions are maintained at a concentration of dissolved oxygen of 2 mg/L. To do this, the aeration zone is equipped with a fine-bubble diffused air aeration system (disk aerators). The nitrate-containing sludge mixture from the end of the aerobic zone is pumped by propeller pumps to the beginning of the anoxic zone.

After the biological tanks, the Activated Sludge mixture enters the radial secondary settling tanks (refer Item 5), where the Activated Sludge is separated by gravity. The separated sludge from the secondary settling tanks enters the return Activated Sludge pumping station. Circulating activated sludge is returned to the beginning of the biological tanks.

Compressed air is supplied to the aerobic zone from the blower building through two pipelines.

The Return Activated Sludge pumping station serves to separate the flows of circulating (return) and excess sludge. The Return Activated Sludge is returned to the biological tanks and participates in the biological treatment process; the excess Waste Activated Sludge is pumped into a mixed sludge tank, then sent to the mechanical sludge thickening system for sludge thickening and dewatering.

In the event of an emergency shutdown of the mechanical sludge dewatering shop, a mixture of raw sludge and excess Waste Activated Sludge from the sludge mixing tank is discharged via pumps located in the mechanical sludge dewatering building to the existing emergency sludge ponds. For this reason, 3 sludge ponds will remain as standby units due to emergency (according to Aquarem).

From the sludge mixing tank, the sludge mixture is pumped to the gravity thickening units through the distribution chamber. Imported substrates from industrial enterprises are collected and then subjected to thermal treatment. The thickened and thermally treated sludge and substrates are collected in the thickened sludge tank, from where they are pumped to the sludge treatment building. After heating in the technical building, the mixed thickened sludge will be pumped to the first stage digesters for pre-digestion. The hydrolysed sludge is returned to the technical building for cooling down to 37°C, and then fed into the second stage digesters for fermentation in the mesophilic mode. The digested sludge is collected in the digested sludge tank, from where it is returned to the technical building for dewatering via centrifuges. Biogas resulting from the sludge fermentation process in the stage II digesters is collected in the upper part of the chambers and discharged to gas holder, with sulphur removal unit. Biogas is supplied to cogeneration units, generating heat and electricity, installed in containers near the technical building. Excess biogas is fed to the flare of combustion system. Generated electricity can be used to power equipment of the plant such as pumps and blowers. Recovered heat is used to maintain the temperature in the digestion tanks, other excess heat can be used for the sludge treatment processes and for heating of various facilities.

Treated wastewater flows to the post-treatment filters. After the filter block, wastewater is fed to the UV disinfection unit. After disinfection, wastewater is discharged to the Sokyr River via the bioponds.

The Karaganda WWTP is designed to dewater and dry the digested sludge. The digested sludge from the AD will undergo dewatering with centrifuges. The dehydrated sludge is then sent to the sludge drying building, where it undergoes further drying. The input to the sludge drying process is anticipated as 100 tons/day digested and dehydrated sludge (at 70% humidity). The design anticipates two high temperature ES1500 drying lines each with capacity of 50 tons/day to process the dehydrated digested sludge (Aquarem FS, 2023).

The drying process is carried out in a closed circuit in order to ensure a high efficiency of the process. A heat recovery system will also be supplied, using the excess energy of the process gas to produce hot water.

Sweco has roughly estimated the generated sludge volumes as follows:

- Primary sludge from the primary settling tanks is about 300m^3/day at 4% solids.
- After digestion this equals 300m^3/day at 2.5% solids.
- After dewatering of the digested sludge in a centrifuge to 25% solids, the flow of sludge decreases to about 30m^3/day at 25% of digested and dewatered sludge. This is equivalent to a dry matter content of 7 tDS/day (DS: dry solids).
- Secondary Sludge is about 13tDS/day, so the total sludge (primary + secondary) is about 20tDS/day. Assuming it leaves the mechanical dewatering (centrifuge) of 25% solids, the flowrate of sludge is about 85m^3/day (which is *approx.* 100 m^3/day).
- The 85 to 100 m^3/day digested and dehydrated sludge corresponds to the designed drying line capacity of 100 t/day (2 x 50 t/day) assuming a volume to weight ratio of close to 1.
- The driers will treat 100m^3/day of sludge at 25% solids and produce 50m^3/day of dried sludge at about 50% solids. This equals *approx*. 50t/day of dried sludge, or *approx*. *18,250* tons/year.

After the drying process the sludge will be stored and covered for two weeks at a designated area on the new proposed WWTP site to stabilise. It is foreseen that the sludge can then be used for agriculture or rehabilitation purposes. A plan for the reuse of sludge and information about the implementation must be provided in the detailed design.

The Feasibility Study by Aquarem (2023) informs that 1,794 tons of reagents (coagulants) will be required annually in the wastewater treatment process.

3.3.5 Relocation of overhead power lines

Parts of existing overhead power lines connecting the existing WWTP need to be relocated to make space for new WWTP infrastructure. Existing overhead lines will pe partly replaced with new overhead lines and partly with a new underground cable located outside the periphery of the proposed WWTP site. The powerline relocation will be implemented by the local power grid company Karagandy Zharyk at the request of KS. Hence, it is expected that the cost of the power line relocation will be borne by KS, although this has not been confirmed.

The E&S impacts of the powerline relocation have been considered in this ESIA and in the associated ESMP as relevant. General mitigation measures in the ESMP also apply to the overhead line relocation, as a part of the overall project.

The following has been proposed in the Aquarem Feasibility study (2023) in terms of the required cable length and the number of towers:

- Four 6kV underground cables 533m+170m+175m+216m=1094 m long spurring from the existing 6kV powerlines.
- A 35kV 952m long underground cable from the power station.
- A 35kV 223m long overhead powerline with 3 additional anchor towers connecting the 35kV underground cable with the existing 35kV overhead powerline.

Different existing overhead power lines with 35kV and 6kV capacity run through the proposed land plot for the new WWTP site and will need to be relocated to make space for the new WWTP infrastructure.
A plan for the relocation of the overhead powerlines, received from Aquarem (in Sept 2023), has been prepared and is shown in Figure 3.9. This plan will be submitted for approval to the city power network management company. The regional electric company will be contracted to do the reallocations works.

Figure 3.8 provides an overview of the existing overhead powerlines and how different sections/parts of the 6kV and 35kV powerlines cross through the proposed plot for the new WWTP, which is circled in green. The blue lines show existing 35kV and the orange lines existing 6kV overhead powerlines.

Figure 3.8 Existing overhead powerlines and proposed plot for the new WWTP (Blue: 35 kV overhead powerline. Orange: 6 kV Overhead powerline).

With regards to the relocation of powerlines, the Aquarem Feasibility study (2023) proposes the introduction of underground cables; four 6kV underground cables and one 35kV underground cable. The proposed location of the underground cables is depicted as purple lines in Figure 3.9. The blue line shows the new 35kV powerline connecting the 35kV underground cable with the existing 35kV line. The white lines show the existing powerlines which will not be altered while the red (light and dark red) lines show the existing powerlines which will be removed. The substation will remain at the existing location within the existing WWTP site.

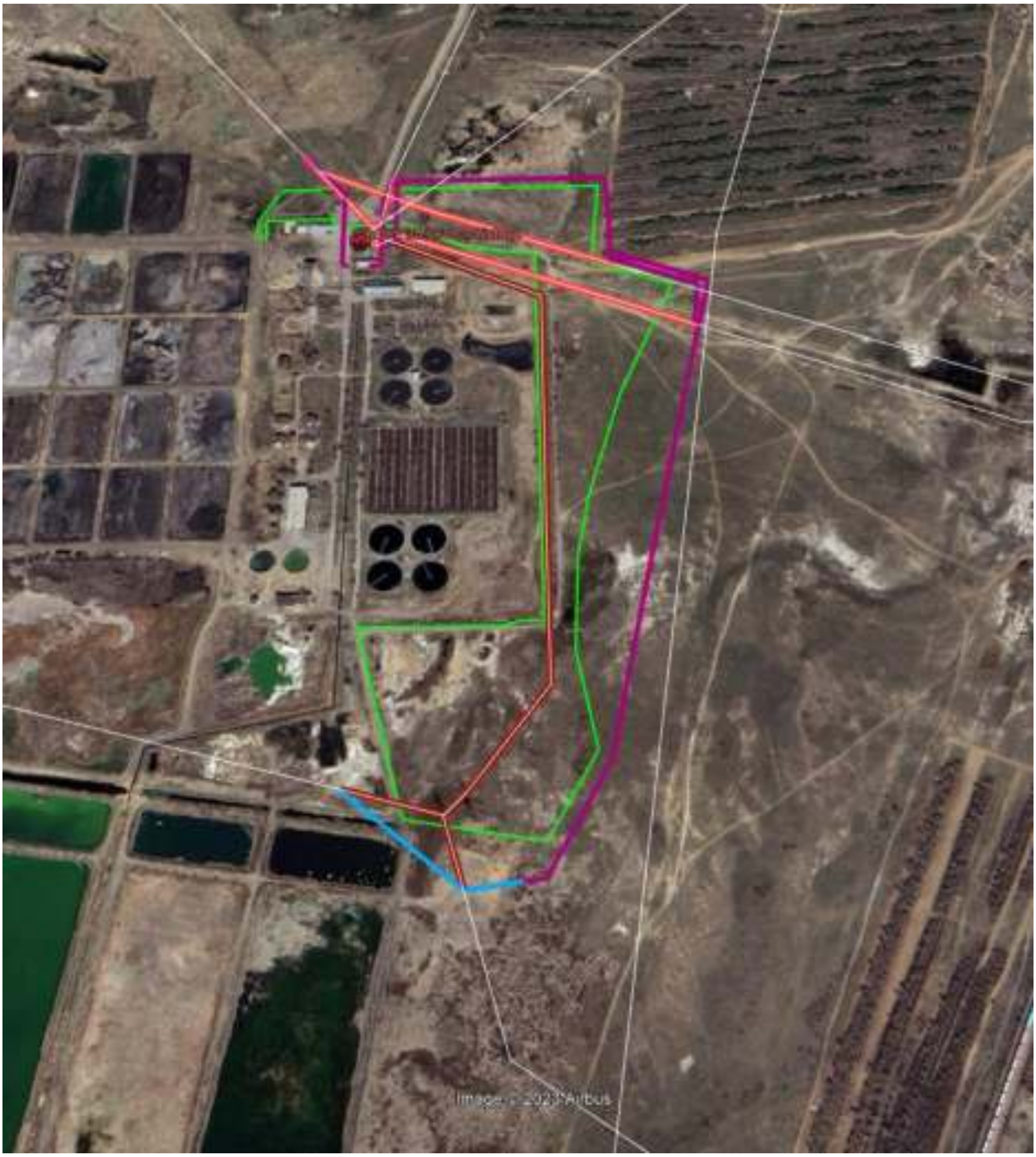

Figure 3.9 Proposed new underground cables (purple lines) and existing overhead power lines which will be removed (dark red over white: 35 kV OHL, light red on white: 6kV overhead lines) and replaced by either underground cables (purple) or a short section of a 35 kV overhead line (blue line) at the south of the site.

3.4 Sanitary Protection Zones (SPZ) for the WWTP

The size of the sanitary protection zones around the KS facilities is determined in accordance with the sanitary and epidemiological requirements for the establishment of sanitary protective zone of production facilities, as specified below. No residential housing and buildings visited by the general public are allowed to be present in this zone (SanPiN RK DSM-2 from 11.01.2022). This means that other buildings and structures, *e.g.,* industrial buildings and animal sheds are allowed within the SPZ. There are no restrictions in the use of land within the SPZ for farming, planting of trees or similar.

According to Aquarem, it is expected that the current SPZ of 500 m will remain unchanged. Even though the extension of the existing site will bring the WWTP site less than 100m to the East, the nearest residential areas will remain more than 500m from the WWTP site. The requirement for this type of facility is that the SPZ is at least 400m (Table 3.7). The SPZ is to be confirmed by the State Environmental Expertise (SEE) based on legal requirements and the findings of the local EIA. The following table shows the minimum SPZ requirements for different types and sizes of wastewater treatment facilities in Kazakhstan, indicating a required size of the SPZ of at least 400 m for the proposed WWTP.

Table 3.7: Minimum SPZ (m) for municipal wastewater facilities (source: SanPiN #RK DSM-2 (2022))

Wastewater treatment facilities	**Design capacity of treatment facilities (thousand m^3/day)**			
	< 0.2	**0.2-5**	**5-50**	**50-280**
Pumping stations and emergency control tanks, local treatment facilities	15	20	20	30
Structures for mechanical and biological treatment with sludge ponds for raw sludge, as well as sludge ponds	150	200	400	500
Facilities for mechanical and biological treatment with thermo-mechanical treatment of sludge in enclosed spaces	100	150	300	**400**
Filtering fields	200	300	500	1000
Irrigation fields	150	200	400	1000
Biological ponds	200	200	300	300

3.5 Decommissioning of the existing WWTP

Existing Karaganda WWTP

The proposed new WWTP has been designed in such a way that location of new WWTP infrastructure components does not overlap with existing infrastructure (Figure 3.10). Hence, the existing WWTP operations can be continued during the construction of the new WWTP.

Figure 3.10 Location of new WWTP components within the existing WWTP site.

After the new Karaganda WWTP is commissioned, the existing WWTP works become redundant.

Aquarem has provided a demolition act (September, 2023) which indicates which components of the existing WWTP will be demolished, and expected quantities of demolition waste that need to be transported and disposed of at the local landfill (Figure 3.11).

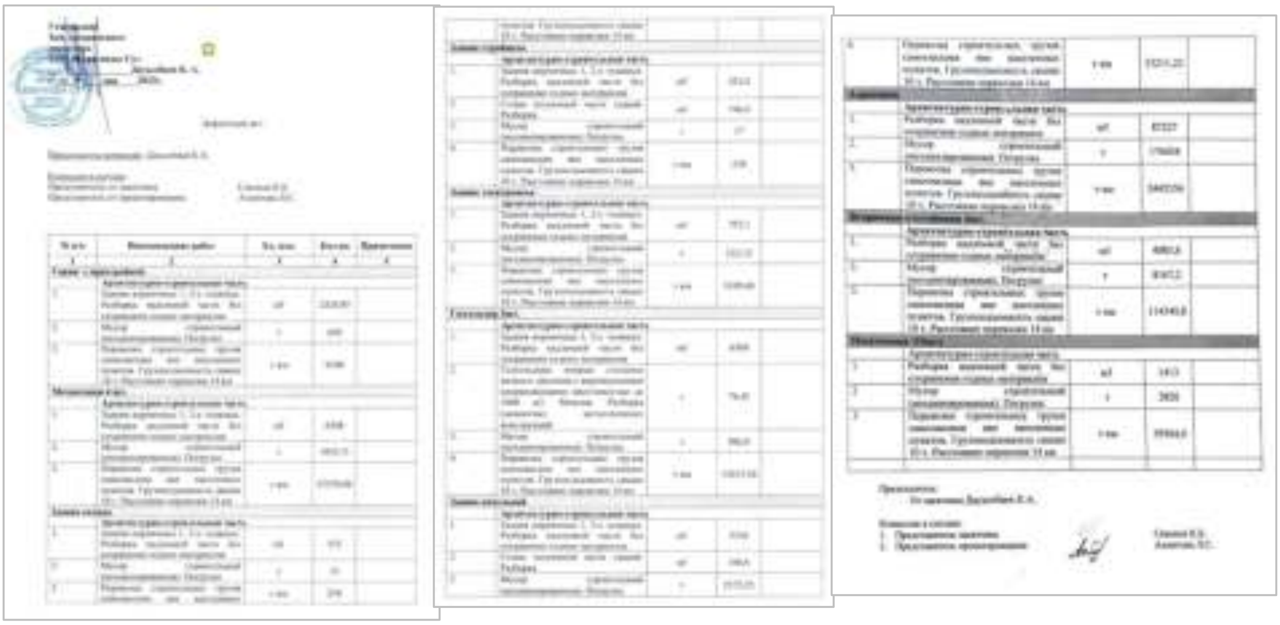

Figure 3.11 Demolition act for the existing WWTP

In summary, the demolition act envisions the following demolition components and associated quantities of demolition waste:

Table 3.8 Demolition Act for transportation of construction waste to the Karaganda landfill 14km away

	Volume (m3)	Mass (tons)
Garage	2325	650
Methane tanks	6368	1956
Warehouse	312	15
Workshop	450	17
Electric shop	757	222
Gasholders (2)	6368	965
Boiler house	5497	33211
Aeration tanks	87 227	174 454
Sec. sedimentation tanks (4)	4084	8167
Sand catcher (10)	1416	39564

Not all the existing WWTP infrastructure will be demolished. For example, it is understood from Aquarem, that the existing primary sedimentation tanks will be kept for use in emergency situations.

Sludge beds

After the new anaerobic digestion and mechanical sludge dewatering system is commissioned, the existing sludge ponds will become redundant. Consequently, Sweco notes there are a number of options for the existing sludge ponds:

- Option 1: Do Nothing Option. Allow the sludge sitting in the existing ponds to completely dry, and in the long-term removal of the sludge. This attracts no capital cost (CAPEX) and very little operating cost (OPEX). It would allow the continued use of the sludge ponds as a standby in emergency situations (which is probably unlikely and would be an odour nuisance for adjacent households). In the long-term, KS or the Municipality may wish to rehabilitate the land.
- Option 2: Decommission ponds and rehabilitate the land for other use. This requires emptying the ponds and land rehabilitation. This attracts capital costs for rehabilitation works (CAPEX) but very little operating costs (OPEX). No continued use of the ponds and no odour nuisance to adjacent households. It allows KS or the Municipality to re-use the land.
- Option 3: Maintain a small number of ponds for emergency use. This would require decommissioning most of the ponds (say 90% decommissioning of the ponds) and long-term rehabilitation. This attracts capital costs for rehabilitation works of most of the ponds (CAPEX), and very little operating costs (OPEX). In general, no continued use of most of the ponds (but some would be retained for emergency use), and limited odour nuisance to adjacent households.

For the immediate term, it understood that KS prefers to retain the existing sludge ponds for emergency situations, however it is likely that it will gain confidence on the operation of the new WWTP, and eventually fully decommission the majority of the existing sludge ponds. Aquarem has informed that there is currently no provision for rehabilitation of the sludge beds as it is located within the Bukpa River water protection zone.

The local Feasibility Study (Aquarem, 2023) envisages to use three (3) of the existing sludge ponds as a standby in emergency situations. Rehabilitation or other works on the sludge beds are not foreseen or planned yet. The ESMP includes a requirement to prepare a decommissioning and rehabilitation plan for the sludge pond area, with a clear timeframe and budget Full implementation of the ESMP is a binding requirement of the ESAP, which implementation will be a condition of EBRD lending.

3.6 Overview of key project activities

3.6.1 Construction phase activities and outputs

In the context of this ESIA, the following activities and outputs for the construction phase were identified during the scoping study and are considered in this ESIA.

- Site preparation and excavation
- Transportation of construction material and construction machinery and equipment
- Transportation of workers
- Operation of concrete batch mixer and aggregate crushing
- Installation of pipes
- Installation of biogas plant and CHP
- Construction of WWTP and Operation of construction machinery and equipment
- Wastewater management during construction
- Demolition and construction waste generation
- Electrical installations
- Site drainage installation
- Relocation of power lines
- Landscaping
- Decommissioning of existing sludge ponds
- Demolition works of three digesters
- Unplanned events:
    - Spill/overflow of WWTP and climate change related events such as heavy rain

- Natural disasters (wildfire, earthquake, *etc.*)

3.6.2 Operation phase activities and outputs

The following activities and outputs of the WWTP operation phase were identified during the scoping study and are considered in this ESIA:

- Transportation of material + equipment + waste
- Transportation of workers
- Vehicle fleet management
- WWTP laboratory operation
- WWTP operation and effluents
- Biogas plant operation and maintenance
- Sludge and/or digestate management
- CHP operation and maintenance
- Site drainage and stormwater management
- Landscaping
- Security operations
- Pest control
- Generation of GHG emissions
- Generation of waste
- Generation of sewerage sludge
- Unplanned events:
  - Spill and leak of oil and chemicals
  - Fire, explosion
  - Natural disasters (wildfire, earthquake)

3.7 Analysis of Project Alternatives

3.7.1 Alternatives considered

The above sections describe key project alternatives considered in the process leading up the current proposed WWTP design, which in particular relate to:

- Project location alternatives (3.1.1)
- Wastewater treatment technology alternatives (3.3.3)
- Sludge treatment technology alternatives (3.3.3)

Additionally, the option to renovate parts of the existing WWTP vs. build an entirely new WWTP has been considered. The Sweco Feasibility Study (2021) proposed the rehabilitation of the existing treatment plant (capacity of an average flowrate of 50,000m^3/d) and new expansion with a parallel treatment line (with an additional capacity of average of 50,000m^3/d). However, this option was not supported by KS, which was of the opinion that renovating the existing WWTP facilities was not feasible given the condition of existing structures and uncertainties with regards to cost of renovation and the resulting lifetime extension obtained. Hence, it was decided to pursue a brand new WWTP to service the whole population of Karaganda, with an average capacity of 100,000m^3/d.

3.7.2 No project or zero alternative

In the "no project alternative" the new WWTP would not be constructed, and the existing wastewater treatment practices will remain unchanged, using the largely derelict WWTP. Assuming current level of maintenance, only sub-optimal operation can be sustained, and effluent quality will continue to be of inadequate quality, exceeding both EU and national standards. Poor quality effluents will continue to be discharged to the Sokyr River and from there to the Nura River and Intumak dam, where they cause negative ecosystem impacts. The existing WWTP does not have capacity to deal with expected increase in population connected to the piped wastewater system and will get increasingly overloaded over time.

Raw sludge from the WWTP would continue to be pumped un-stabilised to the existing sludge ponds for solar drying, resulting in odour problems and substantially higher GHG emissions compared to the proposed Project solution.

4 ESIA APPROACH

This chapter provides an overview of the overall ESIA approach in terms of key steps and methods applied, which are reflected in subsequent chapters of this report.

4.1 Framework of ESIA

The approach to this ESIA builds on the requirements of the EBRD as reflected in EBRD's Environmental and Social Policy (ESP) and associated Performance Requirements (PR), the EU EIA directive, national legal requirements and other good international ESIA practice.

As part of the Project approval process according to local legislation, a separate national EIA is being developed by the local company Aquarem following the development of a Feasibility Study for the proposed WWTP Project. The EIA is being submitted to the State Environmental Expertise (SEE) for review and processing. To progress to the next stage of the Project design, the preliminary EIA has to be approved by the SEE. The national EIA process is discussed further in section 5.3.1 below.

4.2 Stakeholder engagement

Sweco has undertaken engagement with local communities and other stakeholders since the scoping stage and has developed a stakeholder engagement plan (SEP) to inform further stakeholder engagement throughout the lifetime of the Project.

4.3 Project Description and alternatives

The Project as described in chapter 3 defines the focus and scope of this ESIA, based on the Project design outlined in the Feasibility Study conducted by Aquarem in 2023. This reflects the Project design that is being put forward by KS (the project proponent) and is seeking environmental approval from the local authorities (SSE) and financing from EBRD. Hence, the ESIA does not as such assess impacts of alternative project designs. However, previously considered design alternatives (in terms of location, technology, size, scale, and/or design), as well as the non-project alternative, and the rationale for pursuing the current design, are also outlined in relevant sections in chapter 33. Additionally, specific options with regards to, e.g., sludge management are discussed in relevant sections of the impact assessment.

4.4 Scoping stage

The purpose of the scoping stage was to identify key issues related to the Project which would be considered in the ESIA process. The scoping process for the Project in Karaganda involved contact to, and consultation with, representatives of several regional and city authorities and a few households located relatively close to the proposed new WWTP, in addition to several discussions with the Company (KS).

A draft Scoping Report was prepared and made available to EBRD in August 2023. The comments provided by EBRD have been incorporated into the further planning of the ESIA process. The Scoping Report was finalised in October 2023.

4.5 Project Area and scope of assessment

4.5.1 Temporal boundaries

This ESIA addresses impacts arising throughout the lifetime of the Project with primary focus on i) pre-construction (planning) and construction and ii) operation phases. Closure (decommissioning) phase impacts are acknowledged where relevant but not assessed in detail. In general, the closure impacts and required mitigation and management measures are expected to resemble impacts from construction phase activities and should be planned in detail when approaching the WWTP facilities' end-of-life.

4.5.2 Spatial boundaries

Project area

The project area is defined as the area within which new infrastructure will be built and/or where major renovations will take place (actual 'footprint' of the Project), which comprises the existing WWTP site and an extension of the site of 12.75 ha to the East, North and South. Additionally, a limited area on the periphery of the WWTP site will be affected by relocation of overhead power line masts, and the construction of an underground cable which will substitute some of the existing 6 kV and 35 kV overhead powerlines crossing the WWTP site. The planned Project infrastructure and the site boundaries are described in chapter 3. The project area is depicted in Figure 4.1.

The Project area is the area with project activities which are the primary source of impacts during both pre-construction/construction and operation phases. However, the area impacted (influenced) by the project goes beyond the actual project area, and hence the **study area for this ESIA** reaches beyond the actual project area, as discussed below.

Project Area of Influence

The spatial boundaries of the ESIA comprise the geographical area that is potentially affected by the Project, also referred to as the Project Area of Influence (PAI) and reflects the types and geographical scope of potential environmental and social risks and impacts. The key areas that may be directly affected by project activities (Area of direct influence), and thus falling within the scope of the ESIA, include:

1) The **WWTP site** and adjacent area where physical and biological impacts (such as odour, noise, contamination, etc.) can be felt, including areas used for sludge management.
2) **Main roads to and from the WWTP site**, where heavy transport can be a source of impacts.
3) **Inhabited areas** close to the WWTP site.
    - Kir-zavod 3-4 (approx. 800 m on the north side of WWTP) has approx. 83 houses.
    - Proizvodstvennaya Street (approx. 505m north-east of the proposed WWTP site), two houses in close proximity to the WWTP.
    - Railway junction 737 (approx. 530m on the east side of proposed WWTP site), where residents have a clear view to the WWTP; 34-40 families live in 17-20 houses.
    - Fedorovka micro district
4) **Waterways** downstream from the WWTP, where effluents are discharged and impacts on water quality may be felt, including sedimentation ponds (bioponds), the discharge channel at the south of the existing WWTP and the Sokyr River (considered approx. 500m above and 2,500m below the discharge point of the discharge channel to the river).
5) **Arable and horticulture areas** using either treated effluent water for irrigation and/or sludge or digestate from the WWTP.

The PAI consisting of the above key features are reflected in Figure 4.1 below.

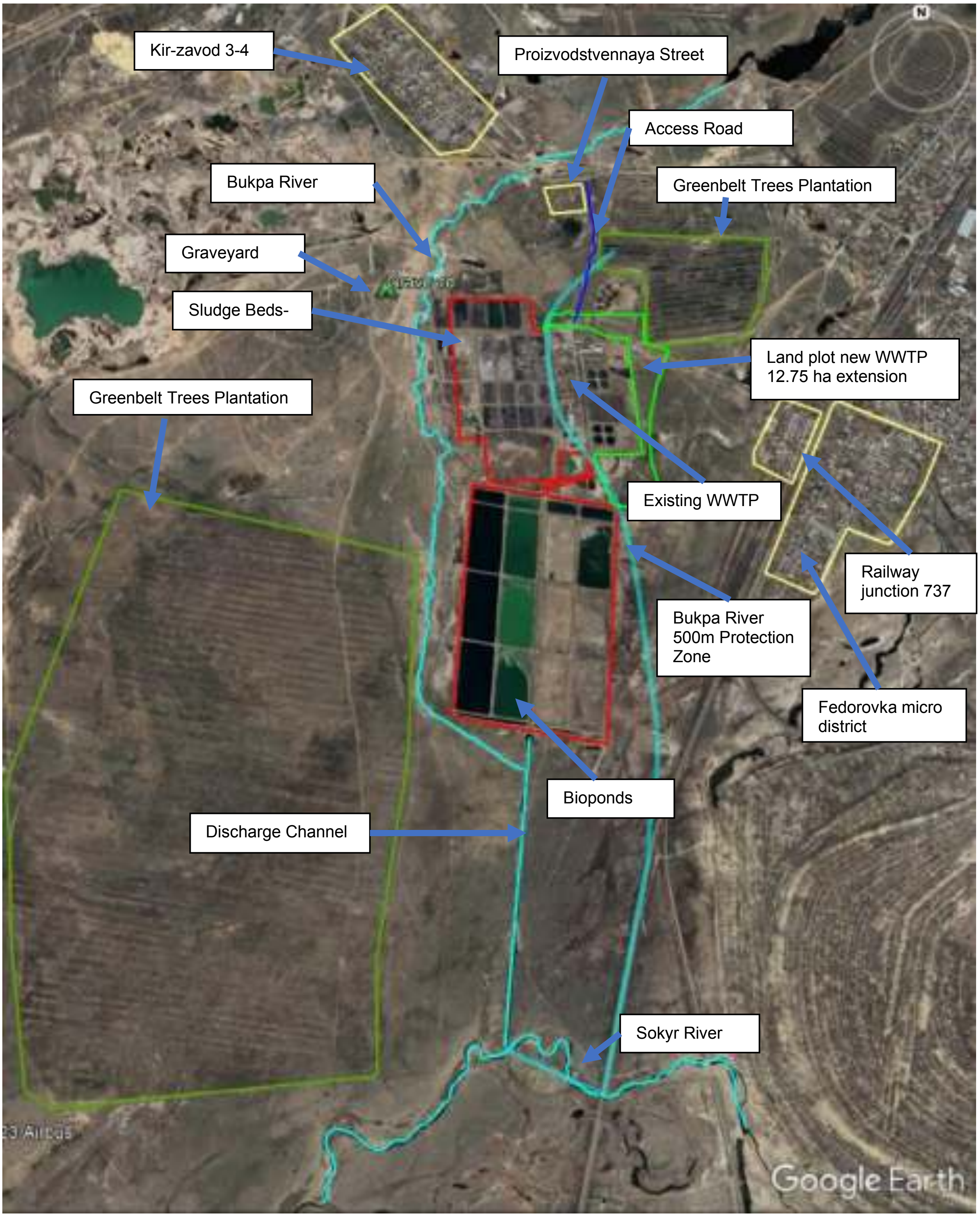

Figure 4.1: The project area of the proposed WWTP Project, consisting primarily of the existing and new WWTP sites, sludge management sites, the discharge channel to the Sokyr River, the Bukpa River and associated protection zone, greenbelt forests, houses and settlements in the vicinity of the Project (nearest settlements marked with yellow lines). (Map source: Google Earth).

The social setting of the Project in terms of residential areas, population, and distance to WWTP operations is set out in Table 4.1 below.

Table 4.1: Residential areas in the study area

Settlement	Population	Distance to existing WWTP
Kir-zavod 3-4	324	800 m on the north side of WWTP
Proizvodstvennaya Street	1	505 m north-east of the WWTP
Railway junction 737	34-40 families	530 m on the east side of WWTP

Brick clay extraction pits are located approx. 500m to the North-West from the WWTP sludge pond area. The pits have not been recultivated after the extraction stopped. Several other industries are located 2-3 km to the North from the WWTP.

A wider area of influence (**Area of wider influence**) is considered in relation to non-physical impacts such as social and cross-cutting impacts which may extend far beyond the area of direct influence. This area includes as a minimum all Karaganda City, where the benefits of the WWTP will be felt, such as economic opportunities associated with employment and improved wastewater treatment. These may also include cumulative and supply chain impacts extending even further away.

The Sokyr river which receives the WWTP effluent through a discharge channel flows westwards to the Intumak Dam/Reservoir also located in the Karaganda region. Hence, the Project is not considered a **source of transboundary impacts.**

The figure below provides a rough overview of the Project's area of influence, as it was defined at the time of the scoping study, based on the initial impact considerations and the inputs given at the stakeholder meeting. The area of direct influence is further defined in Figure 4.1.

Figure 4.2: Area of influence of the Karaganda WWTP Project

4.6 Impact Assessment Approach

The approach for assessing the significance of Project impacts largely follows the EC Guidance on Preparing Environmental Impact Assessment Reports (2017)[3] which applies a multi-criteria analysis and considers the sensitivity of the receiving environment and the magnitude of the predicted effects.

- **Sensitivity** is understood as the sensitivity of the environmental receptor to change, including its capacity to accommodate the changes the Projects may bring about.
- **Magnitude** considers the characteristics of the various changes (timing, scale, size, and duration of the impact) which would occur and affect the receiving environment as a result of the Project.

The term 'receptor' is used to describe environmental features such as air, water, soil, terrain, vegetation, wildlife, (both terrestrial and aquatic), and land use which are valued by society, either for their intrinsic worth and/or their social or economic contribution, and social groups including communities and individuals that may be affected by the Project.

In the context of this ESIA, the following receptors with potential to be affected by the Project were identified during the scoping study and are assessed in this ESIA.

Physical environment components:
- Topography and landscape
- Geology, geomorphology, and soil
- Climate (Climate is both a receptor and a potential source of impacts on the project. The Global climate system is a receptor in the context of project GHG emissions, and the local climate (past and future) is relevant in the context of future climate changes and project's climate resilience)
- Surface and groundwater (quality and quantitative aspects)
- Ambient air quality
- Ambient noise
- Flora and fauna
    - Protected areas
    - Terrestrial
    - Aquatic
- Public resource infrastructure or services supplying:
    - Solid waste management
    - Water supply
    - Energy supply (heat and electricity)

Socio-economic and land use components:
- Local employment and commercial opportunities
- Refugee influx
- Labour and working conditions
- Workers' accommodation
- Workers' health and safety
- Community health, safety and security
- Traffic
- Gender-based violence and harassment
- Land acquisition and land use
- Cultural heritage
- Vulnerable groups
- Social infrastructure: schools, health clinics and other social infrastructure in the vicinity of the WWTP

[3] Environmental impact assessment of projects - Publications Office of the EU (europa.eu)

The baseline (pre-Project) conditions and sensitivity of the identified receptors are described in chapter 6 of this ESIA.

The sensitivity of impact receptors and the magnitude of the impact / potential change are assessed using criteria shown in the following tables.

Table 4.2: Sensitivity of the receiving environment

Sensitivity of the receiving environment	
High	High importance and rarity, national scale, limited potential for substitution and low capacity to accommodate proposed form of change.
Medium	Medium importance & rarity, national scale and limited potential for substitution. The receiving environment has some tolerance of the proposed change subject to design & mitigation.
Low	Low or medium importance and rarity, local scale. The receiving environment is tolerant of the proposed change subject to design & mitigation.

Table 4.3: Scale of impact magnitude

Scale of impact magnitude	
High	Loss of resource and/or quality and integrity of resource over a significant area. Severe change/damage to key characteristics, features or elements for more than 2 years or irreversible.
Medium	Loss of resource, but not adversely affecting the integrity over a significant area. Partial loss of/damage to key characteristics: the impact is felt continuously during the entire construction period of the Project (estimated to be 36 months).
Low	Some measurable change in attributes, quality or vulnerability. Minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.

Table 4.4: Criteria for assessing impact significance

Criteria	**Components of criteria**	**Description**
Sensitivity of the receiving environment	Existing regulations and guidance (law, programmes, guidelines, zoning)	There are specific receptors in the impact area which have some level of protection, either by law or other regulations (e.g. prohibition against polluting groundwater & Natura 2000 areas) or whose conservation value is increased by programs or recommendations (e.g. landscapes designated as nationally valuable).
	Value of the receptor to society (recreational values, natural values, number of affected people)	Depending on the type of impact, it may be related to economic values (e.g. water supply), social values (e.g. landscape or recreation) or environmental values (e.g. natural habitat).
	Vulnerability to the changes (ability to tolerate changes, number of sensitive targets)	Vulnerability to the change describes how liable the receptor is to be influenced or harmed by pollution or other changes to its environment. For instance, an area that is quiet is more vulnerable to increasing noise than an area with industrial background noise.
Impact magnitude (potential change)	Intensity and direction	Intensity describes the physical dimension of a development and direction specifies whether the impact is negative ("–") or positive ("+"). Depending on the type of impact, intensity can often be measured with various physical units and compared to reference values, such as the decibel (dB) for sound.
	Spatial extent (geographical area)	The extent of an impact refers to the geographic area over which the impact can express itself. The geographic extent is described as limited, local, or regional based on the following definitions: • Limited: the impact is restricted to direct project site; • Local: the impact will extend beyond the direct project site, thus affecting the vicinity and neighbouring areas. • Regional: the impact will be felt within a greater area
	Duration	The duration of the impact refers to the period during which the impact will be felt and whether the impact will occur intermittently. The duration of an impact is described as long-term, medium-term, or short-term based on the following definitions: • Long-term: the impact is considered permanent or irreversible;

Criteria	Components of criteria	Description
		• Medium-term: the impact is felt continuously during the entire construction period of the Project (estimated to 36 months) and/or for the full or partial duration of operation; • Short term: the impact is felt temporarily or intermittently for a limited period corresponding to one or a few construction activities/phases.

The assessment of impact significance is made by combining sensitivity and magnitude as presented in Table 4-5. Positive impacts are assessed using the same logic.

Table 4.5: Assessment of negative impact significance

Impact magnitude	Environmental (receptor) sensitivity		
	High	***Medium***	***Low***
High	Major	Major	Moderate
Medium	Major	Moderate	Minor
Low	Moderate	Minor	Negligible

Source: Scottish Natural Heritage. A Handbook on EIA. In: Environmental Impact Assessment of Projects. Guidance on Scoping. EU, 2017

Similar logic is applied with regards to positive impacts, as reflected in the below table.

Table 4.6 Assessment of positive impact significance

Impact magnitude	Environmental (receptor) sensitivity		
	High	***Medium***	***Low***
High	Major	Major	Moderate
Medium	Major	Moderate	Minor
Low	Moderate	Minor	Negligible

4.6.1 Mitigation measures and use of mitigation hierarchy

A series of mitigation measures are identified to address significant adverse impacts, applying a hierarchy of options (the mitigation hierarchy) as outlined below:

- **Avoid** - making changes to the Project's design or location to avoid adverse effects on an environmental feature. This is considered to be the most acceptable form of mitigation.
- **Minimise** - where avoidance is not possible, adverse effects can be reduced through sensitive environmental treatments/design.
- **Restore** - measures taken during or after construction to repair / reinstate and return a site to the situation prior to occurrence of impacts.
- **Compensate/offset** - where avoidance or reduction measures are not available, it may be appropriate to provide compensatory/offsetting measures. It should be noted that compensatory measures do not eliminate the original adverse effect; they merely seek to offset it with a comparable positive one.
- **Improvement measures** - projects can have positive effects as well as negative ones, and the project preparation stage presents an opportunity to enhance these positive features through innovative design

4.6.2 Residual impacts

By default, the impact assessment considers Project impacts without taking into account mitigation measures.

Residual impacts are those that remain following the implementation of the proposed mitigation. These are identified for each of the topics by reviewing the predicted impacts against the mitigation measures proposed and then identifying any residual impact. Residual impacts will be defined based on the same process applied to the evaluation of impacts.

The outcome of the impact assessment for each impact and/or receptor is summarised using the structure shown in Table 4.7, reflecting the assessed pre-mitigation and residual impacts, during construction and operation phases, respectively.

Table 4.7: Table structure for summarising pre-mitigation and residual impacts

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Based on baseline section (Very high, high, medium, low)**	
Pre-construction and construction		
Spatial extent	*Limited, local, regional*	*Limited, local, regional*
Duration	*Long, medium or short term*	*Long, medium or short term*
Magnitude of impact	*High, medium, low*	*High, medium, low*
Overall impact significance	Major, moderate, minor, negligible (Negative or Positive)	Major, moderate, minor, negligible (Negative or Positive)
Operation phase		
Spatial extent	*Limited, local, regional*	*Limited, local, regional*
Duration	*Long, medium or short term*	*Long, medium or short term*
Magnitude of impact	*High, medium, low*	*High, medium, low*
Overall impact significance	Major, moderate, minor, negligible (Negative or Positive)	Major, moderate, minor, negligible (Negative or Positive)

4.6.3 Assessment of cumulative impacts

An assessment of cumulative impacts considers the effects of other past, present, and reasonably foreseeable developments in the vicinity of the Project. It also considers unplanned but predictable activities enabled by the Project that may occur later or at a different location, which when combined with the effects of the Project may have an incremental effect on overall impacts.

4.7 Impact mitigation and ESMP development

Proposed mitigation measures and the overall monitoring plan are compiled in the Environmental and Social Management Plan (ESMP), which forms the framework management plan for the Project. The ESMP also outlines which additional, topic-specific management plans are required as the basis for implementing and monitoring the various mitigation measures during construction and operation of the Project, respectively.

5 LEGAL AND REGULATORY FRAMEWORK

5.1 EBRD requirements

The EBRD has classified the project to modernise the Karaganda wastewater treatment plant as “Category A” because it is over 150,000 PE. For this reason, an Environmental and Social Impact Assessment (ESIA) is required according to the EBRD’s Environmental and Social Policy (ESP, 2019).

The ESP underpins all EBRD financed projects, and all projects shall be structured to meet its requirements. EBRD commits to ensuring that projects are structured to meet the EU environmental principles, practices, and substantive standards where these can be applied at the project level, regardless of geographical location. When host country regulations differ from EU substantive environmental standards, projects will be expected to meet whichever is more stringent.

The ESP recognises the Bank’s commitments to respect human rights, gender equality, the needs of vulnerable people or groups, the importance of addressing the causes and consequences of climate change, a precautionary approach to managing living natural resources, and stakeholder engagement.

The Bank has adopted 10 Performance Requirements (PRs) for key areas of environmental and social sustainability that are embedded within the ESP, and which projects are required to meet (Figure 5.1).

As can be seen, PR1 is cross-cutting, whereas the other 9 are aspect specific:

PR 1 Assessment and Management of Environmental and Social Risks and Impacts			
PR 2	Labour and Working Conditions	PR 6	Biodiversity Conservation and Sustainable Management of Living Natural Resources
PR 3	Resource Efficiency and Pollution Prevention and Control	PR 7	Indigenous Peoples
PR 4	Health, Safety and Security	PR 8	Cultural Heritage
PR 5	Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	PR 9	Financial Intermediaries
		PR 10	Information Disclosure and Stakeholder Engagement

Figure 5.1: EBRD Performance Requirements

The EBRD expects its clients to manage the environmental and social (E&S) issues associated with the projects to meet the PRs over a reasonable period of time. This ESIA for the proposed new WWTP will assess whether there is compliance with PR1-8 and PR10, while PR7 on Indigenous Peoples and PR9 on Financial Intermediaries are not relevant for the ESIA.

The following EU Directives are of key relevance to an EBRD ESIA process for a WWTP modernisation project:

- Environmental Impact Assessment Directive 2011/92/EU, as amended by Directive 2014/52/EU
- Water Framework Directive (2000/60/EC)
- Groundwater Directive (2006/118/EC)
- Drinking Water Directive (98/83/EC)
- Urban Wastewater Treatment Directive (97/271/EEC)
- Ambient Air Quality Directive (2008/50/EC)
- Sewage Sludge Directive (86/278/EEC)
- Minimum Requirements for Water Re-use (2020/741/EC)
- Habitats Directive (92/43/EEC) and Birds Directive (2009/147/EC)

- Directive on minimum safety and health requirements for the workplace (89/654/EEC)
- ATEX Directive 2014/34/EU and 1999/92/EC to protect employees from explosion risk in areas associated with an explosive atmosphere.

5.2 National, regional, and international legislation and regulations

5.2.1 Environment

National

Table 5.1: Overview of relevant national environmental regulations

Environment	The Environmental Code is in effect in Kazakhstan since 2007, but has been modified a number of times, usually as part of the “package laws” introducing amendments to various legal acts at the same time. Codes in Kazakhstan have a higher legal value than laws. There is a new Environmental Code, entered into force on January 2, 2021, and the last amendments were in 2022. The new Environmental Code is based on 7 main principles, where the main one is “the polluter pays and fixes”. According to the new draft, the fines will be gradually increased, the public will be able to participate in all four stages of the EIA, industrial enterprises will undergo a technological audit to be offered the best available technologies to produce fewer emissions. Also, the code will oblige local executive bodies to entirely redirect the revenue from the environmental fines to measures that should reduce emissions, large companies will be required to launch automated emission monitoring systems, strengthen environmental control and the final principle seeks to improve waste management production and consumption by introducing the circular economy principles used in OECD countries.
Water	The Water Code was adopted on July 9, 2003, and the last amendments were in 2022. The objectives of the water legislation of the Republic of Kazakhstan are to achieve and maintain an ecologically safe and economically optimal level of water use and protection of water resources, water supply and sanitation to preserve and improve the living conditions of the population and the environment. The number of regulated indicators of drinking water quality in Kazakhstan is 74 indicators (all factory, microbiological, parasitological, aggregated data, non-organic and organic substances, indicators related to water treatment technology, radiological)in accordance with the Sanitary Rules "Sanitary and Epidemiological Requirements for Water Sources, Water Intake Points for Domestic and Drinking Purposes, Domestic and Drinking Water Supply and Cultural and Domestic Water Use and Safety of Water Bodies", approved by the Order of the Minister of National economy of the Republic of Kazakhstan dated February 20, 2023 No. 26. Additionally, the water preparation process indicators are taken once per shift except of residual chlorine or ozone (if used which are taken once in an hour)
Strategic Environmental Impact Assessment	New Environmental Code includes Strategic Ecological Assessment. It initiates in the early stage, identifies and examines potential negative environmental impact, considers all necessary measures to avoid or minimizes it. This process is carried out by government body. From January 2024 all strategic planning documents will have strategic ecological assessment mandatory. It covers the scope and procedural steps of the SEA mechanism as envisaged by the 2003 Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context (Protocol on SEA). Mandatory SEA will be envisaged for planned programs in such sectors as: agriculture, forestry, fishing, energy, industry, transport, waste management, water management, telecommunications, tourism, regional development, planning and land use.
Environmental Impact Assessment	The obligation to go through the EIA procedure when intending to carry out production activities is regulated by the Environmental Code of the Republic of Kazakhstan. In the new Environmental code project, all stages of the EIA, starting from the submission of the application and the completion of the procedure, will be covered on the websites of the authorized ministry, as well as local executive bodies, to which the territory of the planned activity belongs, and the media. The public will be able to follow all stages of the EIA: express their opinion, defend it at the legal level, and also see whether it was taken into account. Each stage of the EIA will be covered on the above websites, and public hearings will be covered in the mass media. Moreover, the Rule for Conducting Public Hearings No 286 determines the procedure for holding public hearings.

	The Republic of Kazakhstan has special Instruction on Ecological Assessment № 2804 (SEA, EIA, Transboundary Impact Assessment and simplified EA are types of Ecological Assessment) which defines the general provisions for conducting an EIA in the preparation and decision-making on the conduct of planned economic and other activities at all stages of its organization, in accordance with the project documentation.
Wastewater	The Rules for the admission of wastewater to the drainage systems of settlements No. 546 prescribes that the received wastewater before discharge should be treated in accordance with the treatment technology used on them. The following items shall not be admitted to drainage system: • waters containing soil, sand, construction and household waste, fat; • waters containing sediments from local treatment facilities, solid production wastes; • waters to be used in recycling and re-supply systems (water from pools and fountains, steam condensate, drainage and conditionally clean wastewater); • surface run-off from the territory of industrial sites; • chipped ice and snow; • waters containing radionuclides of various decay periods.
Noise	Order of the Minister of Health of the GoK dated February 16, 2022 No. GoK MoH -15. On the approval of Hygienic standards for physical factors that affect a person determines the permissible values of infrasound and ultrasound levels.
Air quality	Kazakhstan has some air quality policy regulations that are based on other strategic documents, such as air protection requirements integrated into the new draft of the 2020 Environmental Code. The new Environmental Code proposes solutions to the air pollution problems, such as modernization of technological processes, introduction of the Best Available Technologies (BAT) and strengthening Emission Trading Scheme (ETS), as well as fines for environmental pollution will be increased. However, one of the significant drawbacks relates to emissions from industrial sector, where large companies will have 10 years lead time for BAT compliance. Since BAT standards will be developed by 2023, which is a rather long time and implies that the industrial sector will be BAT compliant not earlier than 2033. According to the 2022 environmental air quality monitoring, out of 45 settlements, 10 cities belong to a high level of air pollution. For each of these cities, a roadmap will be developed with measures to reduce air pollution.
Nature	Law on protection, reproduction and use of the fauna No 593 was adopted in 2004 with amendments as of January 2023. It consists of 11 chapters that regulates protection, reproduction and use of the fauna and is aimed at ensuring conditions for the conservation of the fauna and its biological diversity, as well as sustainable use of wildlife objects in order to meet the ecological, economic, aesthetic and other human needs, taking into account the interests of the present and future generations. After coming to force in 1997 the Convention on Biological Diversity, the Kazakhstan obligations include setting up the targets and reporting on their achievement. The country has already issued 6 national reports, the last one being in 2018.
National parks	The Law on Specially protected natural areas regulates creation, expansion, protection, restoration, sustainable use and management of nature conservation areas and objects of the national natural reserves, which have ecological, scientific, historical, cultural and recreational value, as well as being a component of national, regional and global ecological networks. The Law pays special attention to flora and fauna preservation in protected areas. The Forest Code regulates the ownership, use and management of the areas assigned to the Forest Fund, and establishes the legal framework for the protection, protection, reproduction, improvement of the ecological and resource potential of the Forest Fund areas and their economic value, and its rational use. At the same time, the regulation of forest legal relations should be carried out on the basis that the forest is one of the most important components of the biosphere, which has global ecological, social and economic importance.
Sanitary Protection Zones (SPZ)	Size of the sanitary protection zones around KS's facilities is determined by relevant authorities in accordance with the sanitary and epidemiological requirements for the establishment of sanitary protective zone of production facilities, as specified in SanPiN RK DSM2 from 11.01.2022. This entails that other buildings and structures, e.g., industrial buildings and animal sheds are allowed within the SPZ. There are no restrictions in the use of land within the SPZ for farming, planting of trees or similar.

Requirements of EU environmental regulations

Relevant EU Directives in the field of environment include the EIA Directive, Drinking Water Directive, Urban Wastewater Treatment Directive, Water Framework Directive, Groundwater Directive, Sewage Sludge Directive, the Nature Directives and the Workplace Health and Safety Directives.

Table 5.2: Overview of relevant EU environmental regulations

Environmental impacts	The EIA Directive (2014/52/EU of 16 April 2014 amending 2011/92/EU) states that all projects that potentially have significant effects on the environment shall undergo a systematic process to identify, predict and evaluate the environmental effects of the project. Particular attention should be given to preventing, mitigating, and offsetting the significant adverse effects of the project. The objectives of an EIA are: - to influence the design of the project to optimize its environmental performance; - to identify appropriate measures for mitigating the negative impacts of the proposal; - to facilitate informed decision making, including setting the environmental terms and conditions for implementing the proposal. The EIA process shall be open and transparent, and provide opportunities for public involvement, in particular to those people who are most directly affected by, and interested in the proposal, in an appropriate manner that suits their needs. The screening determination and information from the environmental studies must be made available to the public. The decision-maker is obliged to take account of the opinions and concerns raised by the public, which may be relevant to those decisions.
Surface water	Protection of surface water bodies within the EU is regulated by the Water Framework Directive (WFD) (2000/60/EC), which is based on a system of management by river basin. The Directive requires Member States to prepare River Basin Management Plans including Programmes of Measures for each River Basin District, including for international river basins. Following the WFD, water bodies are classified in five status classes: high, good, moderate, poor and bad. ‘High status’ is defined as the biological, chemical and morphological conditions associated with no or very low human pressure. This is also called the ‘reference condition’ and is the best status achievable. Assessment of quality is based on the extent of deviation from the reference condition. The aim of the Directive is to achieve at least 'good status' for all ground and surface waters in the EU. The Floods Directive (2007/60/EC) is related to the WFD. This obliges EU Member States to carry out a preliminary assessment of flood risk to identify areas of potential flood risk, to establish and publish flood hazard and risk maps and to develop and implement Flood Risk Management Plans to reduce flood risk.
Groundwater	The Groundwater Directive (2006/118/EC) compliments the WFD and establishes a regime which sets groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater. The directive establishes quality criteria that takes account of local characteristics and allows for further improvements to be made based on monitoring data and new scientific knowledge. It relates to assessments on chemical status of groundwater and the identification and reversal of significant and sustained upward trends in pollutant concentrations. Annex II of the Directive was amended by Commission Directive 2014/80/EC of 20 June 2014.
Drinking water	The Drinking Water Directive (2020/2184) is the EU’s main law on drinking water. It concerns the access to, and the quality of, water intended for human consumption to protect human health. The EU adopted the recast Drinking Water Directive in December 2020 and the Directive entered into force in January 2021. The recast Drinking Water Directive will further protect human health thanks to updated water quality standards, tackling pollutants of concern, such as endocrine disruptors and microplastics, and leading to even cleaner water from the tap for all. The Directive applies to all water, either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes in both public and private premises, regardless of its origin and whether it is supplied from a distribution network,

	supplied from a tanker or put into bottles or containers, including spring waters; all water used in any food business for manufacturing, processing, preserving or marketing of products or substances intended for human consumption.
Wastewater	The Urban Wastewater Treatment Directive (91/271/EEC, amended by Directive 98/15/EC) regulates the collection, treatment and discharge of urban wastewater. The Directive requires collection and treatment of wastewater in all agglomerations of >2000 population equivalents (p.e.), secondary treatment of all discharges from agglomerations of >2000 p.e., and more advanced treatment for agglomerations >10 000 p.e. in designated sensitive areas and their catchments, and monitoring of the performance of treatment plants and receiving waters; and controls of sewage sludge disposal and re-use, and treated wastewater re-use whenever it is appropriate. The Directive is currently undergoing a revision process after a recent evaluation identified certain shortcomings and new societal needs that must be addressed. Commission adoption of the revised text is scheduled for first quarter of 2022. The revision addresses: • *Remaining sources of pollution* not tackled in the existing Directive, e.g. storm water overflows, urban runoff, small agglomerations and IAS; • *Emerging challenges* such as contaminants of emerging concern, and wastewater surveillance in the context of pandemics; and • *Aligning the sector with new EU ambitions* such as nutrients recovery, energy efficiency and production.
Water Reuse	Regulation (2020/741) on minimum requirements for water reuse for agricultural irrigation entered into force in 2020. The aim is to stimulate and facilitate water reuse in the EU. The Regulation sets out: • Harmonised minimum water quality requirements for the safe reuse of treated urban wastewaters in agricultural irrigation; • Harmonised minimum monitoring requirements, notably the frequency of monitoring for each quality parameter, and validation monitoring requirements; • Risk management provisions to assess and address potential additional health risks and possible environmental risks; • Permitting requirements; • Provisions on transparency, whereby key information about any water reuse project is made available to the public. The new rules are to be situated in the context of the new Circular Economy Action Plan adopted in 2020, which includes the implementation of the new Regulation amongst Europe's priorities for the circular economy.
Solid waste management	The Waste Framework Directive (2008/98/EC) sets the basic concepts and definitions related to waste management, such as definitions of waste, recycling, and recovery. The Directive lays down some basic waste management principles: it requires that waste be managed without endangering human health and harming the environment, and in particular without risk to water, air, soil, plants or animals, without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest. Waste legislation and policy of the EU Member States shall apply the waste management hierarchy from reuse as a priority through to disposal. The Directive introduces the polluter pays principle and the principle of extended producer responsibility.
Sludge	The Sewage Sludge Directive (86/278/EEC) sets rules on how farmers can use sewage sludge as a fertilizer, to prevent it harming the environment and human health, by compromising the quality of the soil or surface and ground water. To this end, it sets limits on the concentrations allowed in soil of 7 heavy metals that may be toxic to plants and humans. The Directive specifies rules for the sampling and analysis of sludges and soils. It sets out requirements for the keeping of detailed records of the quantities of sludge produced, the quantities used in agriculture, the composition and properties of the sludge, the type of treatment and the sites where the sludge is used.

Nature and biodiversity	The Habitats Directive (92/43/EEC) aims to promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements. The Habitats Directive ensures the conservation of a wide range of rare, threatened or endemic animal and plant species. Some 200 rare and characteristic habitat types are also targeted for conservation in their own right. Together with the Birds Directive (2009/147/EC), it forms the cornerstone of Europe's nature conservation policy and establishes the EU-wide Natura 2000 ecological network of protected areas, safeguarded against potentially damaging developments.
Noise	Directive 2002/49/EC relating to the assessment and management of environmental noise (the Environmental Noise Directive – END) is the main EU instrument to identify noise pollution levels and to trigger the necessary action both at Member State and at EU level. To pursue its stated aims, the Environmental Noise Directive focuses on three action areas: • the determination of exposure to environmental noise • ensuring that information on environmental noise and its effects is made available to the public • preventing and reducing environmental noise where necessary and preserving environmental noise quality where it is good.
Air quality	The Ambient Air Quality Directive (AAQD, Directive 2008/50/EC) sets thresholds and objectives for the permissible concentrations of air pollutants. Generally, this directive protects human health. It sets limit values for lead (Pb), nitrogen dioxide (NO_2), particulate matter (PM10 and PM2.5), sulphur dioxide (SO_2), benzene, carbon monoxide (CO), certain toxic heavy metals (arsenic, cadmium, nickel and benzo(a)pyrene) and polycyclic aromatic hydrocarbons (PaH) and ozone (O_3). There is a target value and a long-term objective for ozone is intended to provide protection for vegetation.

5.2.2 Occupational health and safety

National

Table 5.3: Overview of relevant national OHS regulations

Safety and health at work	The Labour Code regulates the rights and obligations of employees in the field of occupational safety and health. The fire safety rules No 55 determine the procedure for ensuring fire safety in order to protect people, property, society and the state from fires. The law No 351 regulates public relations arising in the field of compulsory employee insurance against accidents, and establishes the legal, economic and organizational framework for its implementation.
Workplace	The Labour Code defines safety requirements for workplace, such as the buildings compliance with safety and labour protection requirements, emergency routes/exits and hazardous areas with appropriate signage, etc. Moreover, during working hours, the temperature, lighting, and ventilation in the room where the workplaces are located must comply with sanitary and epidemiological requirements as well as work equipment must comply with the safety standards established for this type of equipment, have appropriate technical passports (certificate), warning signs and be provided with fences or protective devices to ensure the safety of workers in the workplace.
Construction	The Republic of Kazakhstan has special Construction norms and rules (SNiPs) that represents a set of technical, economic and legal normative acts adopted by the executive authorities governing the implementation of urban planning activities, as well as engineering surveys, architectural and construction design and construction. The Republic of Kazakhstan has its own 119 building codes, 8 guiding documents, 188 codes of rules, 69 regulatory and technical manuals, and 10 methodical documents in the construction sector This technical regulation on requirements for the safety of buildings and structures, construction materials and products establishes the minimum requirements for the safety of construction objects and construction products at all stages of their life cycle in order to protect life, health of people and animals, property and environmental protection, as well as to prevent actions that mislead consumers (users) regarding the purpose and safety of construction sites and construction products, elimination of technical barriers to trade.

Requirements of EU H&S regulations

Relevant EU Directives in the field of occupational health and safety (OHS) include the Safety and Health at Work Directive, the Directive on minimum safety and health requirements for the workplace, and the directive on minimum safety and health requirements for temporary or mobile construction sites.

Table 5.4: Overview of relevant EU OHS regulations

Safety and health at work	The Framework Directive on Safety and Health at Work (OSH Directive 89/391 EEC) introduces measures to encourage improvements in the safety and health of workers at work. The Framework Directive contains principles concerning the prevention of risks, the protection of safety and health, the assessment of risks, the elimination of risks and accident factors, and the involvement and training of workers and their representatives. The general principles of prevention listed in the directive include (i) avoiding risks, (ii) evaluating the risks and (iii) combating the risks at source. The Framework Directive also contains basic obligations for employers to ensure the safety and health of workers in every aspect related to work, and the financial costs of so doing may not be imposed on the workers. On the basis of this "Framework Directive" a series of individual directives were adopted (see further below) containing more stringent and/or specific provisions.
Workplace	The Directive on Minimum Safety and Health Requirements for the Workplace (89/654/EEC) states that workplaces must satisfy minimum safety and health requirements in areas such as electrical installations, emergency routes and exits, fire detection and firefighting, room temperature and room lighting. Directive 2000/54/EC covers protection of workers from risks related to exposure to biological agents at work and includes work in sewage purification installations in the indicative list of activities.
Construction	The Directive on Minimum Safety and Health Requirements for Temporary or Mobile Construction Sites (92/57/EEC) lays down minimum safety and health requirements for temporary or mobile construction sites i.e. any construction site at which building or civil engineering works are carried out. It establishes a chain of responsibility linking all the parties involved to prevent risks. The client or project supervisor nominates person(s) responsible for the coordination of health and safety at sites where several firms are present. Where a person responsible for coordination is appointed, the project supervisor or client remains responsible for safety and health. The client or project supervisor also ensures that, before work starts at the site, a health and safety plan is drawn up. The person(s) responsible for coordination on the site shall ensure that employers and self-employed persons apply the general prevention principles, particularly in respect of the situations described, and that the health and safety plan is considered when necessary. They shall also organise cooperation between employers in matters of health and safety and check that the working procedures are being implemented correctly as well as ensure that no unauthorised persons enter the site.
Explosion risks	The ATEX Directive 2014/34/EU governs the manufacturing, placing on the market, and use of equipment intended for use in potentially explosive atmospheres. That is, environments where flammable gases, vapours, mists, or dusts are present or likely to be present in sufficient quantities to cause an explosion, such as for biogas facilities. It sets out essential health and safety requirements for equipment to be used in such context and defines the obligations of manufacturers. The ATEX Directive 1999/92/EC complements the ATEX 2014/34/EU directive and focuses on the protection of workers who are potentially at risk from explosive atmospheres. The Directive establishes minimum requirements for improving the safety and health protection of workers in areas where explosive atmospheres may occur, and places obligations on employers to conduct risk assessments, implement appropriate control measures, provide suitable training to employees, and maintain safe working conditions. It also outlines the responsibilities of workers to comply with safety measures and report any potential hazards.

5.2.3 Labour and human resources

National

Human resources (HR) management and other labour practices in Kazakhstan are regulated based on the following main legislative acts:

Table 5.5: Overview of national labour and human resources legislation

The Constitution of the Republic of Kazakhstan	The Constitution was adopted on August 30, 1995, and the last amendments were in 2022. The Constitution prohibits discrimination on various grounds, including gender. The Constitution also provides for freedom of labour, free choice of occupation, the right to working conditions that meet safety and hygiene requirements, and the right to remuneration without discrimination.
The Labour Law	The Law was adopted in 2015, and the last amendments were made in 2022. The purpose of the labour legislation of the Republic of Kazakhstan is the legal regulation of labour relations and other relations directly related to labour relations, aimed at protecting the rights and interests of the parties to labour relations, establishing minimum guarantees of rights and freedoms in the labour sphere. The principles of the labour legislation of the Republic of Kazakhstan are: the inadmissibility of restricting human and civil rights in the field of labour; freedom of labour; prohibition of discrimination in the field of labour, forced labour and the worst forms of child labour; ensuring the right to working conditions that meet the requirements of safety and hygiene; priority of the employee's life and health; ensuring the right to remuneration for work not lower than the minimum wage; ensuring the right to rest; equality of rights and opportunities for employees; ensuring the right of workers and employers to associate to protect their rights and interests; assistance of the state in strengthening and developing social partnership; state regulation of occupational safety and health issues. In addition, the Law prohibits discrimination against women in employment and provides for equal pay for work of equal value. The Law allows for flexible working arrangements and off-site employment, as well as providing for a range of benefits for working parents such as maternity leave, adoption leave, and parental leave. The Labour Law is supplemented by a list of occupations for which the use of female labour is prohibited or restricted (see further explanation at the end of this section).
The Law on State Guarantees of Equal Rights and Opportunities for Men and Women (2009)	The Law prohibits sex-based discrimination and stipulates equal employment opportunities for women and men (including in relation to recruitment, working conditions, promotion, and training).
Concept of Family and Gender Policy in the Republic of Kazakhstan to 2030 (implemented through a national Action Plan)	The Concept was adopted on December 6, 2016. The Concept sets out the Government's key gender policy aims. The Concept includes specific objectives to increase women's participation in vocational training within high-value and technical sectors, combat discrimination against women in non-traditional occupations, and reduce legal prohibitions against women's employment in certain types of work and occupations. The Concept sets an ambitious target for women's participation in decision-making roles, aiming to increase the share of women at decision-making level in the executive, representative, and judicial branches of government as well as in the state, quasi-state, and corporate sectors to 22% by 2020, 25% by 2023, and 30% by 2030. The Concept also sets targets to reduce the gender wage gap at the national level to 30% by 2020, 27% by 2023, and 25% by 2030.
The Law about trade unions	The Law was adopted in 2014, and the last amendments were made in 2021. This Law regulates public relations arising from the exercise by citizens of the constitutional right to freedom of association, creation, activity, reorganization and liquidation of trade unions. The Law also states the prohibition of discrimination of citizens on the basis of membership in trade unions.
Law "On Amendments and Additions to Certain Legislative Acts	As a result of this law, the Labour Law of the Republic of Kazakhstan no longer mentions "prohibited professions,", which means • the abolition of the list of prohibited professions for women • the abolition of the ban on entering into labour contracts and employment of women in professions that were previously inaccessible to women

of the Republic of Kazakhstan on the Issues of Social Protection of Certain Categories of Citizens”	

Fundamental instruments of the International Labour Organisation (ILO)

ILO has eleven fundamental instruments, which include 10 conventions and the 2014 Protocol for Convention No. 29 on Forced Labour. The instruments are summarised below.

Kazakhstan has ratified ILO’s ten fundamental conventions, but not the Protocol from 2014 related to Forced Labour[4].

Table 5.6: Overview of ILO fundamental conventions

C29 Convention concerning Forced or Compulsory Labour, 1930 **P29 Protocol of 2014 to the Forced Labour Convention, 1930**	The Convention prohibits the imposition, or permitting the imposition, of forced or compulsory labour for the benefit of private individuals, companies or associations. Article 2 of the Convention defines forced or compulsory labour as *all work or service which is exacted from any person under the menace of any penalty and for which the said person has not offered himself voluntarily.* A few exceptions are mentioned such as compulsory military service laws for work of a purely military character. The 2014 Protocol, Article 1, stipulates that *In giving effect to its obligations under the Convention to suppress forced or compulsory labour, each Member shall take effective measures to prevent and eliminate its use, to provide to victims protection and access to appropriate and effective remedies, such as compensation, and to sanction the perpetrators of forced or compulsory labour.* Article 2 stipulates that *Each Member shall develop a national policy and plan of action for the effective and sustained suppression of forced or compulsory labour in consultation with employers’ and workers’ organisations…*
C87 Convention concerning Freedom of Association and Protection of the Right to Organise, 1948	Article 2 of the Convention stipulates that workers and employers shall have the right to establish and, subject only to the rules of the organisation concerned, to join organisations of their own choosing without previous authorisation. Articles 3 mentions that workers’ and employers’ organisations shall have the right to draw up their constitutions and rules, to elect their representatives in full freedom, to organise their administration and activities and to formulate their programmes. The public authorities shall refrain from any interference which would restrict this right or impede the lawful exercise thereof.
C98 Convention concerning the Application of the Principles of the Right to Organise and to Bargain Collectively, 1949	Article 1 of the Convention stipulates that workers shall enjoy adequate protection against acts of anti-union discrimination in respect of their employment, while Article 2 mentions that workers’ and employers’ organisations shall enjoy adequate protection against any acts of interference by each other or each other’s agents or members in their establishment, functioning or administration. In accordance with Article 4, measures should be taken to encourage and promote the full development and utilisation of a mechanism for voluntary negotiation between employers, or employers’ organisations, and workers’ organisations on terms and conditions of employment by means of collective agreements.
C100 Convention concerning Equal Remuneration for Men and Women Workers for Work of Equal Value, 1951	Article 2 of the Convention stipulates that the application to all workers of the principle of equal remuneration for men and women workers for work of equal value should be ensured through the methods used to determine rates of remuneration. This may be achieved through national laws or regulations; legally established or recognised machinery for wage determination; collective agreements between employers and workers; or a combination of the mentioned means.

[4] https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:10011:::NO:10011:P10011_DISPLAY_BY,P10011_CONVENTION_TYPE_CODE:1,F

C105 Convention concerning the Abolition of Forced Labour, 1957	Article 1 stipulates a commitment to suppress and not to make use of any form of forced or compulsory labour: a) as a means of political coercion or education or as a punishment for holding or expressing political views or views ideologically opposed to the established political, social or economic system; b) as a method of mobilising or using labour for purposes of economic development; c) as a means of labour discipline; d) as a punishment for having participated in strikes; e) as a means of racial, social, national or religious discrimination.
C111 Convention concerning Discrimination in Respect of Employment and Occupation, 1958	Article 1 defines discrimination as a) any distinction, exclusion or preference made on the basis of race, colour, sex, religion, political opinion, national extraction or social origin; b) such other distinction, exclusion or preference which has the effect of nullifying or impairing equality of opportunity or treatment in employment or occupation as determined after consultation with representative organisations.
C138 Convention concerning Minimum Age for Admission to Employment, 1973	Article 2 stipulates that the minimum age shall not be less than the age of completion of compulsory schooling, and, in any case, shall not be less than 15 years. However, countries whose economy and educational facilities are insufficiently developed may, after consultation with the organisations of employers and workers concerned, where such exist, initially specify a minimum age of 14 years. Article 3 highlights that the minimum age for admission to any type of employment or work which is likely to jeopardise the health, safety or morals of young persons shall not be less than 18 years. However, employment or work may be authorised from the age of 16 years on condition that the health, safety or morals of the young persons are fully protected and that they have received adequate specific instruction or vocational training. Article 7 mentions that light work may be permitted from the age of 13 years.
C182 Convention concerning the Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labour, 1999	Article 2 stipulates that for the purposes of this Convention the term *child* shall apply to all persons under the age of 18. Article 3 defines *the worst forms of child labour* as a) all forms of slavery or practices similar to slavery, such as the sale and trafficking of children; b) the use, procuring or offering of a child for prostitution or pornography; c) the use, procuring or offering of a child for illicit activities, in particular for the production and trafficking of drugs as defined in the relevant international treaties; d) work which is likely to harm the health, safety or morals of children. Article 6 stipulates that member countries shall design and implement programmes of action to eliminate as a priority the worst forms of child labour.
C155 Occupational Safety and Health Convention, 1981	Article 5 stipulates that for the purpose of this Convention the following main spheres of action should be taken account, as they affect occupational safety and health and the working environment: a) design, testing, choice, substitution, installation, arrangement, use and maintenance of the material elements of work; b) relationships between the material elements of work and the person who carry out or supervise the work, and adaptation of machinery, equipment, working time, organisation of work and work processes to the physical and mental capacities of the workers; c) training, including necessary further training, qualifications and motivations of persons involved, in one capacity or another, in the achievement of adequate levels of safety and health; d) communication and co-operation at the levels of the working group and the undertaking and at all other appropriate levels up to and including the national level; e) the protection of workers and their representatives from disciplinary measures as a result of actions properly taken by them in conformity with the policy referred to in Article 4 of this Convention.
C187 Promotional Framework for Occupational Safety and Health Convention, 2006	Article 1 refers the term *national system for occupational safety and health or national system* to the infrastructure which provides the main framework for implementing the national policy and national programmes on occupational safety and health, the term *national programme on occupational safety and health or national programme* refers to any national programme that includes objectives to be achieved in a predetermined time frame, priorities and means of action formulated to improve occupational safety and health, and means to assess progress;

5.2.4 Social aspects

Consideration of social issues, land acquisition in Kazakhstan, access to information and procedures for public consultations are regulated based on the following national legislation:

Table 5.7: Overview of national legislation on social performance practices and management

Land acquisition	The main applicable law regulating land allocation process is the Land Code No. 59-VII amended on 30.06.2021. It establishes conditions and limits for modifying or terminating ownership of land and land-use rights, outlines the rights and responsibilities of landowners and land users, and regulates land relations. Article 101 of Land Code stipulates that the user right to land plots is provided to Kazakhstan citizens in two ways: i) temporary paid land use (lease) for farming for a period of 10-49 years; and ii) temporary free land use for cattle rearing in distant pastures (seasonal pastures). Procedures for determining the lease cost are described by the Republic of Kazakhstan Government Resolution on Establishment of Base Payment Rates for Land Plots, No. 890, 2003 and the Tax Code 2008. According to these laws, the Central Land Management set the lease rates for the land categories made by the land utilitarian value like arable irrigated or non-irrigated, pastures or wasteland. According to the Land Code Article 165, losses caused to land owners or land users are subject to full compensation in the following cases: compulsory land acquisition for state needs, entailing the termination of the right of ownership or land use; restrictions on the right of ownership or land use with a special land use regime establishment; violation of the land owners or land users rights; land quality deterioration as a result of construction and operation of facilities leading to disturbance of soil fertility, worsening water regime, emitting substances harmful to crops and plantations; land acquisition in emergency situations. Article 166.2 defines the compensation constituents: i) the cost of land or land-use rights; ii) the market cost of the assets located on the plot, including fruit trees and perennial plantings; iii) cost of the expenditures associated with development of the land, its operation, implementation of protective measures, improvement of soil fertility taking into consideration their inflation; iv) all losses inflicted on the owner or land user as a result of land acquisition at the time of termination of ownership or land-use right, including losses they incur due to early termination of their obligations to third parties; and v) loss of revenue.
Access to Information	The Law on Access to Information of November 16, 2015, regulates public relations arising from the realization of the constitutional right of everyone to freely receive and disseminate information in any way not prohibited by law. Access to information is based on the following principles: legality; openness and transparency of the activities of information owners; reliability and completeness; relevance and timeliness; equal access to information; non-disclosure of state secrets and other secrets protected by law; inviolability of private life, personal and family secrets; observance of the rights and legitimate interests of individuals and legal entities.
Grievances	The Law on Grievances Handling procedures № 221-III of January 12, 2007, is no longer in force. On June 29, 2020, in the Republic of Kazakhstan a new Administrative Procedural Code № 350-VI was adopted according to which the term of consideration of an appeal is 15 working days from the date of its receipt, unless otherwise is stipulated by the laws of the Republic of Kazakhstan. Herewith, the term of consideration of an appeal may be extended by a reasoned decision of the head of an administrative body or its deputy for a reasonable period, but not more than two months.
Ratification of the Aarhus Convention on Access to Information etc.	Kazakhstan ratified the Convention on the Access to Information, the Public Participation in Decision Making and the Access to Justice in Environmental Matters (the Aarhus Convention) on 23 October 2000.

5.3 National and international impact assessment and approval processes

5.3.1 National environmental approval process for new WWTP

Environmental Impact Assessment (EIA)

In accordance with national law, an EIA must be carried out for the proposed WWTP by a company licensed to perform such assessments in Kazakhstan[5]. An EIA is "compulsory for all types of activities that are listed in Appendix 1 of the Environmental Code. According to this, an EIA is mandatory for a wastewater treatment facility with a capacity of 30,000 m^3 per day or more, which applies to the Karaganda Project. The recent instruction on EIA[6] notes that all stages of the project design must include an assessment of environmental impact to the details responding to the design stage and as knowledge of the technical specifications of the project allows. The correlation between project design stages and corresponding EIA stages is summarized in the table below.

In line with the above, Aquarem and the associated local EIA consultant (EcoMusey) have prepared the Preliminary Environmental Impact Assessment (EIA) which was submitted to the State Environmental Expertise (SEE) by end of December 2023. The FS with preliminary design by Aquarem has been approved by KS and delivered to the SEE for review.

Once completed, in order to progress to the next stage of the project design, the Preliminary EIA has to be approved by the SEE. The SEE can release the developer from conducting the next stage, if the Preliminary EIA proves that the negative effects are absent, small, short-term, and benign. The SEE may be satisfied with a Preliminary EIA which is performed with the feasibility study (pre-design documentation) and focuses on environmental impact scoping and alternatives. If the positive SEE conclusion on the Preliminary EIA does not recommend further environmental work, such approval is considered to be final. However, if the results of a Preliminary EIA or analogies show that impacts from the projected development are likely to be considerable or uncertain, then the SEE recommends performing a full EIA.

Hence, no official project approval has been obtained from the SEE to date. These are expected in about a month from delivering the EIA, if approved by SEE.

Table 5.8: Correlation between the environmental and engineering stages during design

EIA stage	Engineering stage
Preliminary EIA	Feasibility Study (pre-design documentation)
Full national EIA	Technical/detailed design documentation

At the EIA stage, construction pollution will be calculated using the proposed personnel, machinery, and material specifications. Composition of EIA reports can differ between large complex and small benign developments. For example, calculation of the maximum permitted pollution volumes (MPPs) is not required in EIAs for small and benign developments and is set according to the real discharges at the first year of the operation. For the Karaganda WWTP Project, all MPP calculations are to be presented in the SEE approved EIA. These calculations are required in order to obtain an Emissions Permit. The positive conclusion on EIA by SEE acts as a permit for the calculated pollution. The **sanitary protection zone** will be established according to Sanitary-Epidemiological requirements of the Republic of Kazakhstan (RoK) on establishment of sanitary protection zones (SanPiN #RK DSM 2 dated January 11, 2022) on the basis of the calculation of emissions, discharges and waste volumes.

The developer must inform the authorities about any changes in the project approved by the SEE that may affect the environment. The project will not require a second review as long as re-calculated volumes of the used resources, pollution and waste disposal do not exceed the earlier permitted amounts and the level of negative impacts do not increase.

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[5] The RoK Law on Permissions and Notifications No. 202-V, dd 16 May 2014

[6] Instruction for performance of environmental impact assessment No. 204-п, dd 28 June 2007

Other Project approval requirements

Power production from biogas is considered, and therefore compliance with the regulations of the Electric Power Law #588-II from July 9, 2004, is required.

At the construction stage, Emissions Permit must also be obtained by the construction contractors for the emissions of the machinery used in construction. The actual emissions are not measured but are reported proportionally to the passed period of construction. Any on-site concrete plant contractors will also have to obtain an Emission Permit for their plant. A special Water Use Permit will not be required, as there will be no need for additional water abstraction.

Transportation of oversize and excessively heavy parts shall be conducted according to the Procedures for Transportation of Oversize and Heavy Freight on the Republic of Kazakhstan Territory #206, 2015 with amendments. The procedures restrict the speed to 60 km/h, and to 10 km/h when passing dams and bridges and oblige to conduct transportation in the hours of the least road occupancy and during daylight when close to settlements. Furthermore, they specify the conditions when a ‘cover’ car and an escort car with the blinking beacon lights are needed. The Procedures prohibit overtaking of all vehicles that move at speed above 30 km/h. Restrictions may also be applied to some local hard surface roads along the transportation route as being maximum 10 tonnes for a wheel pair load. This limit is lowered further to 8 tonnes during daytime and for the ambient temperature at or above +25°C.

An oversize equipment transportation plan and traffic management plan prepared by the construction contractor are to be approved by:

- Regional branches of the enterprise KazAvtoZhol PLC of the Committee for the Automobile Roads of the Ministry of the Industry and Development;
- Transport Control Inspection;
- Traffic Police;
- Railway operator Kaztemirzholy PLC, if railway is used;
- Municipal electric power, district heating and gas distribution companies.

After commissioning the new WWTP, the environmental protection plan and the environmental operational control plan will have to be updated. Based on the KS Maximum Permitted Discharge (MPD) Project, the environmental expertise conclusion which was issued by the Department of Natural Resources and Regulation of Natural Use of the Region for wastewater discharge, the current WWTP belongs to the first category of hazard. The same category is expected to be given to the new WWTP. An enterprise in this category shall develop an industrial environmental control program and environmental protection plan. The monitoring shall include:

- Quarterly - CO, NO, NO_2, SO_2, soot, benzo(a)pyrene, formaldehyde, C_{12-19} at the air pollution sources identified by the Maximum Permitted Emission Report.
- Quarterly - CO, NO_2, SO_2 and soot at the edge of the operational sites sanitary protection zones (SPZ) upwind and downwind.

Odour monitoring is not a requirement in the environmental protection plan and the environmental operational control plan. Therefore, a specific requirement to establish and implement a structured odour monitoring and management regime has been included in the ESMP for the WWTP project.

In addition to payments for pollution and resource use, KS shall obtain the State Environmental Insurance from a licensed insurer.

The operation is controlled by the Natural Resource Management Department of the Regional Council that involves in the decision making the regional departments of the Emergency Situation Committee, the Regional Committee for Consumer Protection Rights (former Sanitary Epidemiological Service) and the

Ministry of Labour and Social Security. These bodies will be entitled to review all current and historic relevant documentation that has to be retained for 5 years.

Sanitary Protection Zone (SPZ) requirements for new WWTP

Please refer to Section 3.4.

5.3.2 International ESIA process

The ESIA should follow a report format consistent with the EU EIA Directive, and should address the concerns of all EBRD's PRs, e.g., projects involving involuntary resettlement (PR5), risks to biodiversity (PR6), impacts on cultural heritage (PR8) will require an assessment in accordance with the respective PR. The ESIA shall include an analysis of reasonable alternatives, in terms of project location, technology, size, scale and design.

Category A projects, like the WWTP Project in Karaganda, require EBRD's Client – in this case KS – to carry out a formalised, participatory disclosure and consultation process which will be built into each stage of the ESIA process, considering the stage of project development. This process involves organised and iterative consultation leading to the client's incorporating, into their decision-making process, the views of the affected parties on matters that affect them directly.

The Client is to engage in a scoping process with identified stakeholders at an early stage of the ESIA process to ensure identification of key risks and impacts to be assessed as part of the ESIA. The Client will disclose the draft ESIA Report, the Environmental and Social Management Plan (ESMP), the Environmental and Social Action Plan (ESAP), the Stakeholder Engagement Plan (SEP), and a Non-Technical Summary (NTS) of the ESIA. Stakeholders will be able to provide comments on the mentioned draft documents. The EBRD Access to Information Directive provides that the Bank disclose ESIAs for Category A projects 120 calendar days prior to Board consideration for public sector projects.

5.3.3 Comparison of national and international approaches

As can be seen from Figure 5.2, the process steps used in the EBRD ESIA and in the national EIA are relatively similar. The main difference is that while the national EIA is submitted to the SEE for approval and for the development of permit conditions, the ESIA is submitted to the EBRD Board for their consideration. Thus, the national process is legally required in accordance with national law, whereas the EBRD ESIA is required in accordance with EBRD's environmental and social safeguards.

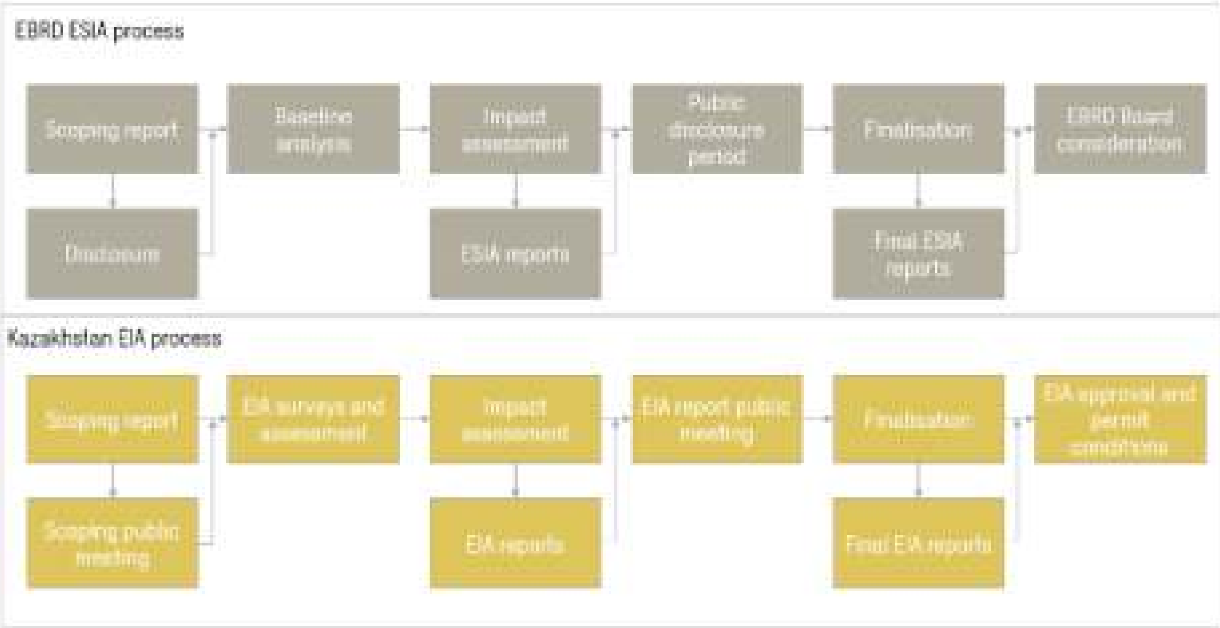

Figure 5.2: Comparison of national EIA process and EBRD ESIA process

Table 5.9 provides a brief overview of the differences between the national and EBRD impact assessments in terms of content covered. A key difference is that social and health and safety aspects are included in the EBRD ESIA process, whereas they are not included in the national process. Topics such as health and safety are managed separately at the national level and are not included in the EIA. Other additional items in the ESIA process include an assessment of Green Economy Transition (GET) indicators to determine if the project makes a substantial contribution to climate change adaptation or mitigation, or if it has other environmental benefits as outlined in EBRD's GET framework.

Table 5.9: Assessment of differences in subject matter between national and EBRD impact assessments

Subject matter	EBRD ESIA	National
Aspects		
Pollution prevention and control	Yes	Yes
Biodiversity	Yes	Yes
Occupational health and safety	Yes	No
Community health and safety	Yes	No
Labour and working conditions	Yes	No
Resettlement and land acquisition	Yes	No
Cultural heritage	Yes	No
Vulnerable groups	Yes	No
Indigenous people	Yes	No
Climate risk and vulnerability	Yes	No
Assessment of Green Economy Transition (GET) indicators	Yes	No
Outputs		
Impact assessment report	Yes	Yes
Non-technical summary	Yes	No
Stakeholder Engagement Plan	Yes	No
Resettlement Framework, if needed (not needed for this Project)	Yes	No
Environmental and Social Action Plan	Yes	No
Environmental and Social Management Plans for construction and operation phases	Yes	No

6 BASELINE CONDITIONS

6.1 Physical and Natural Environment

This section describes the current baseline conditions related to the physical and natural environment within the anticipated PAI (see section 4.5).

6.1.1 Topography and landscape

A topographical overview of the proposed WWTP site and surroundings is shown in Figure 6.1 and Figure 6.2.

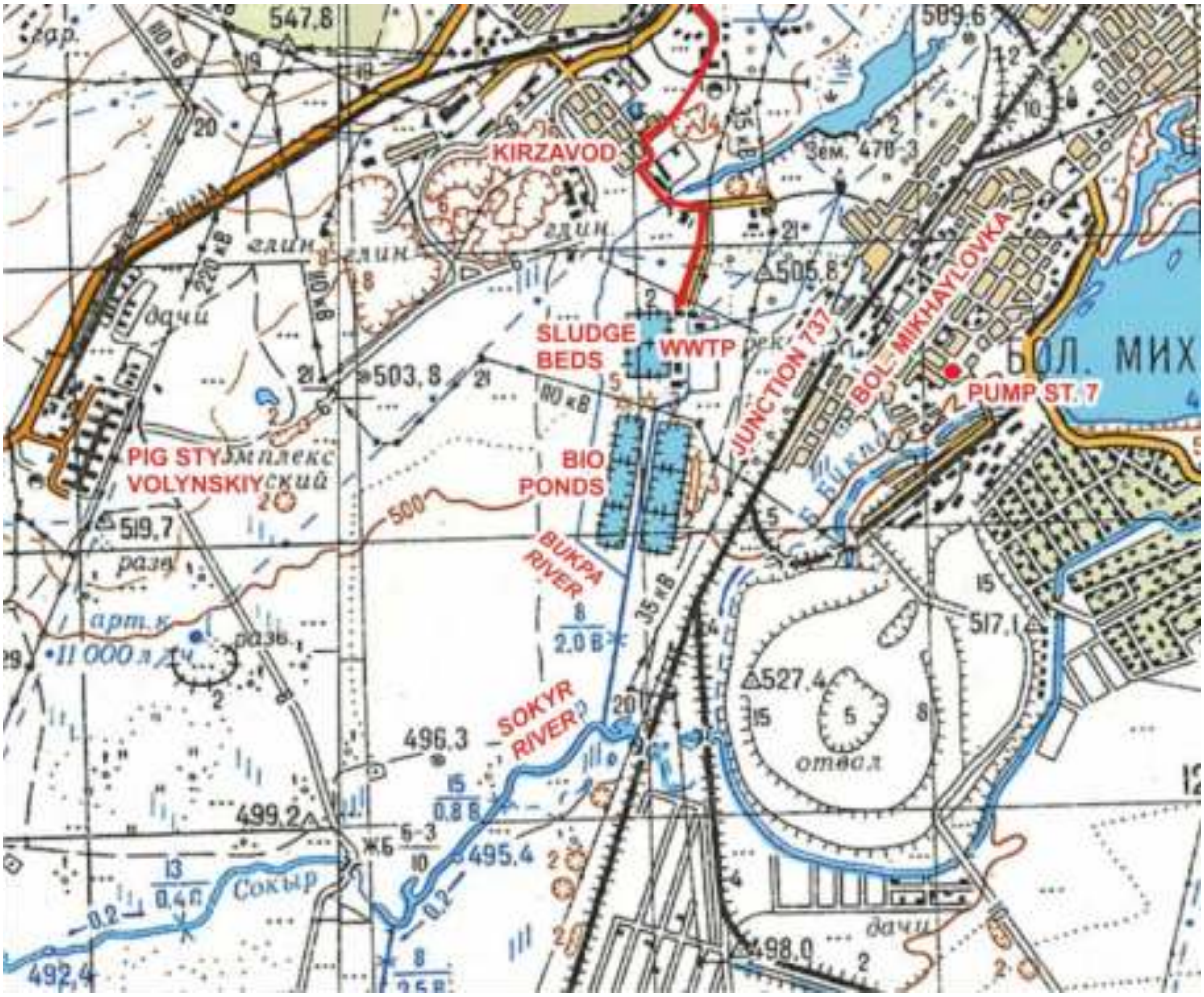

Figure 6.1 Showing the area topography with 20m solid line contours and access route (red line).

Figure 6.2: 1:2000 topographic map of the existing and projected WWTP site (Source: Aquarem, 2023) Existing 110 and 35kV powerlines are shown in red. Planned redirection of the powerlines are shown in purple.

The **topography of the existing and new WWTP site** is characterized by a flat terrain that is slightly inclined towards the south from 504m above mean sea level (amsl.) at its north border to 502m at the south border to 499m at the discharge from the bio ponds and approx. to 496m at the discharge to the Sokyr River (Figure 6.3).

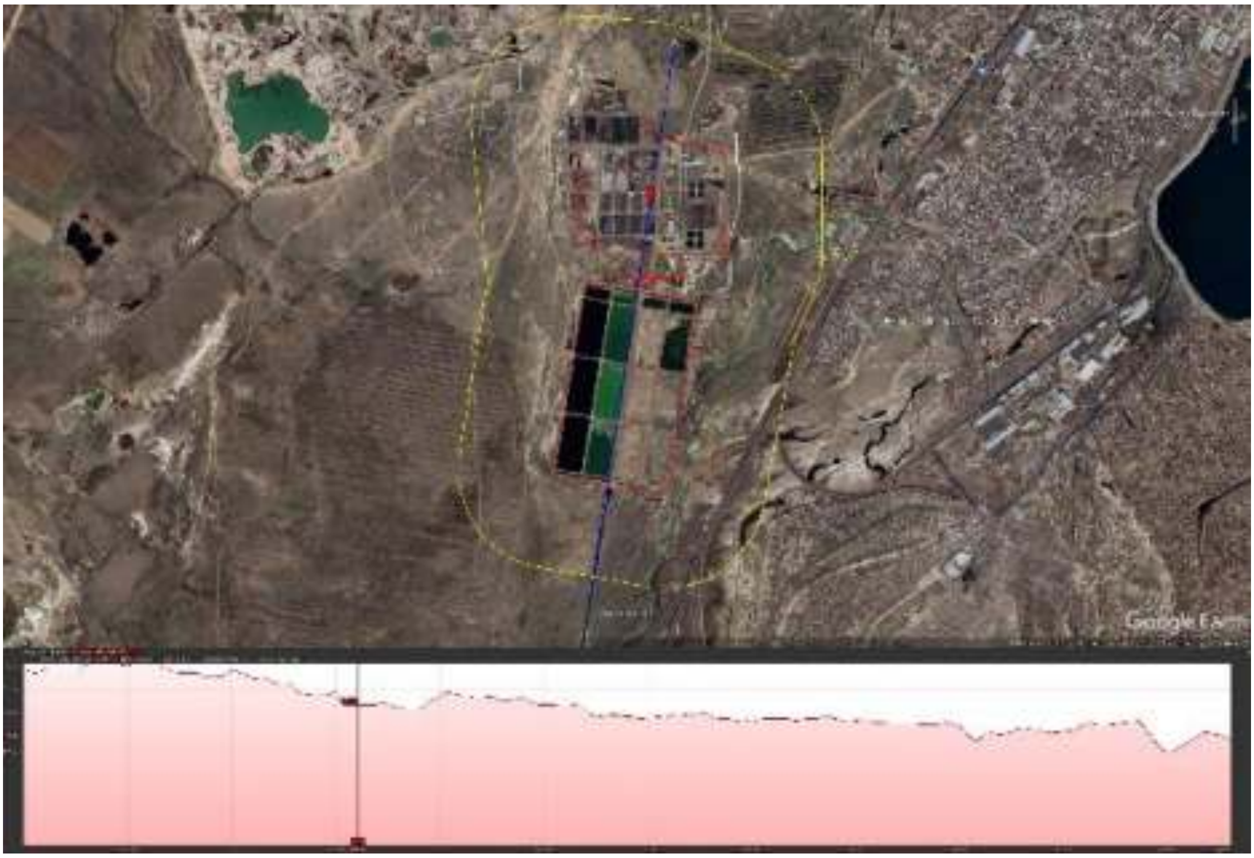

Figure 6.3 Elevation profile (blue line) through the existing WWTP site, sludge pond area and bio ponds from NNE to SSW (blue line from top to bottom and transect from left to right, respectively).

The area from the West of the existing WWTP sludge ponds towards the East of the WWTP is also relatively flat, with elevation of 501m amsl to the West and 502m amsl to the West. The highest point is 504 m amsl between the existing primary sedimentation tanks and aeration tanks. Thaw and rain water collect in 3 small depressions east and south of the WWTP. (Figure 6.4).

The proposed **new WWTP site** will partly overlap with the existing WWTP site but needs to be extended up to just under 100m to the east (Figure 6.4). The North south elevation profile is similar to the rest of the site, ranging from 505m amsl. in the north to 500m in the south (Figure 6.5). Figure 6.2 shows a topographic map of the existing and projected WWTP site.

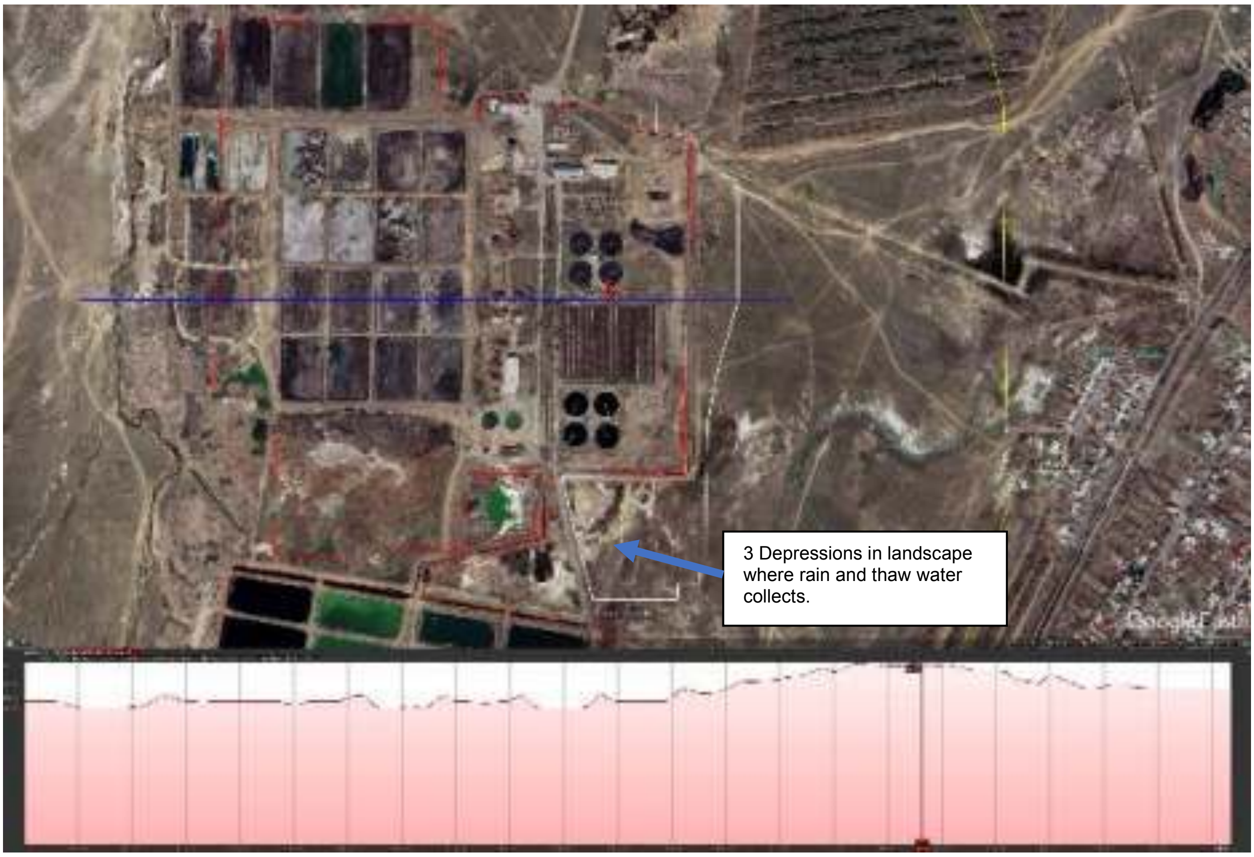

Figure 6.4 Elevation profile (blue line) through the existing WWTP site and sludge pond area from W to E (blue line and corresponding transect from left to right, respectively). The white line to the east of the existing WWTP indicates the boundaries of the site extension required for the proposed new WWTP.

The **land-use and landscape** around the WWTP site area is characterized by the existing WWTP itself on an area of *approx.* 111.2 ha. including the sludge beds to the West of the WWTP and the bioponds to the South. The nearest settlement is Railway Junction 737, which is located approx. 550 to the east from the border of the existing WWTP.

Existing 110 and 35kV powerlines are located to the north of the existing WWTP site, in the direction WNW to ESE (see Figure 6.2).

Figure 6.5 Elevation profile (blue line) through the new WWTP site from N to S (blue line and corresponding transect from up left to right, respectively). The white line to the east of the existing WWTP indicates the boundaries of the site extension required for the proposed new WWTP.

The Bukpa river runs along the Western border of the existing WWTP sludge pond area, from north to south (Figure 6.5). The course of the Bukpa river is in a man-made channel, as the river was rerouted from the east to the west of the WWTP some years ago (understood to have been when the WWTP was built). The banks of the river channel are 0.25-0.5m above the sludge beds and bioponds. This channel cuts off the watershed west of the WWTP. The watershed east of the WWTP is to the south-southeast.

The buildings within the existing WWTP are 2 story-tall and have a low profile in the surrounding rural landscape, which is dominated by the city green belt plantations. Greenery around the houses, located outside the plant's 500m Sanitary Protection Zone, mostly obscures the resident's view of the WWTP making it non-obtrusive. However, the existing WWTP can be observed from the houses located in the residential area of 16 Railway junction 737, approximately 550m to the East. The access road is in a relatively good condition. A field road to Karanozek railway station spurs from it half the way at the hamlet. (See Figure 4.1).

The existing WWTP, sludge beds and bioponds occupy an area of 111.2 ha (refer to section 6.2.11 ‘Land Use’ regarding land ownership).

The land around the WWTP and its dry bioponds is used for non-intensive unattended daily livestock pasturing. Review of satellite images going to back to 2004 shows meltwater standing in depressions to the south and east of the WWTP. Hay harvesting on pastureland surrounding the WWTP and bio-ponds was not observed on these satellite images.

An active Muslim graveyard west of the Bukpa River expands towards the river. Behind and south of it are old clay borrow pits filled with groundwater.

Conclusion on receptor sensitivity – topography and landscape

Based on the current baseline conditions, the proposed WWTP site is located on a relatively flat area largely overlapping and partly adjacent to the existing WWTP site. The nearest residential area is more than 500m to the East. Green belts and greenery around the settlements largely obscures the residents' view of the WWTP making it non-obtrusive and with limited visual impact. The site sensitivity in terms of impacts on topography and landscape is considered low. The sensitivity of nearest residential areas (in particular 16 Railway Junction 737) in terms of visual impacts is considered medium.

6.1.2 Geology, geomorphology, and soil

Geology

No geological drillings have been conducted within the existing or proposed WWTP sites to date. Hence, the geological information herein has been retrieved based on a geological map of the area (Map 1:200 000 M-43-XX) (Figure 6.6) the monitoring well 1 passport (Azimut Geologiya LLP, Karaganda 2022), two reports on the results of a 5-20m deep drilling at the sewage pump station #7 1.5 km East from the WWTP (Inzhenerno geologicheskiey izyskaniya po fondovym materialam, KazTsentr ZhKKh PLC 2019) and in Kungey micro district 9km east from the WWTP (Razrabotka TEO KOS Karaganda technicheskiy otchet Inzhenerno geologicheskiey izyskaniya po fondovym materialam 12-2022.007235-IG, Akva-Rem 2023) both drillings by the Kazvodokanalproekt Institute archive #И-6145, 2020 and #257/2019 respectively). Combined with the geological map, the drillings give an indication of the geological characteristics in the broader WWTP area. The three reports referenced above are included in Annex 6.

The proposed WWTP site is characterized by middle to Late Quaternary brown hard, dense (2.13 g/cm^3 with 2.72 g/cm^3 density of the particles) ductile silty clay of alluvial origin (a$Q_{2\text{-}3}$). They clay becomes softer at 1.7-2m depth. Layers of 10cm thick medium grain sand (0.25mm>61.5%) interbeds also appear. From 3.2m depth this polymictic sand replaces silty clay. Here, it is less dense (2.02 g/cm^3 but with the same density of the particles) and is Figure 6.6 saturated with water. Multicoloured (yellow, grey, reddish brown and lilac) hard manganese (Mn) and iron (Fe) rich clay with gravel and pebble inclusions (25-30%) appears from 3.7-6.5m depth ($N_1^{2\text{-}3}$pv as per map but seems to be erroneously assigned to Jurassic in the stratigraphic columns). Going deeper, this Pavlodarian Formation clay, that extends to 20m depth, is thought to act as a regional seal for shallow groundwater (see section 6.1.6). The map presented below, however, suggests that this seal may be absent under the sludge beds and Middle Jurassic effusive base rock (eJ_2 in the mentioned drilling reports but hJ_2mh on the map) may be sitting directly under the Quaternary sediments that have 0.44-0.48 porosity. The reports do not describe Jurassic rock as it has not been reached by drilling (See further explanations on groundwater in section 6.1.6)

Soil and soil quality

Due to diverse conditions in the alluvial poorly drained plain around the WWTP, several types of soil have formed from mainly light loam Quaternary sediments. Most of the WWTP territory is occupied by dark chestnut solonchak saline soils in the complex (up to 10%) with solonets and solonchaks. The thickness of humus horizon of these soils is 20-40 cm and humus content is 3-4%. Carbonate layer starts at a depth of 30-50 cm.

Solonchak soils of lake-alluvial plains of Neogene age occur in complex with dark chestnut and meadow soils, but in some places, they lie in homogeneous massifs and form the main background of soil cover. Their characteristic feature is the presence of the upper leached light grey horizon, lower solonetz horizon and dense carbonate horizon between them.

Meadow-chestnut clayey and loamy soils are found closer to the Sokyr river and in lowlands where groundwater comes close to the surface. On these soils, various cereal-multigrass intrazonal vegetation groups form with a thicker vegetative cover than in the steppe[7] and a significant admixture of mesophilic cereals and different types of grasses.

Karaganda Su is not required to conduct soil analysis at its WWTP site or around it. It was released from this obligation by the State Environmental Expertise conclusion on the previous local environmental impact assessment. The Expertise agreed that "the impact of the land resources was localised and limited to the territory of the Sanitary Protection Zone, the operation was carried out within the allocated territory and did not result in soil deterioration and the silt residue is temporary stored in the designated areas in accordance with the applicable norms and rules" (Section 3 of the Karaganda Su Industrial Operation Environmental Control Program, 2020).

Figure 6.6 Geological map of the WWTP area and surroundings showing that Neogene clay that protects deep groundwater (from the seepages is absent at the sludge beds area (from https://gis.geology.gov.kz/portal/apps/webappviewer/index.html?id=ef1f588363844f7cb1f646e05558da32).

Soil at the new WWTP area

As part of this ESIA process, soil samples were collected at the proposed WWTP site. As no significant external sources of potential soil contamination had been identified in the area, the soil was analysed for the same metals as for the sludge analysis. Samples were taken at five (5) locations within the proposed WWTP site, as reflected in Figure 6.7. The location of samples was selected to cover different types of areas: near the sludge heaps deposited in 2008-2011 (1, 2 and 5); downhill from the existing sand traps and beds (4) and downhill from the aeration tanks (3). Samples were taken with a hand auger in the first 30 cm of soil at a depth of 30-60 cm below the first root layer of plants.

[7] Steppe is a vegetation complex defined by the climatic zone with 5 year drought cycle.

Figure 6.7: Left: Overview of overall baseline sampling area. Right: Sampling points of soil at the proposed WWTP area (1-5 yellow dots).

The results of the analysis of the soil samples are presented in Table 6.1. For reference, in the absence of local soil quality standards, the table also shows the Dutch quality target values for soil (target and intervention values) and the soil quality standards included in the EU Sludge directive for soil on which sludge will be applied[8]. The comparison shows that the heavy metal concentrations at the WWTP site are well within the reference values and soil has overall low heavy metal concentration.

Table 6.1 Results of soil analysis conducted as part of this ESIA process (mg/kg dry matter)

Soil analysis within new WWTP site						**Dutch Target/Intervention value**	**EU sludge directive limit values for heavy metals in soil***
Points	**1**	**2**	**3**	**4**	**5**		
Depth cm	**0-30**	**0-30**	**0-30**	**0-30**	**0-30**		
pH	6,55	6,93	6,90	7,02	7,08	-	
Cd	1,23	1,10	0,92	1,40	1,25	0.8/12	1 to 3
Ni	1,20	2,00	1,12	2,36	2,45	35/210	30 to 75
Pb	0,85	0,90	0,77	0,75	0,96	85/530	50 to 500
Zn	0,100	0,096	0,150	0,230	0,180	140/720	150 to 300
Cr	0,74	1,00	1,23	1,02	0,96	100/380	-
Hg	less than 0,005 detection limit for all the samples					0.3/10	1 to 1.5

**EU sludge directive summary: EUR-Lex - 01986L0278-20090420 - EN - EUR-Lex (europa.eu)*

Conclusion on receptor sensitivity – geology and soil

The characteristics of geology and soil within the proposed WWTP site is considered typical for the area. Soils within the WWTP site appear clean and without heavy metals contamination. Overall, the sensitivity of soil and geology in context of the project is considered low.

The geology of the site has implications for the groundwater sensitivity. The presence of a regional clay seal under most of the site provides a natural protection against deeper groundwater contamination, although this natural clay protection is likely to be absent under the sludge pond area, as further discussed in section 6.1.6.

6.1.3 Seismicity

Most areas of Kazakhstan are located in a stable zone with little or no seismicity. In such a zone lies Karaganda. Seismicity in the country is concentrated along the southern border with People's Republic of China, Kyrgyz Republic, and Uzbekistan. Events of magnitudes 8.3 and 7.4 were recorded in the vicinity of Almaty in 1887 and 1889, respectively[9].

Both figures below show that the region with the highest peak ground acceleration (PGA) with a 10% or 2% probability of exceedance in 50 years on reference site conditions is around Almaty. Overall, the south and south-eastern regions depict a higher seismic hazard, whereas the earthquake risk in Karaganda is low.

[8] EUR-Lex - 01986L0278-20090420 - EN - EUR-Lex (europa.eu)

[9] https://www.carecprogram.org/uploads/CAREC-Risk-Profiles_Kazakhstan.pdf

Figure 6.8: Seismic hazard map for PGA with a 2% probability of exceedance in 50 years. Source: CAREC

Figure 6.9: Seismic hazard map for PGA with a 10% probability of exceedance in 50 years: Source: CAREC

Conclusion on receptor sensitivity – seismicity

The site is not prone to earthquake risk; hence the sensitivity of the site with regards to earthquake risks is considered to be **low**.

6.1.4 Climate (past conditions)

The distance from the ocean and the vast territory sharply determines the continental climate of Kazakhstan, with hot summers and cold winters. Kazakhstan is one of the largest countries in the world and therefore the climate varies significantly throughout the country. The terrain in Kazakhstan belongs to four natural climate zones – forest-steppe, steppe, semi-arid and desert. For the whole country, the annual average temperature is 6 ºC and the average annual precipitation is 248 mm. The city of Karaganda is in an area dominated by grassland and cropland.

The climate in Karaganda is highly continental and arid, with very cold and windy winters and a fast transition to a hot summer. The climate varies substantially from year to year. The below sub-sections describe the local climate situation based on available data related to **temperature**, **precipitation,** and **wind**. The data is obtained from the local meteorological station in the city of Karaganda. The data is found through the National Oceanic and Atmospheric Administration[10] and the meteorological site Pogodaiklimat[11].

The average monthly precipitation and temperature are shown in Figure 6.10. Precipitation data has been collected from 1933 to 2022 and temperature data from 1938 to 2022.

[10] https://www.noaa.gov/

[11] Karaganda Climate - Weather and Climate (pogodaiklimat.ru)

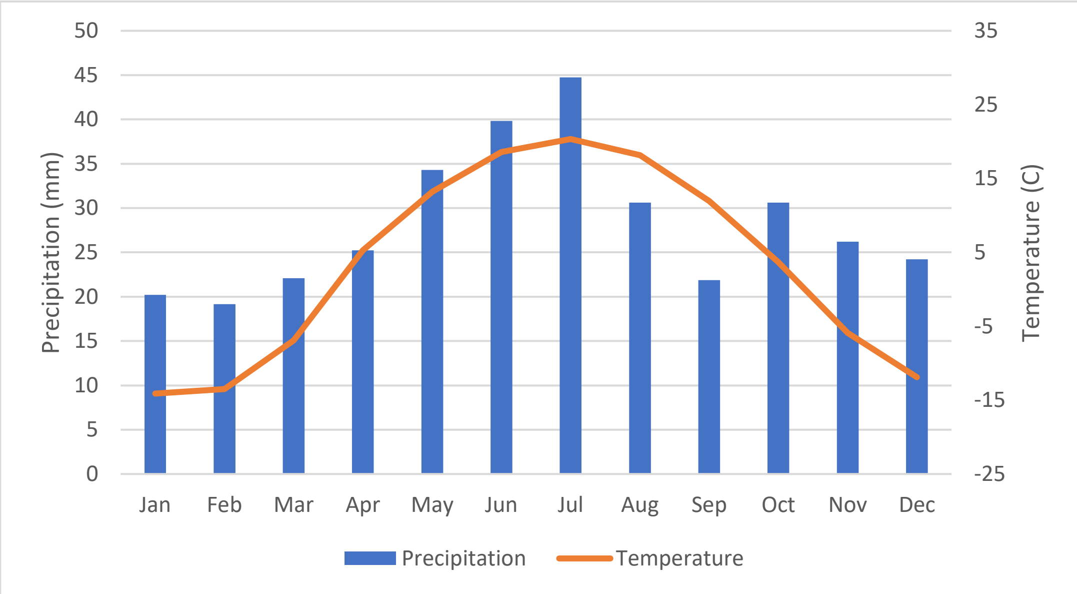

Figure 6.10: Monthly averages for temperature and precipitation for Karaganda, based on measured data from 1933 to 2022 (Source: National Oceanic and Atmospheric Administration)

The annual precipitation in Karaganda is about 340 mm, which is an average low precipitation, but slightly higher than the national average. There is not much difference between the lowest and the highest measured precipitation. The highest monthly precipitation is recorded in the late spring month of May and in the summer months, with July having the highest precipitation. The lowest monthly precipitation occurs in the winter months from December to March. Average temperatures are highest in the summer months and are below freezing in the winter months from November to March.

Temperature

The development in average annual temperature from 1933 to 2022 is shown in Figure 6.11 *Figure 6.11*. The data concludes a yearly average temperature of about 3 ˚C, which is under the country average. There is a variation in the data, but the trend shows an increase in average temperature within the last 90 years. The trend indicates an average rise of 2.5 ˚C in the region over the last 90 years.

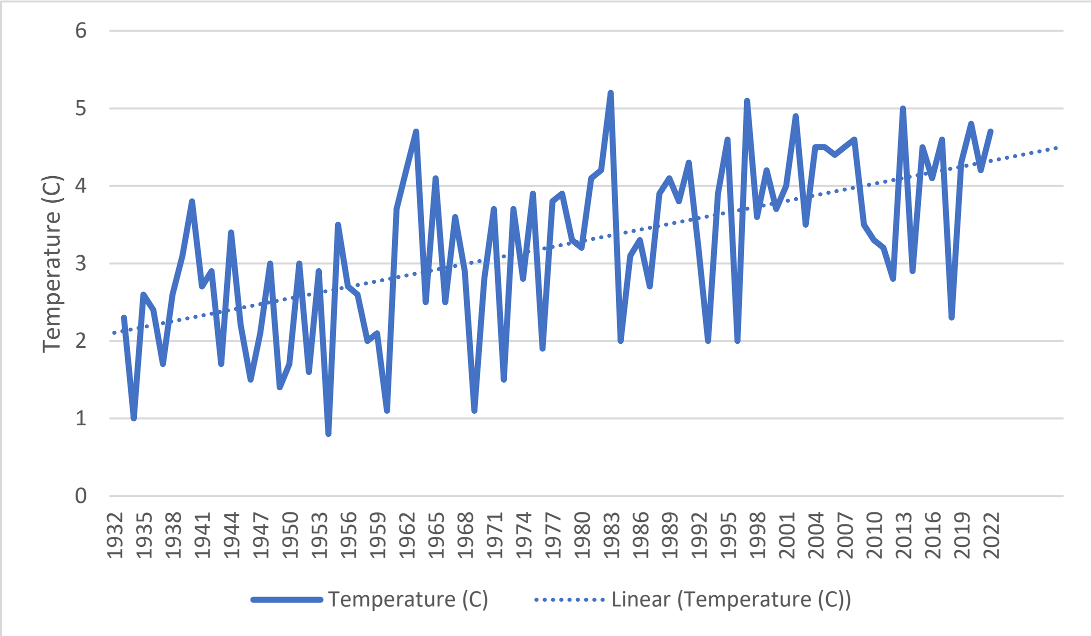

Figure 6.11: Annual mean temperature in Karaganda based on records from 1933 to 2022 from a meteorological station in Karaganda

Figure 6.12 shows the seasonal average temperature, indicating an increase in all seasons. The largest increase in seen in the spring. The lowest increase is seen in the summer months.

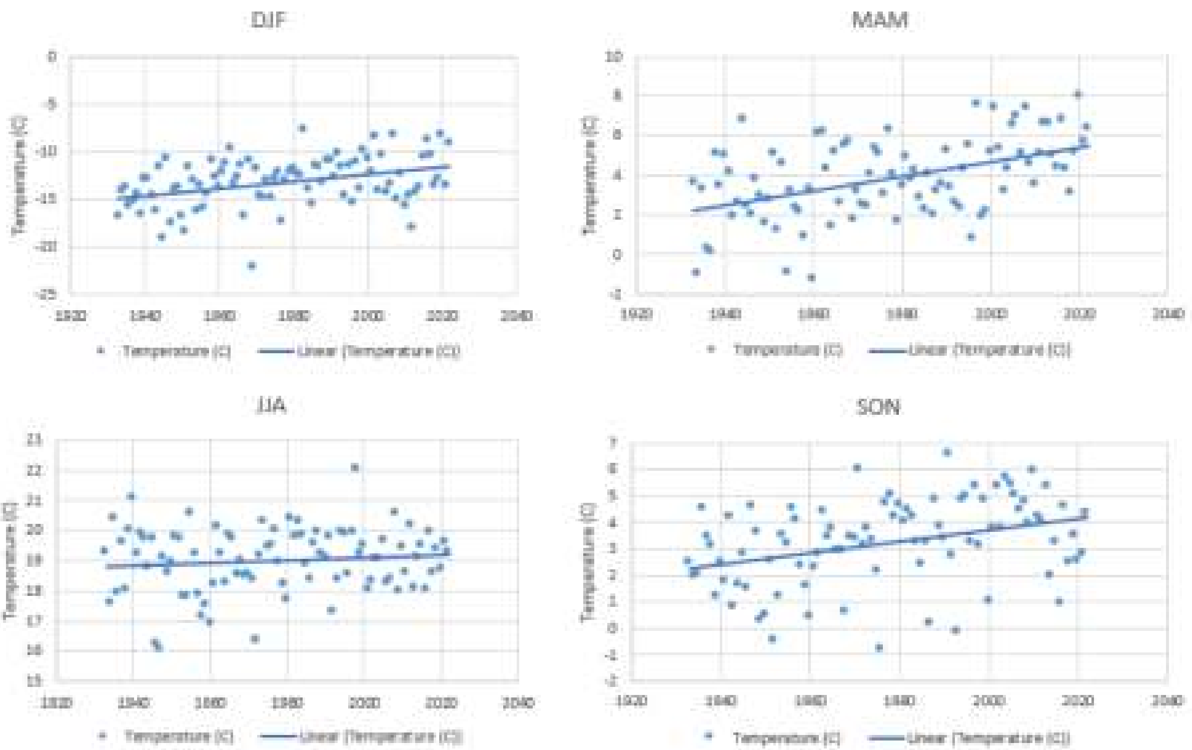

Figure 6.12: Change in seasonal average temperature for: December, January, and February (DJF); March, April, and May (MAM); June, July, and August (JJA); and September, October, and November (SON)

Precipitation

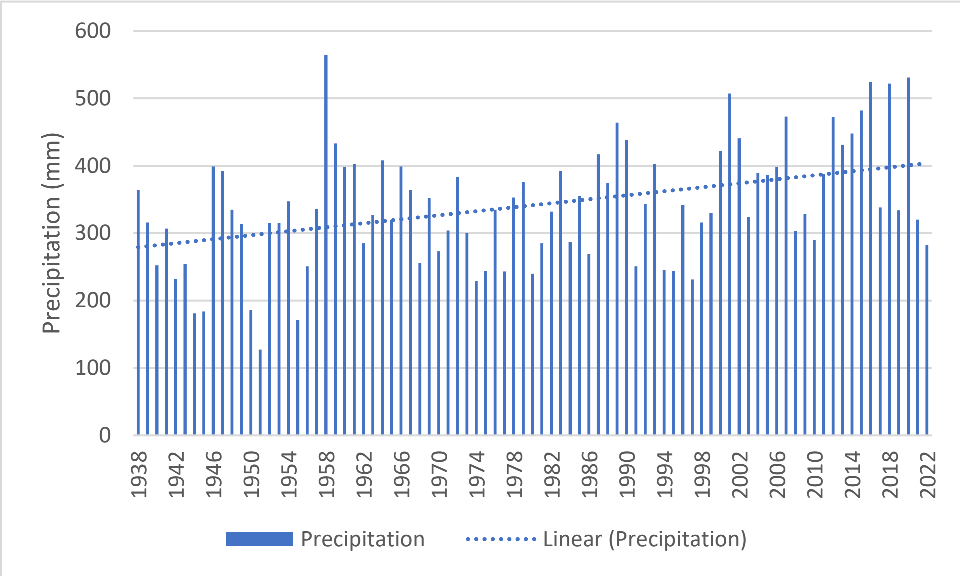

Figure 6.13: Annual rainfall in Karaganda based on records from 1938 to 2022 from a meteorological station in Karaganda

Figure 6.13 shows the annual precipitation for Karaganda covering a period from 1938 – 2022. As for the temperature, there is an indication that annual precipitation has increased over the past 90 years, seemingly by more than 100 mm/year. However, there is a large variation from year to year. When looking at the seasonal variation, an increase is also observed.

Figure 6.14 shows the seasonal precipitation. The figure shows that there is a clear tendency that the precipitation, on average, has increased over the last 90 years. In all seasons, there is a variation from year to year, however a clear tendency of an increase. The season where there is the largest change is the winter months December through February with an increase of about 50 mm for the three months, whereas the smallest change is observed in the summer and fall months June through November, where an increase of 15 mm over the three months is observed.

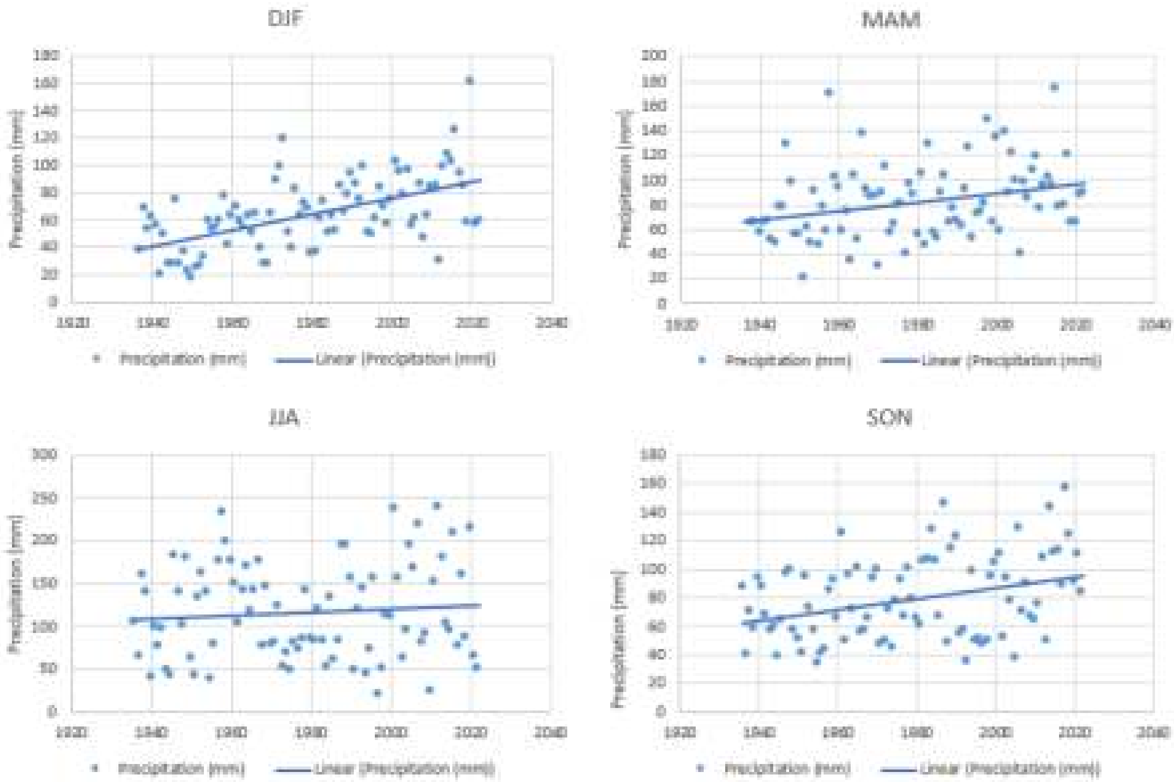

Figure 6.14: Change in seasonal average precipitation for: December, January, and February (DJF); March, April, and May (MAM); June, July, and August (JJA); and September, October, and November (SON)

For comparison with the local climate conditions presented above, Figure 6.15 shows the average monthly temperature and precipitation for the whole country from 1901 – 2020. The tendency for the temperature for Karaganda, shown in Figure 6.10, is the same for the country with warm summer months and cold winter months. The average national temperature aligns with the average temperature for Karaganda. The national patterns for the precipitation are a bit different than for Karaganda. On average it rains more in Karaganda, than nationally. In the summer period, Karaganda receives twice as much rain than the country average.

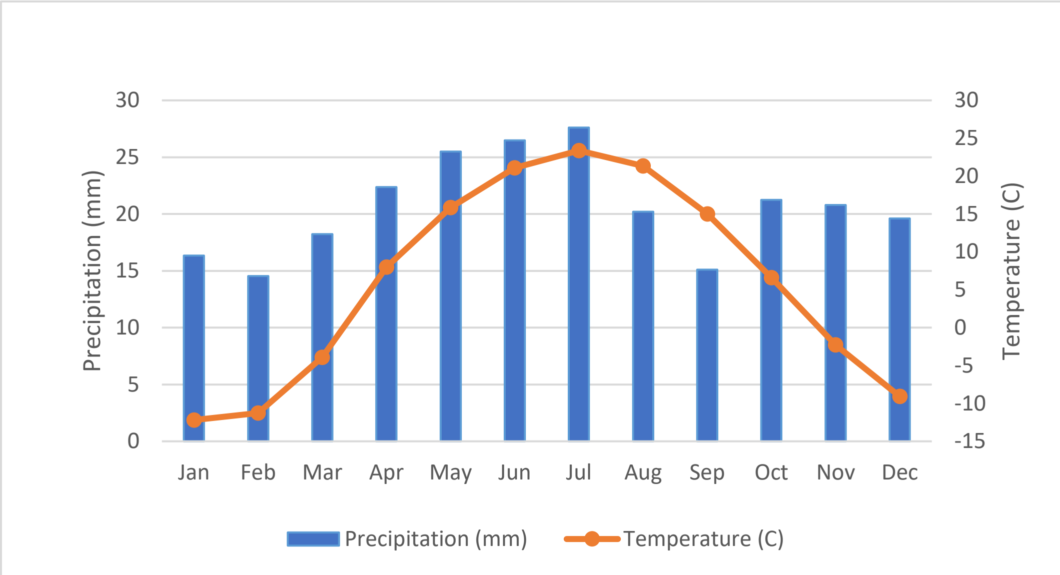

Figure 6.15: Average monthly temperature and rainfall for Kazakhstan from 1901-2020. Source: World Bank Climate Change Knowledge Portal

The following Table 6.2 shows the average number of days with solid, liquid and mixed precipitation, indicating almost 90 days annually with snow.

Table 6.2 Average number of days per year in Karaganda with solid, liquid and mixed precipitation (Source: http://www.pogodaiklimat.ru/, data period and source not provided)

Type of precipitation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Solid	20	17	13	4	0.4	0	0	0	0.2	4	12	18	89
Mixed	1	1	2	2	1	0	0	0	1	3	3	2	16
Liquid	0.2	0.1	2	6	13	12	14	10	8	6	3	1	75

Wind

Dominant wind directions and speed can be relevant in terms of dispersion of odour from WWTP operations, and in relation to the risk of extreme weather events. Wind speed is relatively low and stable throughout the year in Karaganda. However, thunder- and snowstorms are experienced regularly throughout the year (see sub-section below on extreme weather events).

Table 6.3 Average wind speeds in Karaganda throughout the year (m/s) (Source: http://www.pogodaiklimat.ru/), data period not provided

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
3.2	3.5	3.5	3.6	3.4	3.2	2.9	2.8	2.8	3.0	3.2	3.1	3.2

The following table shows the proportion of time with different wind directions in Karaganda per month over the year.

Table 6.4 Proportion of occurrences with different wind directions (%) per month in Karaganda (Source: http://www.pogodaiklimat.ru/), data period not provided

Wind direction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
N	4	5	6	10	10	17	20	19	12	7	7	4	10
NE	9	11	14	15	12	17	18	17	14	11	9	5	13
E	12	14	17	16	14	14	13	13	12	10	10	10	13
SE	16	16	14	11	10	9	8	9	10	12	13	17	12
S	28	24	19	14	15	10	9	10	13	17	22	28	17
SW	24	22	18	14	16	11	9	10	15	23	23	25	17
W	6	6	9	13	15	13	12	12	15	15	13	9	12
NW	1	2	3	7	8	9	11	10	9	5	3	2	6
Calm	14	12	9	10	11	13	14	13	17	14	12	13	13

The above data is depicted below, with averages within each quarter of the year.

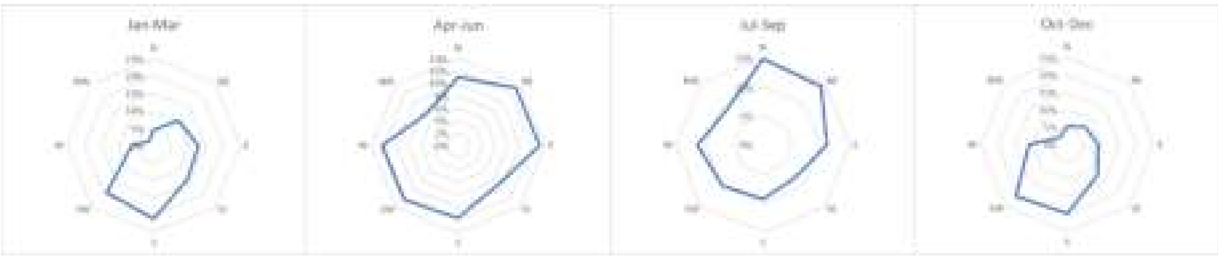

Figure 6.16 Wind directions in Karaganda within the four seasons (average % of time) based on the data in Table 6.4.

Based on the above data, southerly winds appear to be dominant during the period from October to March, whereas westerly, easterly, and northerly wind seem somewhat more frequent during spring and summer, yet without a clear trend.

The following diagram gives an indication of the number of days per month reaching certain wind speeds, for Karaganda. It shows that during the winter (Oct-April) wind speeds above 50 km/h (13.9 m/s) occur 3-4 days/month. More than half of the days during winter (and most during summer) experience relatively low wind speeds of <19 km/h (approx. 5 m/s).

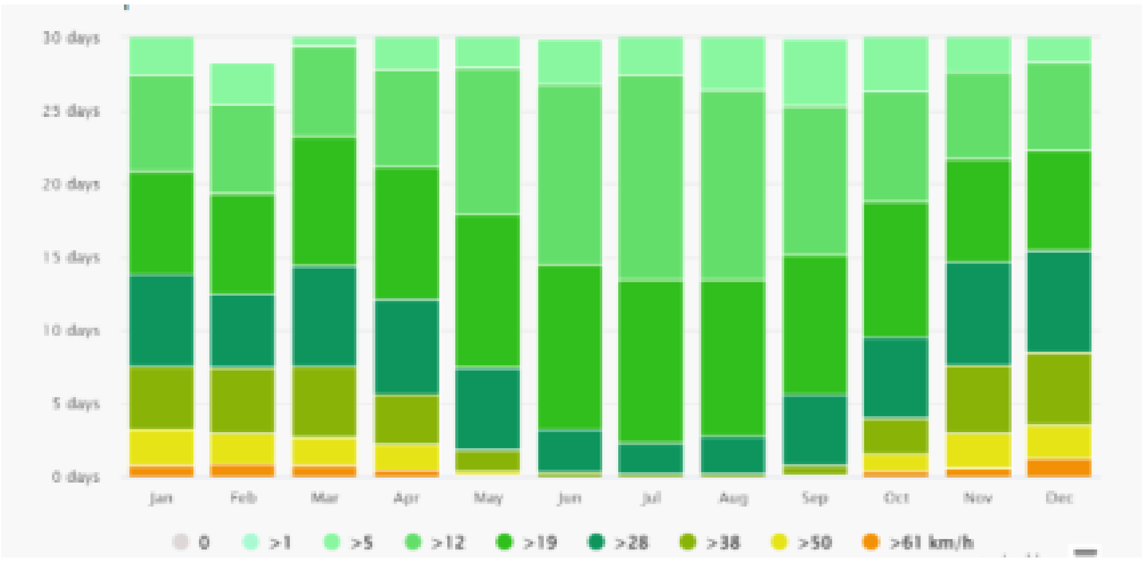

Figure 6.17 Average number of days/month in Karaganda reaching certain wind speeds (source: [Simulated historical climate & weather data for Karaganda – meteoblue](#))

Similarly, the below prevailing winds mapping for Karaganda shows how many hours per year the wind blows from the indicated direction, and the associated wind speeds. It appears to roughly align with the data in *Table 6.4* above, indicating that the dominant wind direction on an annual basis is from the south-west.

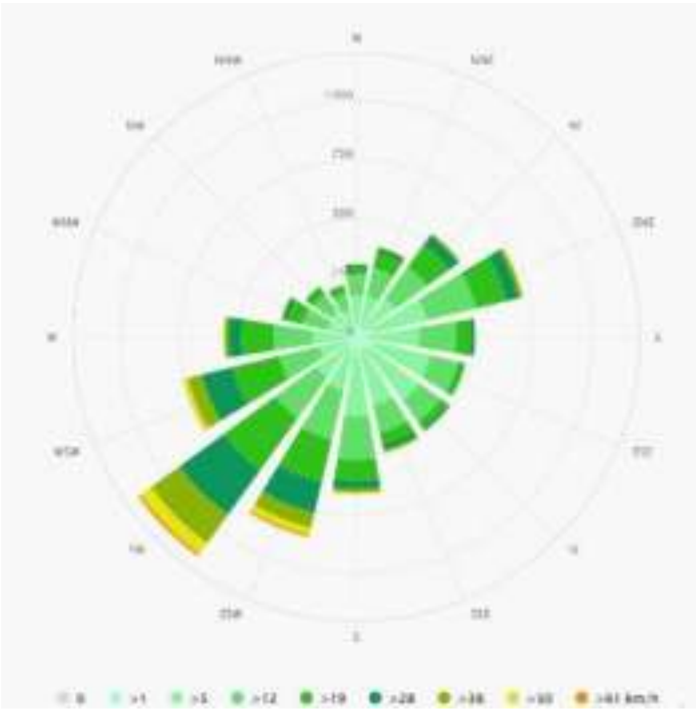

Figure 6.18 A prevailing winds mapping for Karaganda based on [Simulated historical climate & weather data for Karaganda - meteoblue](#).

Extreme weather events

The climate in Kazakhstan varies considerably throughout the country and extreme weather events will vary from the northern to the southern regions of the country. At the national level, projections show an increase in the number and intensity of weather events with the capacity to cause emergencies and natural disasters. A progressive increase in the number of extreme weather events in Kazakhstan is expected until the end of the century. From 2012 to 2017 the number of hydro-meteorological emergencies increased from 39 to 74, according to the Committee on Emergency Situations[12].

In the warm period of the year, heavy showers, accompanied by thunderstorms, may occur. On average, Karaganda experiences 23 days with thunderstorms and 39 days with snowstorms, according to the data provided by pogodaiklimat.ru/.

Table 6.5 Number of days with different weather phenomena in Karaganda throughout the year (Source: http://www.pogodaiklimat.ru/)

Phenomenon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	1	1	4	9	14	12	14	10	9	9	6	2	91
Snow	20	19	15	6	1	0	0	0	1	7	15	19	103
Fog	1	1	2	1	0	0.2	0	1	1	1	2	1	11
Haze	0.03	0	0	0.1	0	0.03	0.3	0.2	0.03	0.03	0	0.1	1
Thunderstorm	0	0.04	0	1	4	5	8	4	1	0.03	0	0.03	23
Snowstorm	10	10	5	1	0.1	0	0	0	0	1	4	8	39
Dust storm	0	0	0.03	0.1	0.3	0.2	0.2	0.3	0.3	0.03	0.03	0	1
Glaze	1	0.2	1	0.3	0	0	0	0	0.03	0.3	1	1	5
Rime	2	2	2	0.2	0	0	0	0	0	0.3	2	2	11

At the national level, the average temperatures increased over the past 20 years and are projected to rise further in the future. The number of days with heatwaves has also increased. In the northern regions of Kazakhstan, the absolute maximum air temperature typically ranges from 40 to 41 ºC at present. Projections suggest that temperatures may reach up to 44 to 45 ºC by 2085. However, this is considered a distinctive feature of the northern regions of Kazakhstan. In extreme situations the absolute maximum air temperatures are predicted to raise to 50 to 55 ºC by 2085.

According to the CAREC Risk profile of Kazakhstan, there is an average of 393 fatalities in the country due to floods, 36 of these being in the Karaganda region. An important distinction is to be made between pluvial flooding (precipitation runoff flooding) and fluvial flooding (river flooding) - where the later plays a large role across the country.

The most extreme rain events are to be expected in the summer. According to historical data provided by pogodaiklimat.ru/. The largest daily amounts of precipitation recorded have occurred in July with 61 mm in 1939 and 2007, respectively.

Climate related implications for WWTP operations

Climate conditions can alter the WWTP operation impact. Sludge odour, transferred to the nearby houses by wind, is commonly sensed by the residents especially in the evenings. With the frequent south-westerly wind (Figure 6.18), the odour reaches Karaganozek houses more often despite them being further away

[12] Environmental Performance Reviews; Kazakhstan (UNECE; https://unece.org/DAM/env/epr/epr_studies/ECE_CEP_185_Eng.pdf

than the Junction 737 houses. During the day, air convection disturbs horizontal wind propagation, and the smell does not reach the houses.

Conclusion on climate

The climate in Karaganda is highly continental and arid, with cold and windy winters and hot summers, and substantial variation from year to year. The average temperature has risen on average 2.5˚C over the last 100 years. Also, precipitation has on average increased over the past 100 years, from approximately 270 mm/year to almost 400 mm/year. However, there is a relatively large variation from year to year. On average, wind speeds in Karaganda are relatively low throughout the year, however, thunder- and snowstorms are experienced regularly throughout the year. South-westerly winds appear dominant during winter (Oct-Mar), whereas westerly, easterly, and northerly winds seem relatively somewhat more frequent during summer, yet with substantial variability. See discussion below on climate change and associated receptor sensitivity.

6.1.5 Climate change projections

This section describes an assessment of future climate conditions in Kazakhstan and Karaganda as caused by climate change, based on available data. It forms the **basis for a climate risk and resilience assessment** for the planned WWTP Project included in the Impact Assessment section further below.

Future Climate Conditions and vulnerability

Future climate projections are generally derived from Global Climate Models (GCMs) or Regional Climate Models (RCMs), which are driven by the global models. Usage of these datasets usually goes through a process of downscaling to represent climate conditions at the site of interest, so a more accurate assessment can be carried out.

The development of climate scenarios entails “forcing” a change in the climate system. This is done by means of a series of emission scenarios (SRES) or representative concentration pathways (RCPs), both of which provide projections of atmospheric concentrations of greenhouse gases. These scenarios are the main input in the GCMs.

There are three main sets of scenarios: SRES, non-SRES and RCP scenarios. The most used until now are the 40 SRES scenarios, which are grouped into four categories (A1, B1, A2 and B2), based on a series of factors, *i.e.*, socio-economic and technological development. More detailed information can be found in the IPCC reports (AR3, AR4 and AR5).

In this ESIA for Karaganda, however, a downscaling analysis cannot be done due to data and time limitations. Hence, the future climate trends analysed in this report are based on a combination of different already-compiled sources showing climate projections, based on different RCMs, with a focus on the climate for the 2050s, as specified in the TOR. Specifically, the following sources have been used for establishing the direction of climate change in Karaganda:

- Kazakhstan’s Sixth National Communication to the United Nations Framework Convention on Climate Change (SNC)
- World Health Organisation
- www.climatewizard.org
- World Bank’s Climate Change Knowledge Portal

The projections of future climate change for temperature and precipitation for the 2050s, according to simulations based on the AR5, can be seen in the following figures, *Figure 6.19* and *Figure 6.20*.

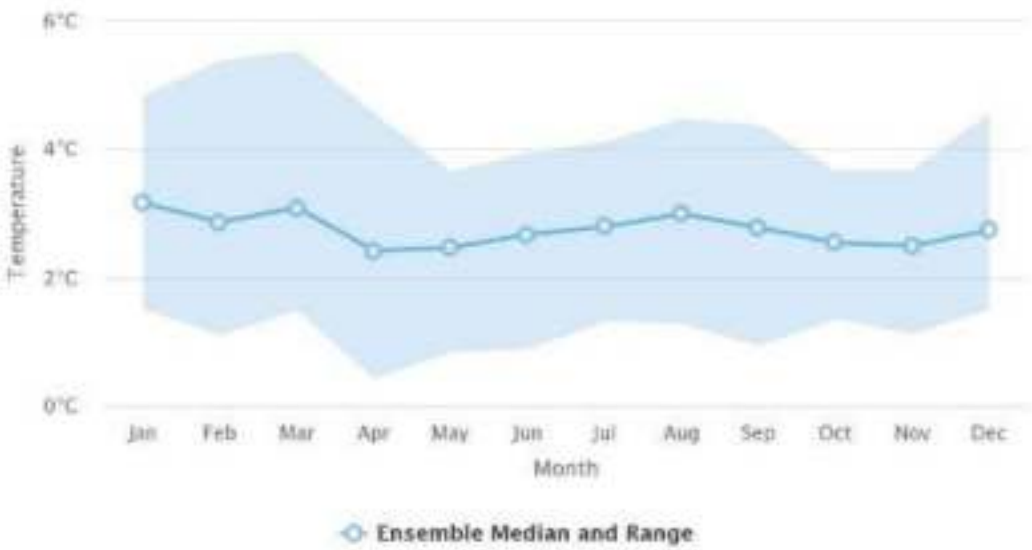

Figure 6.19: Projected change in Monthly Temperature for Kazakhstan in the period 2040-2059, based on the CMIP5 (Source: World Bank Climate Change Knowledge Portal)

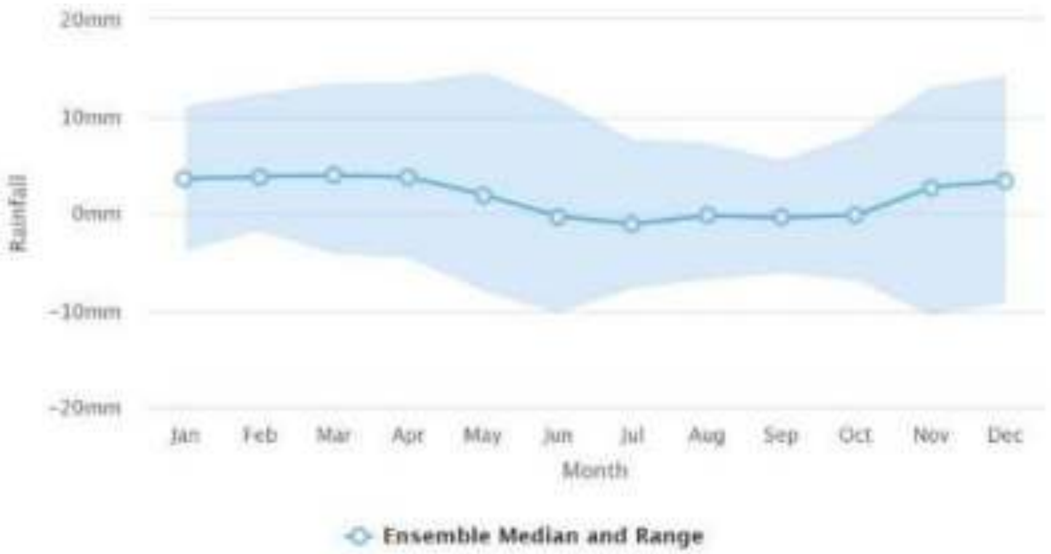

Figure 6.20: Projected change in Monthly Precipitation for Kazakhstan in the period 2040-2059, based on the CMIP5[13]

According to Figure 6.19, the projected change in monthly temperature for Kazakhstan will be an increase of around 2.75 °C in the period 2040-2059, with slight seasonal variations. Especially during December to February and June to August, the temperature will be warmer. It is expected that the number of cold days will decrease in the future. The temperature will have an impact on the water resources in terms of both snow-melting and evapotranspiration – and can have a direct impact on the WWTP in terms of sludge drying and biological processes.

The projected change in precipitation is shown in Figure 6.20. Annual precipitation is projected to rise by a total of 20 mm by 2059. Across the country the precipitation during December through May is projected to decrease by 2-5%, and from June through November the precipitation is projected to increase by 1-4%.

13 World Bank Climate Change Knowledge Portal

Climate Wizard

As Kazakhstan is a large country, it is important to look at the projections of the specific region. They establish a clearer direction of climate change in the region; data from the website *www.climatewizard.org* has been included in this report. Climate Wizard provides global and regional ensemble averages from 9 Global Circulation Models (GCM), using three scenarios: namely, medium A1B, high A2 and low B1 (from AR4), with a grid cell resolution of *approx.* 50 km. The projections for the area around Karaganda as expected by mid-century (2050s), on precipitation and temperature, are shown in Table 6.6 and Table 6.7.

Table 6.6: Ensemble average seasonal temperature changes (°C) in the Karaganda region, by mid-century (2050s), for three scenarios, over 9 GCMs (Source: www.climatewizard.org)

Season	Months	Low B1			Medium A1B			High A2		
		Average	Min	Max	Average	Min	Max	Average	Min	Max
Winter	DJF	2.0	1.1	3.7	5.3	2.7	11.0	2.8	1.7	4.6
Spring	MAM	2.0	0.4	3.7	4.5	-2.3	10.1	2.8	1.0	4.7
Summer	JJA	2.3	1.1	2.8	3.9	-9.1	12.0	2.9	2.4	3.4
Fall	SON	2.2	1.0	4.1	2.0	-5.4	7.9	2.5	1.2	3.6
Annual		2.1	1.0	3.5	3.9	-1.0	9.1	2.7	1.8	3.9

Table 6.7: Ensemble average seasonal precipitation changes (%) in the Karaganda region by mid-century (2050s) for three scenarios over 9 GCMs (Source: www.climatewizard.org)

Season	Months	Low B1			Medium A1B			High A2		
		Average	Min	Max	Average	Min	Max	Average	Min	Max
Winter	DJF	21.4	10.4	46.1	29.9	12.6	62.3	30.4	12.0	60.9
Spring	MAM	17.5	-5.9	34.1	18.7	-8.4	43.3	12.6	-3.1	26.5
Summer	JJA	0.6	-38.3	20.3	3.9	-9.1	12.0	1.0	-38.8	42.0
Fall	SON	7.6	-18.9	31.5	6.3	-15.9	32.3	10.9	-4.5	33.1
Annual		13.9	-1.8	32.6	2.0	-5.4	7.9	13.7	-2.4	30.7

It is important to mention that the data shown in the tables above corresponds to ensemble averages, which means that half of the models project higher changes, while the remaining half project less change.

The projections from the climate wizard regarding temperature show that there is an expected increase within all seasons. The average prediction for the temperature is similar both for the B1 and A2 scenarios. The increase is predicted to be between 2.0-2.9 °C through the seasons and both models. The highest increase will be seen in the summer month, followed by the winter, or fall seasons, depending on which scenario is modelled. The A1B scenario predicts the highest increase in all seasons with 2 °C in the fall months and 5.3°C winter months. Even though the models vary, there is an overall tendency that the temperature for Karaganda will increase in the future.

The prediction for the precipitation varies from model to model and from season to season. On average the precipitation will increase in the future. The largest average increase is predicted in the winter months followed by the spring months. The summer months are predicted to have the smallest increase in precipitation. The model’s predictions vary, but the overall conclusion is that the annual precipitation will increase in Karaganda.

Overall, a trend of higher temperatures in all seasons and an increase in precipitation in all seasons can be observed for the Karaganda region, with summer showing the highest increase in temperature and the lowest increase in precipitation.

Climate related implications for WWTP operations

There is an important differentiation to be made between precipitation in general and extreme events. The above sections indicate the general future trends for precipitation. In terms of extreme events, “Kazakhstan’s Sixth National Communication to the United Nations Framework Convention on Climate Change (SNC)” states that “In view of precipitation insignificance and its big mobility in space and time it was approved in Kazakhstan that change of precipitation amount can be neglected in future, wherefore its current climate rated values can be applied in calculations”.

This conclusion is backed up on a local level. Looking at the World Bank Climate Change Knowledge Portal the future return period of a current 5-year precipitation event is a 4-6 year event in the Karagandiskaya region – meaning that extreme rainfall might even be less frequent in the region.
This means that in terms of flood risk, it should be sufficient to consider historical events and data when designing future infrastructure.

The tables above show a trend of higher temperatures in all seasons and an increase in precipitation in all seasons. Higher precipitation during the colder months could lead to higher risk of fluvial flooding in the area during e.g., spring melt and/or if rain falls on frozen ground. Flooding is only expected to increase in low lying areas that are near rivers. Extreme precipitation events are not expected to be more frequent, why pluvial flooding should not be more frequent. Snow melt could, on the other hand happen faster than previously, meaning that rivers will flood nearby areas.

Figure 6.21 shows the catchment of the Bukpa river that passes by the WWTP on the western side by the sludge drying beds.

Figure 6.21: Approximate catchment of the river (Bukpa) passing by the WWTP

The catchment is approximately 8200 ha and includes much of the city. Despite this fact it is a small stream that is reported to only carry water few months of the year. No big changes to the flow are expected as a result of climate change, but as explained above there is a risk that more snowfall in the winter and more drastic changes in temperature could lead to a higher flow in the spring. This change will be small however, with predicted annual precipitation in 2059 being 20 mm higher than today, the fraction that will be involved in a single snow-melt event is not expected to be large enough to pose a real risk.

As stated previously in this report, the riverbanks are at a higher level than the sludge drying ponds, why these are at risk of flooding. This flooding is not expected to be more frequent or severe in the future. The eastern part of the treatment plant, where the construction will happen, is at a higher elevation than the river (Figure 6.4), why the flooding is not expected to impact the newly constructed area.

The puddles (landscape depressions) that are forming within the area due to an unknown combination of precipitation, soil types, groundwater and lack of drainage are not expected to worsen over time, but it should be managed to ensure the structural integrity of the concrete. This should be included as part of a regular drainage system when designing a new impermeable area with concrete structures and paved surfaces, and the design does not require any particular consideration of climate change.

Conclusion on the location's sensitivity to climate and climate change

As Kazakhstan is such a large country with different climate zones, the effect of the climate change varies throughout the country. Overall, the projections show a clear trend towards higher temperatures across the entire country. At the national level, temperature increase is greater for the summer and the winter seasons. The local data relevant for Karaganda shows that the winter and spring season on average has the most significant increase of temperatures. However, both in the projection and in the measured data there is a trend of increasing temperatures within all seasons. The projections for precipitation show there is an increase in precipitation within all seasons, about 20 mm more than today by 2059 on a yearly basis, but no change in extreme precipitation events is expected.

It is noted that the climate change assessment reflects future scenarios which are subject to various uncertainties. These are further outlined in Annex 2.

The location of the WWTP is considered of mild (low) sensitivity in regards of flood risk, since it is seen that extreme events should not be expected to be more frequent – and the nearby river has a small catchment area. It should be noted that any flooding risk is not particularly linked to climate change, but is also present today.

In terms of water stress and drought, the Karaganda region is not expected to experience seasonal issues and could be estimated to be of mild (low) sensitivity.

The Sokyr river will receive the effluent from the WWTP. The river is fairly small, with no glacial sources or known groundwater sources, making rainfall runoff the primary and perhaps only source. With the projections of more precipitation throughout all seasons, there is no reason to expect lower flows in the river, i.e., the capacity for dilution of the effluent should either remain the same or increase slightly.

In conclusion, climate change is not expected to impact the WWTP in any significant way. While both temperatures, precipitation in the wastewater catchment, flood risk and dilution of effluent need to be considered in the design of the plant, this is not related to climate change, but should instead be treated as normal design parameters to be considered during the detailed design of the WWTP.

6.1.6 Surface and groundwater

Overall river basin and water resource context

There are seven main river basins in Kazakhstan as shown in Figure 6.22. Karaganda is in the Nura River basin, marked with pink on the figure, in the central part of the country. The basin is dominated by the Nura River, upstream from Karaganda to Lake Tengiz (and the Kurgaldzhino wetlands). The Nura River basin extends over 60,800 km^2 of Kazakhstan and is not trans-boundary. The Karaganda WWTP effluent is discharged to the small Sokyr River which flows to the Sherubainura River which then flows into the Sherubainura River, which in turn flows into the Nura River. Eventually, the Nura River empties out to Lake Tengiz.

Figure 6.22: Map of main river basins in Kazakhstan (Source Water resource Committee of the Republic of Kazakhstan)

Surface water resources are extremely unevenly distributed within the country and are marked by significant perennial and seasonal dynamics. Central Kazakhstan, for instance, has only 3 percent of total water resources in the country. The current volume of river runoff in Kazakhstan seems to differ significantly from previous estimations and long-term averages. Reduced surface runoff could provide evidence of significant climatic and anthropogenic effects on water resources and reflects the strong tendency towards possible reduction of surface water resources in the country. The western and southwestern regions (Atyrau, Kyzylorda and Mangystau regions) have a significant water deficit and there is hardly any fresh water available. Most of the runoff occurs in the spring due to snowmelt, especially from the mountains. There are no mountains around Karaganda, so the Nura River is recharged through surface runoff following rainfall and by surface snowmelt during spring. A change in precipitation patterns and temperature can therefore have a large influence on the river flow patterns.

WWTP area and immediate surroundings

There are two natural water bodies in the immediate WWTP area, the Sokyr and Bukpa Rivers. The Sokyr River runs south of the WWTP area from east to west. The distance from the discharge point of the bioponds to the confluence with the Sokyr River is about 1.2 km. The Bukpa River flows in the channelised course from north to south along the west side of the WWTP until it mouths into the discharge channel of the bioponds to the Sokyr River. Reportedly, when the WWTP was constructed, the Bukpa river course was moved away from the railway to prevent its flooding in spring, to its current location.

Besides the two rivers, the bioponds, sludge beds and the discharge channel from the bioponds to the Sokyr River present major water surface bodies within the PAI.

Groundwater in the WWTP area

In October 2019 at the pump station 7, which is located at the same altitude as the WWTP and at the same bank of the Bukpa river (Figure 6.23), unconfined groundwater was found and stabilised at 1.4-1.8m depth. It is replenished by thaw and rainwater and presumably by wastewater from the WWTP bioponds, as well as sedimentation and aeration tanks that may be leaking. From its minimum level in September-October and March, groundwater may rise to 0.3-0.4m in the beginning of May. Rarely, the second rise may occur in June-August. The water is sulphate-sodium, alkaline, moderately hard. Mineralisation is 1.383g/L (Kazvodokanalproekt Institute archive #257/2019).

Because Jurassic effusive (and most likely fractured) bed rock outcrops under the existing sludge beds as presented in chapter 6.1.2, and because there is understood to be no man-made sealing of the sludge beds, the discharge water of the sludge beds may percolate into deeper groundwater. The new WWTP however is planned above the regional groundwater seal that prevents shallow groundwater from entering the deeper aquifers (see Geology, geomorphology, and soil section for discussion). The presence of this seal was evident from the satellite image 28.04.2023 (Figure 6.23) that shows standing water in the south part of the new WWTP area and the area south of the existing WWTP. Here a small lake was still present during the visit in June, which was conducted as part of this ESIA baseline work. It has been informed that the WWPT will be raised to improve drainage of the area. With regards to the absence of natural or man-made seal under the sludge beds, it should be noted that the existing sludge beds will not be used for sludge treatment as part of the proposed WWTP, which will be equipped with anaerobic digestion of sludge. A requirement to decommission and rehabilitate the sludge pond area is included in the ESMP. Full implementation of the ESMP is a requirement of the ESAP.

Four groundwater monitoring wells were installed adjacent to the WWTP in 2020 by an experienced local contractor Azimut (Figure 6.23).

Figure 6.23 Location of sources of groundwater data: Pump station 7 and groundwater monitoring wells (1-4) adjacent to the existing WWTP.

Groundwater chemical analysis was conducted following installation of the wells in 2020, and the results are presented in Table 6.8.

Table 6.8 Groundwater quality upstream, west, east and downstream of the WWTP (mg/L) based on measurements in 2020 (From the passports of four wells drilled in 2020). The water at all 4 wells is assigned the lowest quality class 5 – suitable for industrial use only. Parameters considered to be excessive by the wells installation contractor are highlighted red.

Well #	1 Up	2 West	4 East	3 Down
Well depth, m	15	14.73	9.34	7.15
Water level, m *	2.69	1.68	2.64	2.63
BOD_{20}	1.3	14.3	3.5	23.5
COD	43.4	189.7	53.0	53.0

Well #	1 Up	2 West	4 East	3 Down
Permanganate oxidation	-	12.8	-	-
Phosphates	<0.02	0.43	0.04	<0.02
Nitrates		390.6	-	-
Ammonia	-	-	40.0	-
Oil products	0.351	0.273	0.063	0.032
Surfactants	<0.025	0.136	0.158	0.080
Mn	0.145	2.536	4.582	2.998
Fe	2.17	11.60	0.64	0.55
Hardness	2.2	53.00	17.0	10.8
Salinity	1900	7500	2100	1800
Mineralisation	Cl-Na-K	Cl-Na_2SO_4-K	Ca-Na-K	Na-K
Susp. Solids	948	300	17.1	24.4
pH	8.09	6.93	7.74	7.96

Full analyses of groundwater in the four wells were made in March and June (30.06) 2023 by an accredited local laboratory GIOTRADE. The results are presented in Table 6.9 below. As there is no official groundwater standard available for Kazakhstan, Dutch groundwater values are shown for reference[14]. The sampling indicated zinc concentration being persistently over the Dutch Intervention value in all wells including the well upstream of the WWTP, which suggests high ambient concentration of zinc in the regional unconfined aquifer.

Table 6.9. Groundwater quality monitoring in 2023 by a certified laboratory GEOTRADE. Note differences in units for microelements. Dutch target and intervention values are shown for reference. Values exceeding the Dutch intervention value are indicated with red colour.

Well#	Unit	1 Up		2 West		3 East		4 Down		Dutch Standards (reference values)	
Month		March	June	March	June	March	June	March	June	Target	Intervention
pH	-	8.34	7.45	7.83	7.76	7.8	7.88	7.26	7.65	-	-
Smell at 20°C	*rate*	0	0	0	0	0	0	0	0	-	-
Smell at 60°C	*rate*	0	0	0	0	0	0	0	0	-	-
Colour	*grad*	19	63	23	28	26	175	48	59	-	-
Suspended solids	*mg/L*	3.53	11.8	1.11	3.74	2.95	21.8	3.32	12.5	-	-
α-radiation	*Bq/L*		<0.02		<0.02		<0.02		<0.02	-	-
β-radiation	*Bq/L*		<0.1		<0.1		<0.1		<0.1	-	-
Activated Silicone acid	*mg/L*	1.07	1.123	1.24	1.268	1.22	1.208	1.32	1.268	-	-
Mineralisation	*mg/L*	1959	1901	5522	5092	1519	1080	1576	1719	-	-
Hardness	*mg-eq/L*	4.1	4.3	35	33.5	14	14.5	18.5	6.9	-	-
Sulphates	*mg/L*	77	289	173	1389	115	321	173	338	-	-
Chlorides	*mg/L*	627	589	941	1978	361	256	428	861	100	-
Fluoride ions	*mg/L*	0.12	0.037	0.031	0.034	0.13	0.036	0.12	0.042	-	-

[14] https://en.wikipedia.org/wiki/Dutch_pollutant_standards and http://enviroeng.eu/wp-content/uploads/2022/01/LISTA-HOLANDESA-2013.pdf

Well#	Unit	1 Up		2 West		3 East		4 Down		Dutch Standards (reference values)	
Month		March	June	March	June	March	June	March	June	Target	Intervention
Permanganate oxidation	*mg/L*	1.63	0.32	2.1	0.56	1.98	0.4	2.1	0.52	-	-
Petroleum Hydrocarbons	*mkg/L*	42	30	55	35	47	34	58	42	50*	600*
Surfactants	*mkg/L*	210	29	820	27	370	28	1170	36	-	-
Phenol	*mkg/L*	<5	<5	<5	<5	<5	<5	<5	<5	0.2	2000
Polyphosphates	*mkg/L*		39		28		41		31	-	-
Lindane γ-HCH	*mkg/L*		<1		<1		<1		<1	0.009	-
DDT isomers	*mkg/L*		<5		<5		<5		<5	-	-
2.4-D	*mkg/L*		<700		<700		<700		<700	-	-
Cr^{+6}	*mkg/L*	<1	<1	<1	<1	<1	<1	<1	<1	1	30
Zn	*mkg/L*	120	80	88	250	80	46	68	92	65	80
Pb	*mkg/L*	1.8	1	2.2	2	1.2	0.24	1.6	1.6	15	75
Cd	*mkg/L*	0.68	0.52	0.88	0.88	0.72	0.58	0.68	0.82	0.4	6
Hg	*mkg/L*	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05	300
Ni	*mkg/L*	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Cu	*mkg/L*	32	38	46	48	36	50	36	60	15	75
Al	*mkg/L*	200	120	280	300	200	120	240	160	-	-
Mn	*mkg/L*	45.5	60.8	51.2	108.8	49.9	41.2	48.7	51.8	-	-
Mo	*mkg/L*	20	35	30	71	25	48	30	54	5	300
As	*mkg/L*	<1	<1	<1	<1	<1	<1	<1	<1	10	60
Ba	*mkg/L*	<10	10	11.2	11.2	<10	<10	<10	<10	50	625
Be	*mkg/L*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.05	15
B	*mkg/L*	<100	100	<100	260	<100	100	<100	120	-	-
Cyanide	*mkg/L*	<10	<10	<10	<10	<10	<10	<10	<10	5	1500
Se	*mkg/L*	<2	<2	<2	<2	<2	<2	<2	<2	0.07	160
Sr	*mkg/L*	56	60	77	100	80	80	86	98	-	-
pH	-	8,34	7.45	7,83	7,76	7,8	7,88	7,26	7,65	-	-
Smell at 20°C	*rate*	0	0	0	0	0	0	0	0	-	-
Smell at 60°C	*rate*	0	0	0	0	0	0	0	0	-	-
Colour	*grad*	19	63	23	28	26	175	48	59	-	-
Suspended solids	*mg/L*	3,53	11,8	1,11	3,74	2,95	21,8	3,32	12,5	-	-
α-radiation	*Bq/L*		<0,02		<0,02		<0,02		<0,02	-	-
β-radiation	*Bq/L*		<0,1		<0,1		<0,1		<0,1	-	-
Activated Silicone acid	*mg/L*	1,07	1,123	1,24	1,268	1,22	1,208	1,32	1,268	-	-
Mineralisation	*mg/L*	1959	1901	5522	5 092	1519	1080	1576	1719	-	-
Hardness	*mg-eq/L*	4,1	4,3	35	33,5	14	14,5	18,5	6,9	-	-
Sulphates	*mg/L*	77	289	173	1389	115	321	173	338	-	-
Chlorides	*mg/L*	627	589	941	1978	361	256	428	861	100	-
Fluoride ions	*mg/L*	0,12	0,037	0,031	0,034	0,13	0,036	0,12	0,042	-	-
Permanganate oxidation	*mg/L*	1,63	0,32	2,1	0,56	1,98	0,4	2,1	0,52	-	-
Petroleum Hydrocarbons	*mkg/L*	42	30	55	35	47	34	58	42	50*	600*

Well#	Unit	1 Up		2 West		3 East		4 Down		Dutch Standards (reference values)	
Month		March	June	March	June	March	June	March	June	Target	Intervention
Surfactants	*mkg/L*	210	29	820	27	370	28	1170	36	-	-
Phenol	*mkg/L*	<5	<5	<5	<5	<5	<5	<5	<5	0,2	2000
Polyphosphates	*mkg/L*		39		28		41		31	-	-
Lindane γ-HCH	*mkg/L*		<1		<1		<1		<1	0,009	-
DDT isomers	*mkg/L*		<5		<5		<5		<5	-	-
2,4-D	*mkg/L*		<700		<700		<700		<700	-	-
Cr^{+6}	*mkg/L*	<1	<1	<1	<1	<1	<1	<1	<1	1	30
Zn	*mkg/L*	120	80	88	250	80	46	68	92	65	80
Pb	*mkg/L*	1,8	1	2,2	2	1,2	0,24	1,6	1,6	15	75
Cd	*mkg/L*	0,68	0,52	0,88	0,88	0,72	0,58	0,68	0,82	0,4	6
Hg	*mkg/L*	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	0,05	300
Ni	*mkg/L*	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Cu	*mkg/L*	32	38	46	48	36	50	36	60	15	75
Al	*mkg/L*	200	120	280	300	200	120	240	160	-	-
Mn	*mkg/L*	45,5	60,8	51,2	108,8	49,9	41,2	48,7	51,8	-	-
Mo	*mkg/L*	20	35	30	71	25	48	30	54	5	300
As	*mkg/L*	<1	<1	<1	<1	<1	<1	<1	<1	10	60
Ba	*mkg/L*	<10	10	11,2	11,2	<10	<10	<10	<10	50	625
Be	*mkg/L*	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	0,05	15
B	*mkg/L*	<100	100	<100	260	<100	100	<100	120	-	-
Cyanide	*mkg/L*	<10	<10	<10	<10	<10	<10	<10	<10	5	1500
Se	*mkg/L*	<2	<2	<2	<2	<2	<2	<2	<2	0,07	160
Sr	*mkg/L*	56	60	77	100	80	80	86	98	-	-

Figure 6.24 Depression south of the WWTP filled with groundwater from unconfined aquifer. In front is soft sludge placed for drying in 2022.

Influent and Effluent quality from the existing WWTP

Influents to the WWTP include domestic wastewater form households, public and industrial enterprise customers.

Karaganda is an industrial city, with key industries dominated by the processing industry (69.3%) and the supply of electricity, gas, steam, hot water, and air conditioning (24.5%). Based on information received from KS, industrial enterprises of Karaganda discharge only their domestic wastewater to the sewer collection network.

Treated effluents from the existing WWTP are continuously discharged to the subsequent biopondsand from there to the Sokyr River.

Table 6.10 summarises the influent and effluent characteristics for the existing Karaganda WWTP (average values for 2022).

Table 6.10: Karaganda WWTP Influent and Effluent Characteristics (annual averages, mg/L), the calculated and approved maximum permitted discharge (MPD) standard and standards of the EU Urban Wastewater Treatment Directive. Values in red indicate non-compliance with national effluent requirements (MPDs).

Parameter	Influent	Effluent from Secondary Sedimentation Tanks	MPDs	EU effluent Standards
	2022	2022	2021-2030	
BOD_{20}	310.91	5.30	3.00	BOD_5: 25.0
COD	416.70	79.93	30.40	125.0
Suspended Solids (SS)	158.27	18.36	12.40	35.0
Ammonium Nitrogen	35.02	3.89	2.49	
Nitrogen Nitrite	0.13	0.13	0.37	
Nitrogen Nitrates	0.13	17.18	28.50	*10
Phosphates	11.93	11.30	13.80	*1
Dissolved solids	1244.84	1146.19		
Chlorides	287.56	281.88	443.12	
Sulphates	240.84	243.57	432.27	
Petroleum products	0.25	0.06	0.05	
Anionic surfactants	2.30	0.11	0.10	
Copper	0.03	0.01		
Zinc (II)	0.03	0.03		
Iron	1.06	0.09	0.11	
Mn(II)	0.00	0.00	0.05	
Chrome (VI)	0.01	0.00		

*EU standards for Total Nitrogen and Total Phosphorus are applicable to sensitive waters only (>100,000PE).

With regard to the influent, it can be noted that the influent pollutant concentrations are within the expected levels for a wastewater influent typical for a city the size of Karaganda. With an Ammonium Nitrogen concentration of 35.02 mg/L, the Total Nitrogen in the Karaganda influent can be expected to be at around 50 – 55 mg/L as it is typically composed of 60% Ammonium Nitrogen and 40% organically bonded nitrogen. The given Phosphates concentration corresponds to usual influent concentrations.

Based on the data provided by Karaganda Su, the quality of the effluent discharge from the secondary sedimentation tanks does not comply with the MPD limits for BOD, COD, Suspended Solids, Ammonium

Nitrogen, Petroleum products, Anionic surfactants. The effluent, however, meets the standards for treated effluents of the EU Urban Wastewater Treatment Directive for BOD, COD, and suspended solids. In case, the WWTP effluent discharges to a sensitive river as defined in the EU Urban Waste Water Treatment Directive (which is assumed to be the case), Total N and P concentrations exceed EU limits. Note that the Sokyr river is classified as class 5, which is the lowest class with water suitable for power generation, transportation, and mineral extraction only (see discussion on Sokyr river quality below).

Overall, it can be said that the WWTP is well functioning in terms of the removal of nutrients with the BOD and COD effluent concentrations of 5.3 mg/L and 79.93 mg/L being below the treated effluent standards set in the EU Urban Wastewater Treatment Directive and on a very low level. However, the treated effluent exceeds the very high standards for BOD and COD set in the national MPD criteria. The Ammonium Nitrogen and Suspended Solids concentrations of the treated effluent are slightly exceeding the set respective MPD. For Suspended Solids, the WWTP effluent concentration meets the standard of the EU Urban Wastewater Treatment Directive.

For the purpose of the present ESIA study, and for data verification purposes, effluent samples were taken over a period of one week in July 2023 at a location after the secondary sedimentation tanks. As can be seen from Table 6.11 the BOD and COD values are at very low levels complying with the standards for treated effluents of the EU Urban Wastewater Treatment Directive. With regard to BOD, the BOD5 values are in line with the annual effluent concentration of BOD20 of 5.3mg/L presented in Table 6.10 (BOD20 of 5.3mg/L corresponds to around 3.66mg/L of BOD5The COD concentrations measured in July 2023 are significantly lower than the annual average effluent concentrations and comply with the strict MPD limit for COD. It is uncertain why the measured COD values are below the COD annual average concentrations for 2022. Potential reasons could be less pollution concentrations in the influent to the WWTP during these days, better functioning of the WWTP as for instance more blowers were switched on or also potentially a measuring error.

Nevertheless, and subject to this uncertainty, the test results seem to indicate a relatively well functioning nutrient removal by the current WWTP. However, Total P values appear extremely low and as no enhanced biological phosphorus removal process is used at the Karaganda WWTP, the low Total P values appear unrealistic. Therefore, a measurement error is probable. Inquiries to the responsible laboratory have not given clarity on that issue. However, it is concluded that the WWTP meets the MPD for phosphates as shown in Table 6.10. *E. Coli* were not detected but should be expected in a well-operating WWTP.

Table 6.11 Pollution concentration after secondary sedimentation tanks from 10.07-19.07.2023

Date/ Parameter	**10.07**	**11.07**	**12.07**	**13.07**	**14.07**	**17.07**	**18.07**	**19.07**	**Eu effluent standard**
pH	7.45	7.30	7.00	7.55	7.64	7.00	7.40	Mistakenly stopped as 7 days passed	
BOD5	4.60	3.40	3.00	3.20	2.45	2.90	3.15		25.00
COD	28.0	26.0	34.0	32.0	25.0	27.0	23.0		125.00
Total N	Not analysed due to failure to deliver the samples in time	12	10	14	9	10	9	11	
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Zn		0.028	0.030	0.040	0.022	<0.0005	<0.0005	0.022	
Cd		0.00032	0.00026	0.00036	0.00022	<0.0001	<0.0001	0.00020	
Ni		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	
Pb		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
Hg		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	
Cr3+		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	

Date/ Parameter	10.07	11.07	12.07	13.07	14.07	17.07	18.07	19.07	Eu effluent standar d
Cr6+		<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	
E. Coli	**Not detected**								
Helminths eggs and larvae, intestinal pathogenic protozoan cysts **not detected**									

Bioponds

The final recipient of treated effluent from the existing WWTP is the Sokyr river, *approx.* 2.2 km downstream from the WWTP. As the effluent after the secondary treatment process does not meet the MPDs, the WWTP directs this discharge to bioponds for additional retention and treatment, from where the effluents are discharged into the Sokyr River. The bioponds are made of 4 parallel lines (trains) with 3 ponds each (in total 12 ponds) with inflow at the northern end and outflow at the southern end (see for example Figure 6.25). Each pond has an approximate size of 34,000 m^2 and the total bio-pond area is approx. 40 ha. Effluents from the WWTP are discharged to two trains of bio-ponds at each time, with rotation every 2-3 years. In this period, the two trains of bio-ponds not in use mostly dry out. Water from the bio-ponds then flows via a discharge channel to the Sokyr river.

Based on the proposed WWTP design by Aquarem (2023) the bioponds will continue to be used for the new WWTP in the same way as has been done in the past. I.e. effluents from the WWTP will be discharged to the bioponds, after which they flow to the Sokyr river. No changes to the bioponds are foreseen or have been proposed in the proposed WWTP design.

The below table reflects results of effluent monitoring below the outlet from the bioponds, before entering the Sokyr river. Despite its intent, the bioponds appear not to add significantly to the effluent water quality when compared to Table 6.10. However, COD and SS are both somewhat lower below the ponds. BOD is already low after the secondary sedimentation.

Table 6.12 Biopond Effluent Annual Average Concentration

Parameter	Unit rev.	2020	2021	2022	MPDs	EU Effluent standard
Temperature	°C	11.53	12.42	12.08	19.00	
pH		7.59	7.62	7.00	7.00	
Transparency	cm	>16.0	>16.0	>16.0	16.00	
BOD20**	mgO2/L	4.72	5.62	5.41	3.00	25.00
COD	mgO2/L	62.75	64.77	60.41	30.40	125.00
Dissolved O2	mgO2/L	10.22	9.43	9.31		
Suspended solids	mg/L	12.61	14.21	11.33	12.40	35.00
Ammonium nitrogen	mg/L	4.96	5.58	3.57	2.49	
Nitrite nitrogen	mg/L	0.73	0.22	0.75	0.37	
Nitrate nitrogen	mg/L	14.19	11.10	16.86	28.50	*10
Phosphates	mg/L	9.63	14.43	12.04	13.80	*1
Dissolved solids	mg/L	1124.89	1165.01	1108.16		
Chlorides	mg/L	263.98	282.43	283.98	443.12	
Sulphates	mg/L	283.45	270.46	251.12	432.27	
Petroleum products	mg/L	0.04	0.06	0.05	0.05	

Parameter	Unit rev.	2020	2021	2022	MPDs	EU Effluent standard
Fats	mg/L	0.98	1.54	1.08		
Anionic surfactants	mg/L	0.13	0.10	0.12	0.10	
Cu	mg/L	0.00	0.01	0.01		
Zn (II)	mg/L	0.03	0.03	0.03		
Mn (II)	mg/L		0.00	0.00	0.05	
Fe	mg/L	0.13	0.09	0.10	0.11	
Cr	mg/L	0.00	0.00	0.00		
Cr (VI)	mg/L	0.00	0.00	0.00		
Cr (III)	mg/L	0.00	0.00	0.00		
Total microb. count	CFU	6500.00	15005000.00			
Coli-index	pcs	66320.00	130900.00			
Coli- titer	ml	0.01	0.00			
Helminth eggs		Not detected	Not detected			

*EU standards for Total Nitrogen and Total Phosphorus are applicable to sensitive waters only (>100,000PE)
** Some inconsistencies in measuring BOD5 or BOD20. E.g., in 2020, they measured BOD5 in the first month and then switched to BOD20, similar inconsistency in 2021 and 2022.

Bioponds sediments

As part of this ESIA study, sediment samples were taken from the eastern two biopond lines, which are currently not being used for effluent discharge, and hence were dry and accessible. From each of the two lines (referred to as ‘east’ and ‘west’ sections) 2-3 bulk samples of bottom sediments were taken from each section, with a hand auger at a depth of 0-30cm. The location of the samples taken is presented in Figure 6.25.

The samples were analysed for total metals as an indication of accumulation of contaminants in sediments from the WWTP effluent water. Nutrients were not analysed because the sediments were well integrated with the ground and covered with vegetation precluding by this the use of the sediments as fertiliser. The results of the sediment sampling analysis are shown in Table 6.13. For reference, this table also includes heavy metal limit values for soil on which sludge may be used as fertiliser according to the EU sludge directive.

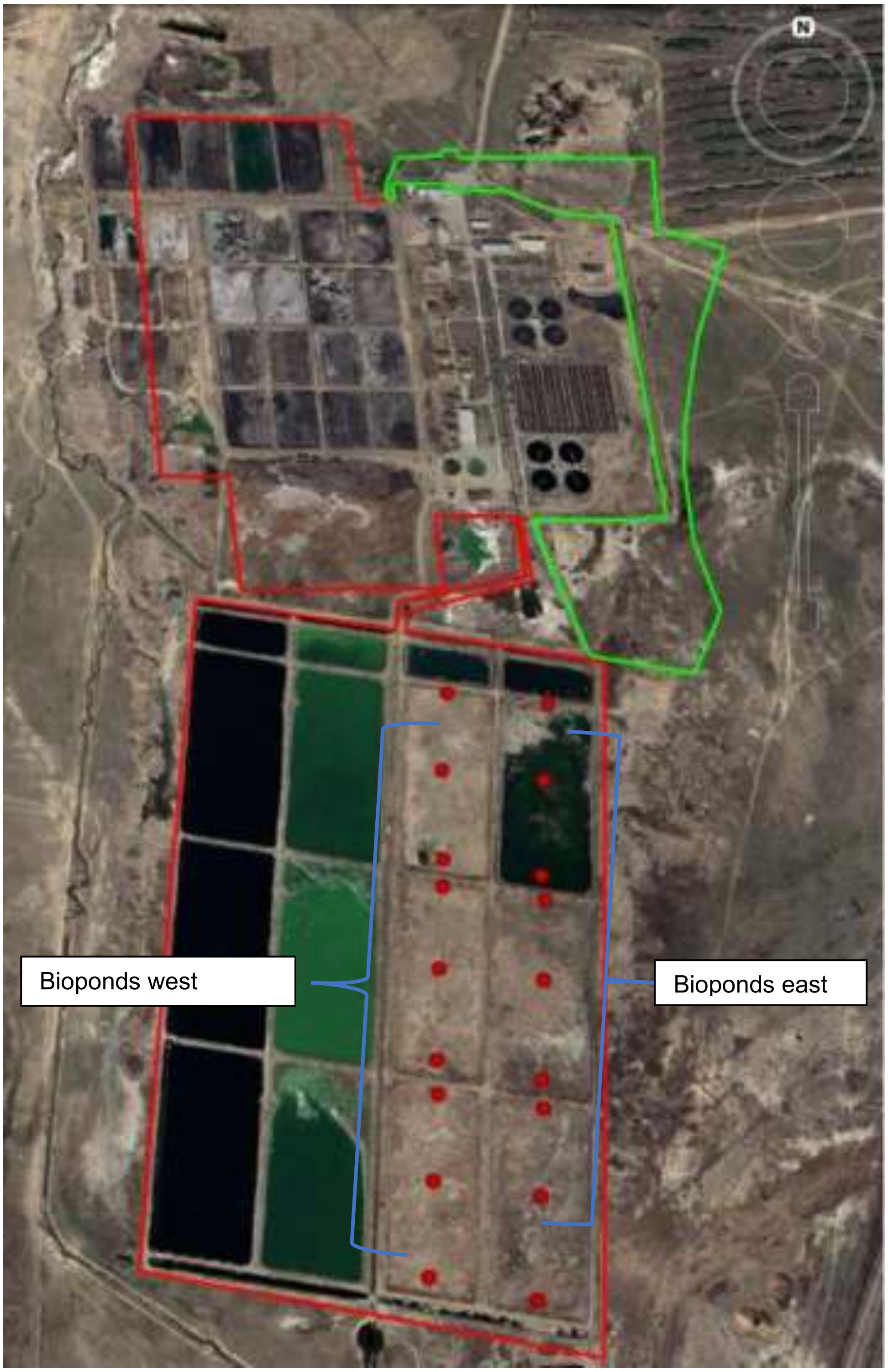

Figure 6.25 Location of biopond sediment sampling in July 2023

Table 6.13 Results of Biopond sediment analysis conducted in July 2023

Parameter values in mg/kg	**Bioponds**		**Limit values for concentrations of heavy metals in soil***
	East	**West**	**mg/kg of dry matter**
Sample depth (cm)	5-30	5-30	
pH	6.25	6.56	
Cd	**3.69**	2.98	1 to 3
Ni	6.30	5.10	30 to 75
Pb	0.5	0.68	50 to 300
Zn	0.680	0.550	150 to 300
Hg	<0,005	<0,005	1 to 1.5
Cr	1.2	1.36	—

* *EU sludge directive summary:* *EUR-Lex - 01986L0278-20090420 - EN - EUR-Lex (europa.eu)*

The results of the sediment sampling analysis as shown in the table above indicate that most of the heavy metals concentrations are within the Limit values for concentrations of heavy metals in soil of the EU sludge directive. The only exceedance detected is for Cadmium at sample point 1.

Sokyr River water quality

Karaganda Su monitors the Sokyr River water quality 500m upstream and downstream of the discharge point of WWTP effluent.

The Sokyr River is classified in the lowest water quality class of 5 according to the Water Resources Committee order #151 from 2016 on approval of the Unified System of the Water Bodies Water Quality Classification. Accordingly, water is suitable for power generation, transportation, and mineral extraction. Based on the river classification the maximum permitted concentration (MPC) of pollutant in a river are determined.

The Sokyr river flow is not measured at the WWTP discharge point and is therefore not well known. It is however understood to be relatively low compared to the WWTP effluent flow. A flow meter located 30 km downstream (see section below) indicates flow rates in the Sokyr river of as low as 0.61 m^3/s and frequent flow rates between 1-2 m^3/s and peak flowrates of up to 20 m^3/s during snowmelt in April. For reference, WWTP effluent flow of 100,000 m^3/day would equal on average 1.16 m^3/sec.

Given the low flow in the Sokyr river and considering that the river is already polluted and with water quality class 5, the receiving waters should be considered “sensitive” according to the EU’s Urban Wastewater treatment Directive, consequently requiring nutrient removal. The current WWTP does not have nutrient (N and P) removal. However, prior to discharge to the Sokyr River, the treated effluent from the treatment process enters a series of effluent ponds which contributes to a relatively high quality of effluent.

A summary of the average results for the monitoring period May to September, for the years 2020 to 2022 respectively, are shown in Table 6.14. The table also includes the maximum permitted concentration (MPC) levels for the Sokyr River.

Table 6.14: The Sokyr River average water quality 500m above and below the WWTP discharge and the maximum permitted concentration (MPC) in the river (Data source: Karaganda Su)

Average concentration May-September (mg/l)								
Name of pollutant	**Year**	**2020**		**2021**		**2022**		
	Measurement unit	**above**	**below**	**above**	**below**	**above**	**below**	**MPC (mg/l) (class 5)**
Temperature	°C	16.5	16.8	18	17.9	17.2	17.6	
pH		7.96	8.05	8.06	8.16	7.00	7.00	9.00
Transparency	cm	> 16.0	> 16.0	16	16	>16.0	>16.0	
Biological oxygen demand BOD 20	mgO_2/l	6.39	4.47	8.77	7.22	6.92	7.71	6.00
Chemical oxygen demand COD	mgO_2/l	121.14	80.26	94.22	179.81	152.80	78.69	35.00
Dissolved oxygen	mgO_2/l	10.82	9.90	9.03	9.56	8.83	8.95	
Suspended solids	mg / l	21.24	22.60	9.62	24.64	17.66	14.52	10.00
Ammonium nitrogen	mg / l	1.40	2.66	1.08	2.22	3.10	2.18	
Nitrogen nitrite	mg / l	0.17	1.04	0.69	0.40	1.03	0.76	3.30
Nitrogen nitrate	mg / l	0.26	9.26	3.42	2.35	4.75	8.86	45.00
Phosphates	mg / l	3.81	8.86	12.89	8.45	6.78	10.89	1.00
Dissolved solids	mg / l	3007.70	1305.50	1414.06	2820.33	2568.66	1126.60	2000.00
Chlorides	mg / l	694.93	373.11	376.25	749.38	667.00	338.94	350.00
Sulphates	mg / l	625.25	339.65	387.55	1426.68	733.95	318.18	1500.00
Oil products	mg / l	0.01	0.04	0.05	0.04	0.13	0.03	0.30
Fats	mg / l	1.26	3.26	2.10	1.80	0.60	1.02	
Anionic surfactants	mg / l	0.18	0.10	0.12	0.10	0.23	0.27	
Copper	mg / l	0.00	0.00	0.04	0.02	0.01	0.02	1.00
Zinc (II)	mg / l	0.01	0.02	0.001	0.001	0.036	0.027	1.00
Manganese (II)	mg / l			0.001	0.001	0.001	0.003	0.10
Iron Total Fe	mg / l	0.158	0.17	0.08	0.12	0.19	0.17	0.30
Chrome common	mg / l	0.00	0.00	0.000	0.000	0.006	0.005	0.55
Chromium (VI)	mg / l	0.000	0.000	0.000	0.000	0.001	0.005	
Chrome (III)	mg / l	0.000	0.000	0.000	0.000	0.000	0.000	

The above data is depicted in the following graphs, against the applicable MPCs, comparing the water quality 500 m upstream the discharge point (u/s, blue colour) against the quality 500 m downstream the discharge point (d/s, red colour). Where the red coloured area is higher than the blue, there is a negative impact on water quality due to the WWTP effluent discharge into the Sokyr river.

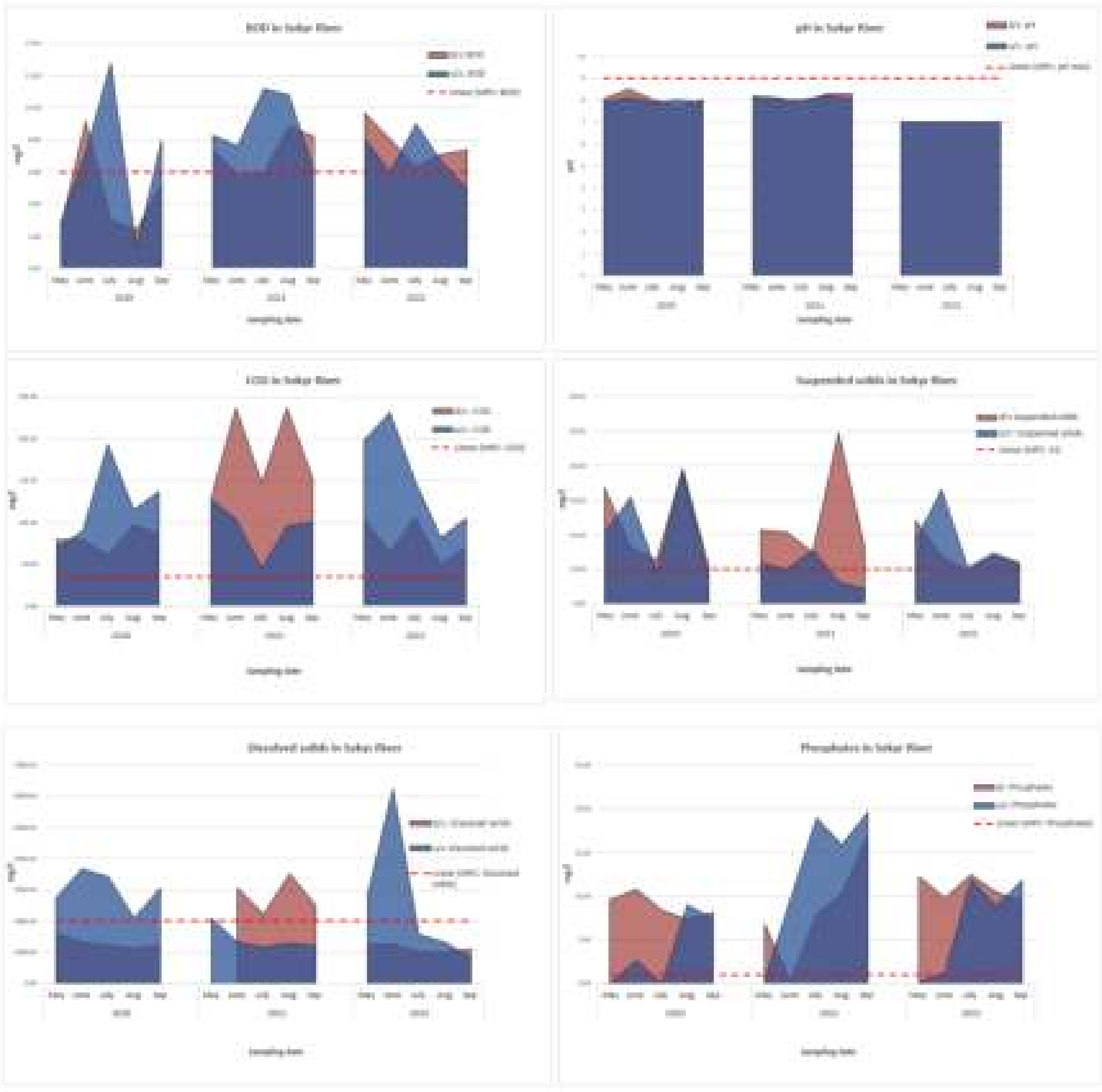

Figure 6.26. Graphs showing the measurements in the Sokyr River against the MPC (red dotted line) in 2020-2022 for the parameters: BOD, pH, COD and Suspended solids, dissolved solids and phosphates. The blue area reflects the upstream (u/s) (above discharge from WWTP) and the red downstream (d/s) (below discharge from the WWTP)

As shown in Figure 6.26, WWTP effluent discharge led to increased concentrations for Suspended Solids, COD and Dissolved Solids in 2021. Besides increased phosphate concentrations in 2020 and 2022 due to WWTP effluent, WWTP effluent may appear to mostly contribute to improved Sokyr river water quality through dilution, considering the above parameters. This said, it must be noted that the Bukpa river also discharges into the Sokyr river below the WWTP and hence also has an impact on the Sokyr river quality. Hence, drawing conclusions about the contribution from the WWTP is very difficult.

Figure 6.27 Graphs showing the measurements in the Sokyr River against the MPC (red dotted line) in 2020-2022 for the parameters: Nitrite nitrogen, Nitrate nitrogen, Chlorides, Oil products, Sulphates and Zinc, Iron and Copper. The blue area reflects the u/s (above discharge from WWTP) and the red d/s (below discharge from WWTP)

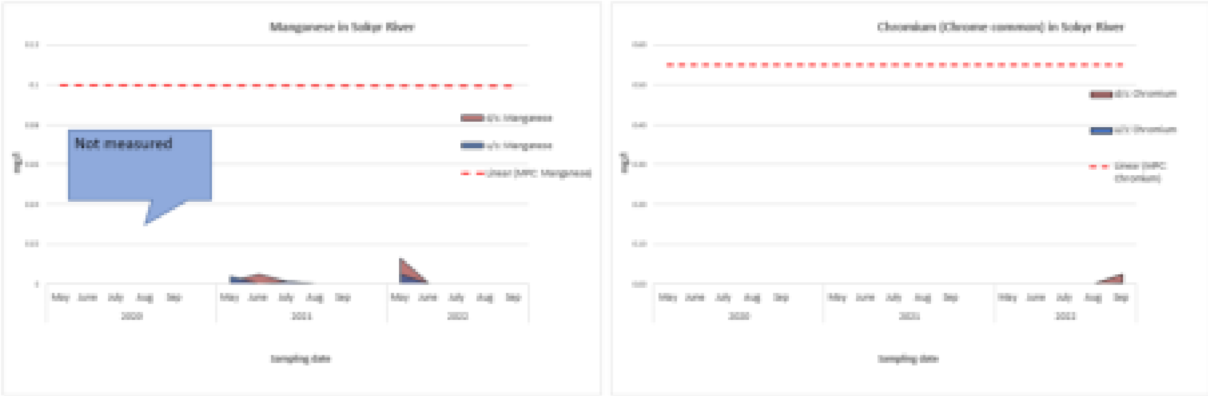

Figure 6.28 Graphs showing the measurements in the Sokyr River against the MPC (red dotted line) in 2020-2022 for the parameters: Manganese and Chrome common. The blue area reflects the u/s (upstream, above discharge from WWTP) and the red d/s (downstream, below discharge from WWTP)

Concerning the parameters presented in Figure 6.27 and Figure 6.28, WWTP effluent discharge appears to contribute to both a reduced and an improved quality of the river depending on the month and year of discharge. No clear statement can be made about the contribution from the WWTP, due to the strong fluctuations and considering also that the Bukpa river also mouths into the Sokyr river below the WWTP.

Sokyr River water flow

In terms of the water flow in the Sokyr river, the most proximate flow data that is available is from a hydropost near Karazhar town located 30 km SW (and downstream) from the current WWTP (Table 6.15). presents the monthly average water flow of the Sokyr River for the period 2020 – 2023, measured at the Karazhar village hydropost.

Table 6.15 Monthly water discharge (m3/s) Sokyr River near Karazhar for period 2022 - 2023

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2020	1.10	0.43	2.39	21.1	3.86	1.68	1.63	2.15	1.47	1.16	0.91	1.14
2021	1.04	0.55	0.24	6.3	3.67	1.63	1.27	1.38	1.06	1.26	1.49	1.47
2022	0.61	-	-	21.1	3.11	1.60	0.63	0.77	0.90	0.91	1.06	0.68
2023	0.69	-	-	5.6	1.79	1.99	1.37	-	-	-	-	-
Average	0.86	0.49	1.32	13.5	3.11	1.73	1.23	1.43	1.14	1.11	1.15	1.10

Looking at the river flow data (Figure 6.29), it is apparent that the Sokyr River experiences substantial fluctuations throughout the year, with the lowest water flow in February and a significantly higher flowrate in April due to snowmelt (up to above 20 m^3/s). From September to January the water discharge is on a relatively stable level ranging from the lowest flow 0.61 m^3/s in January 2022 and the maximum flow 1.49 m^3/s in November 2021. For reference, WWTP flow of 100,000 m^3/day equals on average 1.16 m^3/s.

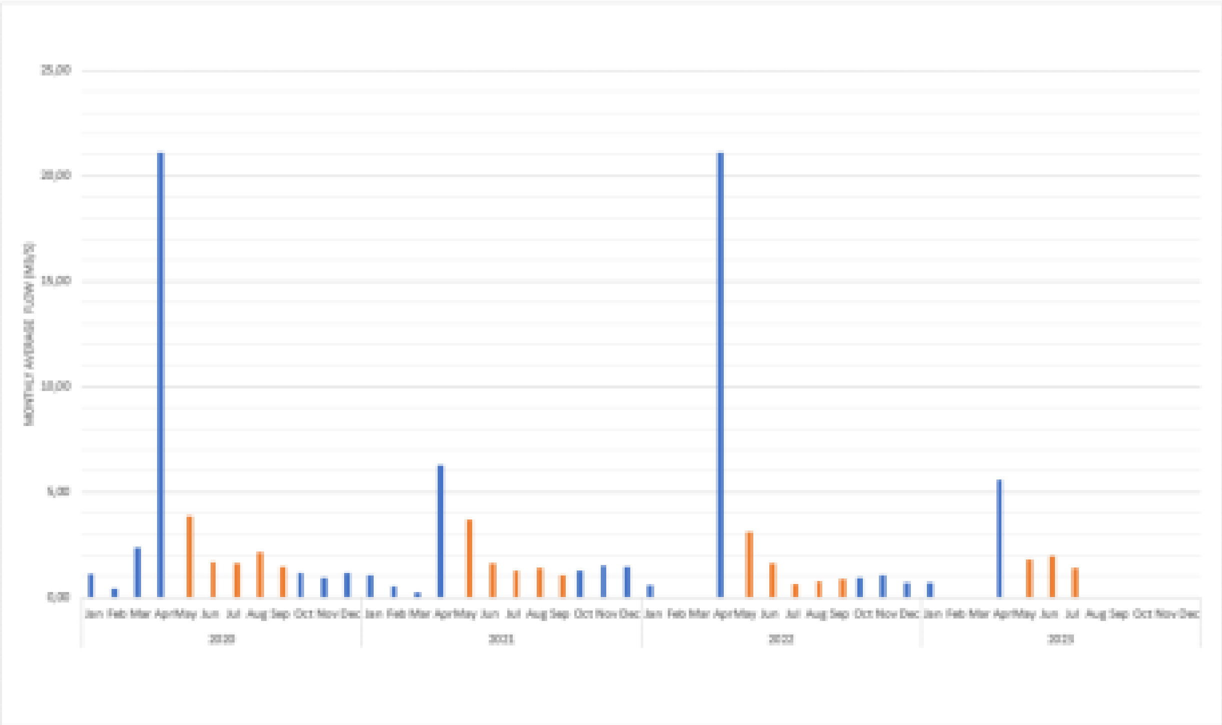

Figure 6.29 : Showing variations in the monthly average flow in the Sokyr river (in m3/s) for the annual period in the years 2020, 2021, 2022 and 2023.The colour orange represent the months for which quality data was collected.

Figure 6.30: Location of Hydropost near Karazhar town and Karaganda WWTP

The Sokyr river mouths into the Sherubainura, 276 km from the Karaganda WWTP.

Bukpa River

The Bukpa river runs from the north and parallel with the western boundary of the existing WWTP, before it joins the WWTP discharge channel, which mouths into the Sokyr River. The Bukpa river is not assigned a quality class according to "*The Water Resources Committee order #151 from 2016 on approval of the Unified System of the Water Bodies Water Quality Classification*".

The Bukpa river is of Central Kazakhstan type. It is full flowing only in late March and early April, during the period of active snowmelt. The natural flow is 90 per cent due to snow. By the end of April, like most steppe rivers, it dries up. There are only splashes left, connected by a brook only in the most high-water years.

Although it is classed as a "river", it is understood the Bukpa River does not support direct beneficial uses to the public (e.g., water supply, fishing, recreation, etc.).

The Bukpa river has an assigned water protection zone of 500 meters to each side. Although the WWTP sludge beds are located within the protection zone, new components of the plant are not allowed to be placed in this zone. For this reason, the proposed WWTP area is located outside the zone.

Water quality is monitored in the Bukpa river by the Regional Environmental Protection Department and analysis results from May 2021 are presented in Table 6.16 below. The Bukpa river discharge quality is relevant as it enters the WWTP discharge channel downstream from the biponds and potential pollutants in the river will cumulate with biopond effluents and affect the water quality in the Sokyr river.

Although the river has not been assigned a water quality classification, the MPC for a class 5 river (same as Sokyr river) can be used for reference and is included in the below table.

As can be seen from this table, the pollutant concentrations were mostly below the MPCs except for COD, suspended solids and chlorides.

Table 6.16 Bukpa River pollutant concentrations in May 2023

Name of pollution	Unit rev.	May 2021	MPC
Temperature	0 C	14	
pH		8.1	9.00
Transparency	Cm	16	
Biological oxygen demand BOD	mgO_2 / l	5.39	6.0
Chemical oxygen demand COD	mgO_2 / l	102.05	35.00
Dissolved oxygen	mgO_2 / l	9.97	
Suspended solids	mg / l	18.6	10.00
Ammonium nitrogen	mg / l	0.15	
Nitrogen nitrite	mg / l	0.012	3.300
Nitrogen nitrate	mg / l	0.3	45.00
Phosphates	mg / l	0.2	1.00
Dissolved solids	mg / l		2000.00
Chlorides	mg / l	436.3	350.00
Sulphates	mg / l	634.3	1500.00
Oil products	mg / l	0.08	0.30

Name of pollution	Unit rev.	May 2021	MPC
Fats	mg / l		
Anionic surfactants	mg / l	0.1	
Copper	mg / l	0	1.000
Zinc (II)	mg / l	0	1.00
Manganese (II)	mg / l	0.001	0.10
Iron total	mg / l	0	0.30
Chrome common	mg / l	0	0.55
Chromium (VI)	mg / l	0	
Chrome (III)	mg / l	0	

Existing sludge beds and sludge quality

Sludge from the existing WWTP is pumped to sludge beds located to the west of the WWTP. The sludge thickness in the sludge beds around 1m at the inflow pipe to each sludge pond to 0.3 m further away from it. The beds do not have a liner membrane but have a clay lock below and wells that allow returning water to the start of the wastewater treatment process.

The extensive sludge ponds are used for dewatering of the sludge (by wind and sunlight and some percolation into the ground, which is evident from greener vegetation around the ponds). Because the sludge is not stabilized with anaerobic digestion, bacterial activity continues in the sludge ponds, hence the ponds emit foul odours when they are emptied. The ice-locked sludge can start to be extracted only in spring. It takes a long time for a front-end loader and 2 dump trucks to clean 8-9 beds per season. Hence, sludge handling and transport is ongoing from spring and throughout most of the summer. The trucks drop the sludge into sludge heaps around the effluent ponds (called bio-ponds) for long-term storage, which is illegal, and the company is routinely fined for it once a year.

Within the sludge pond and biopond area, the historic sludge heaps are laterally separated in most of the cases between those that were deposited before 2003 and those from 2023. Figure 6.31 shows 73 locations within the sludge pond area with the identified year of deposition. Normally, a particular year is represented by 4-5 locations. This varies from 1 location for 2015 to 10 locations for ‘before 2003’. Differences between the seasons within one year cannot be separated.

Sludge samples were collected as part of this ESIA process and analysed for key nutrients as well as heavy metals, as an indication of contaminants in the incoming wastewater and the potential to reuse sludge as fertilizer or soil conditioner, *e.g.,* in agriculture. Bulk samples were taken from 30-90cm depth in the dried sludge beds, or the heaps made in 2023, from heaps made in 2022, 2021, 2017, and 2010.
The assumption was made that despite general absence of specific contamination source in the sewage collection system, some years may be suitable for the purpose, but some are not, hence important to take samples from various periods. It is also assumed that weathering of the contaminants may have occurred in the first 30cm of the historic heaps of sludge while the lower layers may still contain them. For the worst case, it is assumed that the lower layers concentration of contaminants will be present in the top 30cm layer too.

The distribution of sludge samples and associated year of disposal is shown in Figure 6.31. Overall, 5 bulk samples were collected within each month.

Figure 6.31 Distribution sludge samples WWTP site

The results of the sludge analysis is provided in Table 6.17, and compared against the EU Sewage Sludge Directive "Limit values for heavy metals concentrations in sludge for use in agriculture". The results indicate that heavy metal values in the sludge are low, and well within the EU limit values. Hence, based on this the sludge is suitable for use in agriculture.

Table 6.17 Results of analysis of historic sludge heaps for selected years

Historic sludge heaps analysis (deposit year)						**Limit values for concentrations of heavy metals in soil***	**Limit values for heavy-metal concentrations in sludge for use in agriculture***
Parameter values in mg/kg	**2010**	**2017**	**2021**	**2022**	**2023**		
Depth cm	30-60	30-60	30-60	30-60	0-10		
pH	7.12	7.10	7.08	7.20	7.18		
Cu	Not measured as the lab was not accredited for Cu					50 to 140	1000 to 1750
Cd	0.25	0,36	0.40	0.25	0.50	1 to 3	20 to 40
Ni	8.75	7,23	9.00	4.56	6.38	30 to 75	300 to 400
Pb	0.90	0.96	0.85	0.70	0.91	50 to 300	750 to 1200
Zn	0.052	0.070	0.063	0.080	0.096	150 to 300	2500 to 4000
Cr	0.88	0.50	0,63	0.43	0.60		
Hg	less than 0,005 detection limit for all the samples					1 to 1.5	16 to 25
P	12.30	14.00	14.40	12.80	13.20		
N	18.0	15.0	19.30	10.0	9.30		
Organic matter (humus)	10.2%	9.8%	10.3%	11.9%	9.2%		
E.Coli	**not detected**						
	Helminths eggs and larvae, intestinal pathogenic protozoan cysts **not detected**						

** EU sludge directive summary: EUR-Lex - 01986L0278-20090420 - EN - EUR-Lex (europa.eu)*

Sludge quality is not monitored by KS and there is no regular reuse of the sludge (see discussion on sludge reuse below).

Impact of climate change on water resources

Climate change is projected to have an influence on Kazakhstan's water resources, exacerbating existing water shortages and placing greater pressures on agricultural activity.

Basins in some parts of the country already face significant water shortages and much of Kazakhstan's arable land is subject to drought. The A2 scenario discussed in Chapter 6.1.5 projects that other river volumes in the entire country will decrease by 7-10.3%. Climate change is projected to significantly influence Kazakhstan's water resources, and the climate in the agricultural regions will become more arid. Agriculture is one of the key elements in Kazakhstan's economy and, overall, crop yields in central Asia are projected to decrease by up to 30% by 2050[15]. The demand for water will also increase due to the growth from Kazakhstan's population, which is projected to reach 24 million in 2050, and due to demands of the industry as well as from neighbouring countries.

Increased temperature may lead to more frequent droughts and exacerbate water scarcity. Hence, reusing treated effluent water for agricultural purposes offers an obvious opportunity to increase climate resilience.

A Country Risk Profile for Kazakhstan established by CAREC (March 2022) notes that since 1960, Kazakhstan has experienced significant warming, and that "over the recent period 2000-2016, four near country wide droughts have occurred, leading to widespread agricultural losses" (CAREC, p.33). The report

15 World Health Organization

also summarises that in Kazakhstan “flood risk is much more pronounced than earthquake risk. // .. with heavy rainfall and snow melt causing significant damage” historically (CAREC, p.8).

As discussed in chapter 6.1.5, the location of the proposed WWTP site is considered of mild (low) sensitivity in regards of flood risk. It is not anticipated that occurrences of extreme events will increase in frequency. No big changes to the Bukpa river flow are expected as a result of climate change, but there is a risk that more snowfall in the winter and more drastic changes in temperature could lead to a higher flow in the spring. However, the proposed site for the new WWTP is at a higher elevation than the Bukpa river and the Bukpa river has a small catchment area.

Nonetheless, it is important that the site applies an effective storm water management and landscaping to direct water away from key WWTP infrastructure, although this can be seen as regular flood proofing and dimensioning can be based on historic precipitation data and events.

Current agricultural reuse of WWTP treated effluent and sludge

Treated effluents from the WWTP are currently not used for agricultural irrigation purposes, although the effluents appear to meet minimum requirements of the EU Water Reuse Regulation[16].

There seems to be an opportunity for local re-use of effluent within the green belt forestry area approx. 0-2 km to the west and south-west from the WWTP. It is recommended that KS explore further the potential to reuse effluents for agricultural irrigation (and/or other industrial purposes) in the vicinity of the WWTP, in dialogue with relevant authorities, farmers and industry associations. The water used for crops would, however, require regular testing that pathogen concentration does not exceed the appropriate EU limits.

Similarly, there is currently no systemic reuse of sludge from the Karaganda WWTP for agricultural purposes. In general, KS has indicated that there is insufficient land for sludge application, but at the same time it was noted that a green belt of trees and other vegetation is being created around the city, but using sludge for these areas was difficult and required special permission. It was noted however that last year (2022) a local energy company used dried sludge from the WWTP in a one-off project (291,000 m3) to cover and rehabilitate a disposal area used for (incineration) ash. While sludge quality measurements have likely been conducted in this regard, KS did not have access to these. Sweco also notes that there is substantial coal mining activity around the city, hence likely areas of overburden and other areas needing rehabilitation. Therefore, a dedicated effort to identify areas for reusing sludge with mutual benefits seems possible but requires focused coordination between different stakeholders to be successful.

As the above discussed testing of heavy metals in historic sludge indicates, the levels are low and in line with the EU Sewage Sludge Directive limit value, and therefore the sludge appears suitable for agricultural use. This also indicates that future sludge streams from the proposed AD process are likely to have low heavy metal concentrations, although monitoring is required prior to any reuse of treated sludge following the EU sludge Directive.

In Kazakhstan, the reuse of sludge for agricultural purposes is accepted, although there is no sludge disposal policy in Kazakhstan. However, waste handling and disposal requirements are given in the Environmental Code. Sludge is categorised as non-hazardous waste and can be used in agriculture or horticulture, providing the maximum permitted concentration of pollutants and pathogens in the soil are met, and subject to permission from local authorities. Composting sludge is also considered to remove pathogens but rarely applied.

Conclusion on receptor sensitivity – surface and groundwater

The key surface and groundwater receptors with potential to be affected by the project, and their sensitivities can be summarised as follows:

[16] eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R0741&from=EN

- **Surface and groundwater sources immediately within and around the WWTP site (including sludge ponds)**: There are no significant natural surface bodies within the WWTP site. The nearest natural surface bodies are the Bukpa river to the west from the sludge ponds (and dry during winter) and the Sokyr river which is located >2km to the south. The WWTP sludge ponds and bioponds are the significant surface water bodies closest to the WWTP site. Unconfined groundwater appears to be at a relatively shallow depth of 1.4-1.8m depth in September-October and March but may rise to 0.3-0.4m in the beginning of May. It is replenished by thaw and rainwater and presumably by wastewater from the WWTP bioponds, as well as sedimentation and aeration tanks that may be leaking. There are some depressions within the WWTP site which carry thaw water and groundwater throughout the year. As discussed in the geology section, the presence of continuous regional clay seal (section 6.1.2) everywhere but under the existing sludge beds that inclines towards the river, protects the deeper aquifer from potential contamination. The probability of the deeper aquifer contamination during construction is possible if a construction camp is located north of the WWTP entry, but due to the expected low volumes of contamination, the consequences are not expected to be significant. Use of more sensitive sludge beds will be discontinued. There are not known to be any direct uses of groundwater at or in the vicinity of the site. Hence, sensitivity of this receptor is considered **low to medium.**
- **Bio-ponds and discharge channel to Sokyr river:** The bioponds have the function of a tertiary treatment as they receive and retain effluent water from the secondary sedimentation tanks of the WWTP. Sediment sampling in the dry part of the bioponds indicates low heavy metals concentrations, with the exception of cadmium at one sampling point. The bioponds also serve as a habitat for various birds, including some rare and vulnerable species. Based on the information received, the project does not include any changes to the bioponds which function, and design will remain the same for the new WWTP. The sensitivity is considered **low to medium.**
- **Sokyr river:** The river is the final receptor for treated effluents from the WWTP. It has relatively low water flow and hence has limited capacity to dilute large amounts of polluted water and should be considered sensitive in the context of the EU urban WWTP directive. The river is already a subject of various anthropogenic impacts in the form of both water extraction and discharge upstream and downstream. It is classified as class 5 according to the Unified system of classification of water quality in the water bodies and suitable for power generation, transportation, and mineral extraction only. Hence, overall, the sensitivity of the river for continued use for effluent discharge is considered **medium.**
- **Bukpa river**: The Bukpa river runs adjacent to the west of the existing WWTP from the north to the south and is as such not affected by the existing or proposed WWTP. However, the river joins the discharge channel from the WWTP bioponds and potential pollutants in the river are therefore discharged into the Sokyr river at the same location as the WWTP effluents. Hence, it is more a source of cumulative impact rather than being a receptor as such.

6.1.7 Ambient air quality

Ambient air quality in Karaganda City

Karaganda is a major industrial and economic centre in Kazakhstan. The city has a diversified economy with a mix of industries, including mining, metallurgy, chemical production, and machinery manufacturing. The city has large coal reserves, and the coal mining industry is a major contributor to the local economy. Other key industries in Karaganda include food processing, construction materials, and telecommunications.

Table 6.18: presents the **yearly average** pollutant concentrations measured at stations 6 and 7 for the years 2018-*2022.*

The review of the Karaganda ambient air quality is based on data provided by the National Hydrometeorological Service of Kazakhstan (Kazhydromet). Kazhydromet operates 10 stationary monitoring stations in the city of Karaganda. Area stations 6 (4.08 km north of the WWTP area) and 7 (3.8km north-east of the WWTP area) are those with the greatest proximity to the proposed WWTP project area (See Figure 6.32). The ambient air quality in this area is not representative of the WWTP site but can be assumed to be worse than what is experienced at the WWTP Project site for those types of pollutants not originating from the existing WWTP.

Pollutants measured at fixed stations	**Annual average concentrations from stations #6 and #7 (µg/m3)**									
	2018		**2019**		**2020**		**2021**		**2022**	
	#6	**#7**	**#6**	**#7**	**#6**	**#7**	**#6**	**#7**	**#6**	**#7**
Fine Particles PM-2.5 (µg/m3)	74.27		63.9		58.5		103.1		170	
Fine Particles PM -10 (µg/m3)	77.24		59.20		60.70		104.40		170.50	
Sulphur dioxide (µg/m3)	8.57	47.66	9.5	40.00	8	28.40	14.9	33.10	19.7	29.60
Carbon monoxide (mg/m3)	2.04605	2.67192	0.4935	2.1081	0.6744	1.5258	0.6332	1.5111	0.7090	1.3931
Nitrogen dioxid (µg/m3)	[illegible]	58.40	0	46.90	0	40.30	34.9	47.30	110.7	49.10
Nitrogen oxide (µg/m3)	0.18	22.84	0	19.20	0	11.70	20.7	16.20	45.3	20.00
Hydrogen sulphide (µg/m3)	1.08		1.1		1		2		1.8	

Figure 6.32: Location of air quality monitoring stations 6 and 7.

The pollutant concentrations presented for area stations 6 and 7 have been compared with the WHO[17] and EU[18] air quality standards. In addition, the values are also compared with the Maximum Permissible Concentrations (MPC) from the Kazakh Hygienic Standard for Atmospheric Air in Urban and Rural Residential Areas and Areas of Industrial Organisations #29011 from 2.08.2022. The following two tables summarize the respective air quality standards.

Table 6.19: WHO and EU ambient air quality standard levels

Pollutant	Averaging time/period	WHO Standard	EU Standard
Fine particles (PM2.5)	Annual	5 μg/m³	20 μg/m³
	24 – hour	15 μg/m³	-
Fine particles (PM10)	Annual	15 μg/m³	40 μg/m³
	24 – hour	45 μg/m³	50 μg/m³
Nitrogen dioxide (NO_2)	Annual	10 μg/m³	40 μg/m³
	24 – hour	25 μg/m³	-
Sulphur dioxide (SO_2)	24 – hour	40 μg/m³	125 μg/m³
Carbon Monoxide (CO)	24 – hour	4 mg/m³	10 mg/m³ (Maximum daily 8 hour mean)

Table 6.20: Kazak Hygienic Standards for Atmospheric Air in Urban and Rural Residential Areas and Areas of Industrial Organisations

Pollutant	Maximum Permissible Concentrations (MPCs)	
	Maximum one-time	Daily average
Fine particles (PM2.5)	160 μg/m³	35 μg/m³
Fine particles (PM10)	300 μg/m³	60 μg/m³
Nitrogen dioxide (NO_2)	200 μg/m³	40 μg/m³
Sulphur dioxide (SO_2)	500 μg/m³	50 μg/m³
Carbon Monoxide (CO)	5 mg/m³	3 mg/m³

Source: Approval of the Hygienic Standards for Atmospheric Air in Urban and Rural Residential Areas and Areas of Industrial Organisations #29011 from 2.08.2022

It should be noted that the data for stations #6 and #7 are annual average concentrations, whereas some of the EU and WHO standard values are only given as 24-hour averages. That limitation aside, the following can be observed for monitoring stations #6 and #7 when comparing with the WHO and EU air quality standards:

- **Fine particles (PM2.5):** All annual average values of station 6 exceed the annual WHO and EU limits quite drastically. The annual values of station 6 in the years 2021 and 2022 are particularly high.
- **Fine particles (PM10):** All annual mean values of station 6 are above the annual limit values of the WHO and the EU, partly with significant exceedances. The annual values of station 6 in the years 2021 and 2022 are particularly high.
- **Nitrogen dioxide (NO_2):** All annual average values of stations 6 and 7 are above the yearly WHO limits and the EU limits, except for values at station 6 in the years 2018 and 2021. Concentration values of 0 in the years 2019 and 2020 at station 6 indicate measuring errors. Annual average values of station 6 in 2022 show a strong exceedance.
- **Sulphur dioxide (SO_2):** All annual average values are below the daily EU limits and also mostly below daily WHO limits except at station 7 in 2018 and 2019.

[17] https://www.who.int/publications/i/item/9789240034228
[18] https://environment.ec.europa.eu/topics/air/air-quality/eu-air-quality-standards_en

- **Carbon monoxide**: All annual average values are below the daily WHO and EU limits.

With regard to the MPCs set in the Hygienic Standards for Atmospheric Air in Urban and Rural Residential Areas and Areas of Industrial Organisations #29011 from 02.08.2022 the following can be said:

- **PM2.5**: All annual average values of stations 6 and 7 are above the daily limits. The same applies to PM10, except for station 6 in 2019 where the value is slightly below the daily limit.
- **Sulphur dioxide (SO_2):** All annual average values of stations 6 and 7 are below the daily limit.
- **Nitrogen dioxide (NO_2):** Only the annual average values of station 6 in 2018 and 2021 are below the daily limit.
- **Carbon Monoxide (CO):** All annual average values of stations 6 and 7 are below the daily limit of Nitrogen dioxide.

At station 6 from 2020 to 2022, there is a clear trend toward increasing concentrations of fine particulate matter (PM-2.5 and 10) reaching high annual average concentrations above 100 $\mu g/m^3$. A steep increase of nitrogen dioxide concentrations occurred from 2021 to 2022 at station 6. A trend toward decreasing carbon monoxide is visible at both stations. Regarding the other pollutants, no clear trend is visible with minor variations of pollutant concentrations appearing throughout the years.

Overall, it can be said that the concentration of particulate matter is at a high level exceeding the considered standards partly quite significantly. A trend from 2020 to 2022 toward increasing particulate matter is also noticeable. The measured concentrations of sulphur dioxide and carbon monoxide are mostly below considered standards. It can be assumed that the high concentrations of particulate matter are due to the extensive activities in the coal sector. The coal found in Karaganda is low in sulphur which is likely to explain the low measured SO_2 values.

Ambient air quality at the Karaganda WWTP site

Karaganda Su does not monitor the ambient air quality at the WWTP site. However, Karaganda Su is required to calculate their yearly emissions of pollutants of all their operations and report them to Bureau of National Statistics. The data shall reflect the volume of emitted pollutants from the number of emitting stationary sources of pollution and the volume of captured and utilised pollutants from stationary sources being equipped with treatment facilities. However, no pollutant emissions have been captured and neutralised at the WWTP site by Karaganda Su in 2022, prior to release.

Odour situation (qualitative)

The following potential sources of odour have been identified, during the ESIA site visit and through the results of the conducted focus groups discussions (FGDs). In addition to that, a media search and a stakeholder meeting held on the 1st of March 2023 have provided additional insights related to the odour situation (please refer to section 7.3 for further information).

- Sludge beds adjacent to the WWTP area and in particular when being emptied / cleaned and sludge being transported and dropped around the bioponds for long term storage.
- The WWTP itself with its biological tanks, primary and secondary tanks.
- Pig farm, located approx. 3.5 km to the west of the WWTP area (based on FGDs).

Two FGDs were held in September 2023 with residents living relatively close to the existing WWTP, *i.e.,* at Railway Junction 737 and at Kir-zavod 3-4. In addition, a FGD was held with representatives of NGOs. Further information about the FGDs and their participants are provided in section 7.3.

FGD participants from Railway Junction 737 and Kir-zavod 3-4 complained that they are exposed to a strong and often permanent odour. For instance, a resident of the Railway Junction 737 mentioned that "*sometimes there is no wind, but the smell is there"* while a resident of Kir-zavod 3-4, when asked when the odour occurs, replied: *"In the afternoon, any time and in the morning, early in the morning, in the* *evening, at night. It comes at any time. As soon as they drain and we start to smell, there is no specific time or season”.* Furthermore, it was expressed that the presence of wind amplifies the odour intensity.

Residents of Kir-zavod 3-4 noted that the odour exposure is felt more intense during the summer months as the hot temperatures require the opening of windows which, however, would be impossible due to odour. In addition, Kir-zavod 3-4 residents explained that they cannot spend much time outside their houses as the odour is too intense. The same residents also noted that in 2022, the odour was much stronger and that its intensity has declined lately. One resident noted a sore throat during the night due to the odour.

Residents of the Railway Junction 737 also reported sicknesses of many horses which are grazing together with cattle, and sheep close to the Karaganda WWTP area. The reason for the sickness of the horses is unknown. Some residents at Railway Junction 737 mention that they often do not smell the odour anymore as they believe they have become accustomed to it, however, getting reminded of its presence when guests come to visit. Residents in both settlements also indicated that hanging laundry to dry outdoors is problematic, so laundry is often dried indoors.

In addition, representatives of NGOs indicated during their FGD that they believe the pig farm to be another source of odour affecting the nearby residents of the Karaganda WWTP. However, they did not indicate which settlements are more, or less, affected by the odour or whether there are variations throughout the year. KS also believes that odour is emitted from this pig farm.

Moreover, a conducted media seach revealed that some odour complaints have been registered from the Karaganda WWTP on webportals. Webportals indicated that in 2018, residents of the Novyi Gorod, Bolshoi Mikhailovka station, Kir-zavod 1-2, and the Mikhailovka district felt an unpleasant smell from the WWTP. As a response to these complains, it was explained by KS specialists the odour generation is a natural process of oxidation of the sludge, resulting in release of hydrogen sulfide, methane, nitrogen and an unpleasant odour, arising under certain climatic conditions and mainly when sludge beds are emptied. Additionally, south-western winds would also intensify the odour issue.

During the Sweco site visit in March 2023, Karaganda Su staff reported that the ice-locked sludge in the sludge beds can start to be extracted only in spring. It takes a long time for a front-end loader and 2 dump trucks to clean 8-9 beds per season. Hence, sludge handling and transport is ongoing from spring and throughout most of the summer. The trucks drop the sludge around the bioponds, which is illegal, and the company is routinely fined for it once a year as mentioned previously.

The map below shows the different sources of odour circled in red and in contrast the key potential receptors of odour circled in yellow.

Figure 6.33 Overview of sources of odour and its key potential receptors

Conclusion on receptor sensitivity – ambient air quality

The existing WWTP is located on an open area in the outskirts of Karaganda city, yet relatively close to nearest residential receptors, with nearest receptor (Railway Junction 737) located approx. 510 m. to the east from the WWTP boundary. There is no ambient air quality data available for the WWTP site itself but given its location it is considered likely that the air quality is generally better than within the city, where particles (PM2.5 and PM10) and NO_2 are high and exceed annual average limits. In general, the air quality in Karaganda appears poor and with low capacity to accommodate further negative impacts, albeit is assumed to be somewhat better at the WWTP site. Hence, the sensitivity is considered **medium when excluding odour**. However, the WWTP is a source of odours, and nearby residential areas are already significantly impacted by odour from the WWTP. Main sources of odour are presumably the sludge ponds and sludge handling, although the exact source cannot be precisely determined by the affected people consulted. The main source of impacts from the current WWTP is odour. This is already a significant issue and an important source of nuisance and reduced wellbeing in inhabited areas closest to the WWTP. Hence, air quality in relation to odour is considered of high sensitivity, with low capacity to accommodate further negative impacts. The **overall air quality sensitivity is therefore considered medium to high.** There is a large pig farm further to the west from the WWTP (distance 3.5 – 4.5 km from the areas affected by the WWTP) which according to KS and representatives of consulted NGOs is also a source of odour. However, it has not been possible to verify to what extent the pig farm is a source of odour as compared to the WWTP as no systemic odour monitoring has taken place.

6.1.8 Ambient Noise levels

The WWTP site is located in a relatively remote rural suburb of Karaganda approx. 510m from the nearest residential area. The main source of noise emissions related to the operation of the WWTP are WW pumps and the blowers supplying air to the aeration tanks, which are all located inside buildings hence have limited impact outside. During a visit to the WWTP, the noise inside the blower building was measured from 90 dBA next to the working aeration blowers down to 70 dBA away from them. The sludge pump houses produce low level humming noise notable only in close vicinity. The outside source of manmade noise constitutes the railroad line which runs > 1 km east of the WWTP site. It is not considered a nuisance by the interviewed owners of 4 houses of 737km hamlet (15 houses with 30 families) 120m from the railroad line and the trains were barely heard at the WWTP bioponds quiet area. Only the residents of this hamlet that live 30m from the railroad found the railway to be issue at night.

The nearest noise receptor to the WWTP site constitutes a house located in the hamlet 511 m north. Other close noise receptors constitute houses in Junction 737, located 560m east from the WWTP site and houses in Kir-zavod located 800 m north of the WWTP site.

As no roads pass by these houses, a traffic survey was not conducted. No other potential sources of noise were noted in the area. Figure 6.34 shows the three locations of the noise measuring conducted as part of this ESIA.

Figure 6.34: Location of noise measuring at selected houses nearest to the WWTP site.

As part of this ESIA process, ambient noise was measured on the working days 29.06-1.07.2023 at the nearest residential houses in the above mentioned three settlements. The inhabitants of houses Kir-zavod and Junction 767 reported no noise propagating from the existing WWTP but on the other hand noted a persistent hydrogen sulphide smell from the WWTP (see previous section on odour).

The environmental conditions during the noise measurement consisted of 0-3 m/sec S→SSW→SWW→NW→NNW wind and temperature that varied between 18.3 and 24.6°C during the day and down to 12.2°C at night. The atmospheric pressure was stable with 759.8 falling to 757.6 kPa at the end of the measurement. The relative humidity varied from 23% during the day to 70% at night. High feather clouds did not significantly obstruct sunlight.

Three 1st grade precision noise meters Shi-01 (Zaschita) were used with the sensitivity range set to 40-110dBA. The meters were placed 1.5m from the house's facade. There were no physical barriers between the noise meter microphone and the WWTP. The wind effect was minimized by sheltering the microphone from it and putting a wind cancelling bowl on top of the microphone. The measurements were conducted for 13.5 consecutive hours from 9:20 to 22:50 during the day and for 9 hours from 23:00 to 8:00 during the next night. The results of the measurements at the three described locations are presented in Table *6.21*.

By comparing the noise measuring results in the table above with the national[19] and WHO limits**[20] it can be said that the results for the residential areas are within the national and WHO limits except for the measured day L_{Aeq} which was 55.2 dBA in Kir-zavod and the maximum (fast) noise level during the night with 60.1 dBA. Both exceedances are minor.

Table 6.21 Ambient noise (in dBA) measured at the three nearest residential areas

Setting	**Junction 737km**		**Hamlet**		**Kir-zavod**	
	Day	Night	Day	Night	Day	Night
L_{Aeq}	53.9	43.5	52.5	42.7	55.2	44.1
Max	59.7	53.3	56.0	50.2	60.1	53.4
Min	47.8	45.1	42.1	43.6	45.3	45.1
1 s averaged (fast)	67.8	45.2	62.3	46.0	64.8	40.2
Max	71.1	58.7	57.2	49.7	69.6	60.1
Min	40.0	27.3	40.5	26.3	37.0	28.8
Distance to WWTP, m	560		511		800	

* The GOST 12.1.036-81 (ST SEV 2834-80) Safety Standard System. Noise. Permitted levels in houses and public buildings, 1982 prescribes 63dB(A) LAeq $_{0.5hour}$ for the day and 55dB(A) LAeq $_{0.5hour}$ for the night with maximum fast being allowed to 10dB(A) higher.

** The Who limits is 55dB(A) LAeq $_{16hours}$ for the day and 45dB(A) LAeq $_{8hours}$ for the night with maximum fast being allowed to 60dB(A) (from Table 1 of Berglund, Lindval, Schvwela. Guidelines for Community Noise. WHO, 1999

Conclusion on receptor sensitivity – noise levels

The nearest settlements do not experience noise from the existing WWTP. Overall, the sensitivity in terms of **noise levels** and noise receptors is considered as **low.**

6.1.9 Biodiversity - Flora (vegetation)

The survey area for vegetation was determined by the area expected to be affected by the proposed Project. This includes first and foremost the approx. 12.75 ha area planned for the new WWTP. Other areas which may be affected by the project and allow conclusions to be drawn about the prevalent vegetation of the project area include the existing sludge beds and biponds, the Bukpa riverbank, the discharge channel and the adjacent city green belt tree plantation. All these areas were examined on 29 June 2023. Figure 6.35 shows the different areas surveyed.

[19] The GOST 12.1.036-81 (ST SEV 2834-80) Safety Standard System. Noise. Permitted levels in houses and public buildings, 1982 prescribes 63dB(A) LAeq $_{0.5hour}$ for the day and 55dB(A) LAeq $_{0.5hour}$ for the night with maximum fast being allowed to 10dB(A) higher.
[20] The Who limits is 55dB(A) LAeq $_{16hours}$ for the day and 45dB(A) LAeq $_{8hours}$ for the night with maximum fast being allowed to 60dB(A) (from Table 1 of Berglund, Lindval, Schvwela. Guidelines for Community Noise. WHO, 1999

Figure 6.35 Survey area for flora.

According to the physical-geographical zoning, the survey area is located in Turgai province, in the steppe region of Central Kazakhstan[21].

The areas covered in the vegetation survey are described below (numbers corresponding to locations in Figure 6.35).

1. Proposed area for new WWTP

The area of the new WWTP can be divided into three habitats: steppe/flat areas, depressions, and wasteland.

Plots with plain steppe are covered with lessing feather grass (*Stipa Lessingiana*) and austrian wormwood (*Artemisia austriaca*) associations. Cultivated plantings of golden currant and rough elm are also present along the road stretching almost the entire plot. Formations of grass (*Leymus ramosus* (Trin.) Tzvelev) can be found on flat areas.

Within the steppe contour of the site Iris (*Iris scariosa* Willds. ex Link) was found which is an ecologically sensitive species. The species is, however, not included in the Red Data Book of the Republic of

[21] Milkov F.N. Natural zones of the USSR. Edition 2nd, supplement and revision. M., Mysl, 1977. - 293 p

Kazakhstan but protected in neighbouring countries (included in the Red Data Books of the Russian Federation and other regions).

Along depressions yarrow (*Achillea millifolium*), blue eryngo (*Eryngium planum*), lady's bedstraw (*Galium verum*), austrian wormwood (*Artemisia austriaca*) and Couch Grass (*Elytrigia repens*) were identified. There are also thickets of chinese liquorice (*Glycyrrhiza uralensis* Fisch. ex DC).

On wasteland, weeds such as austrian wormwood and *southern wormwood* are dominant.

Overall, significant anthropogenic impact on vegetation is evidenced by the abundance of most associations of austrian wormwood (*Artemisia austriaca*) - a species that plays a leading role in the structure and functioning of the present ecosystem.

No rare and endangered plant species were found on the proposed land plot for the new WWTP.

However, based on the flora survey, it was noted that the characteristics of the land plot for the new proposed WWTP indicate that it may be suitable as a habitat for certain rare and protected ephemerals (perennials) and ephemeroids (annuals) species whose life cycle runs rapidly immediately after snowmelt. This could include species such as: *Tulipa patens*, *Adonis vernalis* L. and *Pulsatilla patens* (L.) Mill, which characteristics are as follows:

- *Tulipa patens*, commonly known as the Kazakhstan tulip or the steppe tulip, is a species of flowering plant. It grows in a variety of habitats, including gravelly and clayey slopes, small sedge meadows, and salt marshes[22]. *Tulipa patens* is considered a threatened species and is included in the Red Book of the Republic of Kazakhstan. One of the main threats to *Tulipa patens* is the destruction of its natural habitat. Human economic activities such as plowing the steppes for agriculture can result in the loss of the plant's native habitat. The conversion of land for farming and development reduces the available space for the species to grow[23].
- *Adonis vernalis* L., commonly known as pheasant's eye or false hellebore, is an herbaceous perennial plant native to various parts of Europe and Asia. This species is typically found in grasslands and meadows. It prefers open, sunny habitats and can thrive in a variety of soil types.
  One of the most significant threats to *Adonis vernalis* is habitat loss and degradation. This is primarily caused by the transformation of natural grasslands into agricultural areas, wood plantations, and urban development. Soil extraction from the habitat further disrupts its integrity. These changes reduce the available habitat for the species[24]. *Adonis vernalis* is listed as Least Concern in IUCN and in CITIES is categorize in Appendix II, taxa that are not necessarily threatened with extinction, but trade must be controlled in order to avoid utilization incompatible with their survival.
- *Pulsatilla patens* (L.) Mill., commonly known as eastern pasqueflower and cutleaf anemone, is a flowering plant native to Europe, Russia, Mongolia and China[25]. This specie typically grows in sparse pine forests, dry sunny slopes, grassy slopes, and mountain slopes under forests. The species *Pulsatilla patens* is currently categorized as Data Deficient (DD) by the IUCN, but it holds an Endangered (EN) status on the Red List in both Finland and Russia. Its primary threat is the unauthorized collection and excavation of the plant from its natural habitats for ornamental or horticultural purposes, with a notable focus on private garden cultivation. This activity poses a substantial risk to the species, potentially resulting in the depletion of its wild populations, the disruption of natural ecosystems, and a decline in genetic diversity[26].

[22] *Tulipa patens* C.Agardh ex Schult. & Schult.f. in Freiberg M (2020). The Leipzig catalogue of vascular plants. German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig. Checklist dataset https://doi.org/10.15468/9qxmn3 accessed via GBIF.org on 2023-10-19.
[23] Tulips in Red Book of Kazakhstan (silkadv.com)
[24] IUCN Red List
[25] *Pulsatilla patens* subsp. *multifida* USDA PLANTS database
[26] Bilz, M. 2011. *Pulsatilla patens (Europe assessment)*. *The IUCN Red List of Threatened Species* 2011:e.T165908A6162193.

As these species life cycle runs rapidly immediately after snowmelt, and the site survey was carried out in June, the occurrence of the species within the site or immediate surroundings cannot be ruled out. Although the likelihood of occurrence within the site is seen as low, an additional site survey should be conducted as a precautionary measure during early spring by a qualified botanist, to verify the absence of any protected ephemerals and ephemeroids species within the WWTP site (and the locations directly affected by the overhead transmission line and underground cable installations) or, should they be found, define appropriate mitigation measures that should be taken by the project. A recommendation is this regard is included in the proposed ESMP.

2. Bioponds site

Due to their anthropogenic origin, the sides of the ponds are covered mainly with ruderal vegetation. As such the bioponds are characterized by the presence of weeds and hydrophytes.

Weeds of mesophytic type are mainly represented at the bioponds by species such as southern wormwood (*Artemisia abrotanum* L.), common wormwood (*Artemisia absinthium* L.i). In addition, on some plots the formation of branching grass (*Leymus ramosus* (Trin.) Tzvelev) is visible on flat upland plots.

With regard to hygrophytic species, small fragments of lesser bulrush (*Typha angustifolia* L.) were observed. Common reed (*Phragmites australis)* was also seen in depressions in some dry meadows.

Among the hydrophytes, common duckweed (*Lemna minor* L). was observed at the surface, forming a continuous cover in some parts of the pond. No protected or endangered species were found.

3. Sludge beds

The site is characterized by heavy human activity and impact, so the vegetation consists mostly of sparse weeds. Weeds are represented here by species such as field bindweed (*Convolvulus arvensis* L.) and blue lettuce (*Lactuca tatarica*).

At the sludge bed edges there are predominantly common wormwood (*Artemisia absinthium*) and southern wormwood (*Artemisia abrotanum* L.) groupings. No protected or endangered species were found.

4. Bukpa River

At the time of the survey, the river channel was at low-water. The vegetation of the riverbed is meadow mesophytic sedge-grass communities.

The upper floodplain terrace is represented by steppe sod-grass-wormwood associations on dark chestnut soils in complex with Atriplex verrucifera (*Halimione verrucifera* (M. Bieb.) Aellen) on typical hydromorphic solonchaks. No protected or endangered species were found.

5. Forest belt behind Bukpa River

The area behind the Bukpa River, west of the WWTP, is represented by elms (*Ulmus* spp.), russian olives (*Elaeagnus angustifolia* L.) and other trees. Woodland is interspersed with steppe sod-grass-wormwood associations. No protected or endangered species were found.

6. Discharge channel from bioponds to Sokyr river

The species composition of the close areas surrounding the discharge channel is quite diverse. The over drain terrace is composed of steppe sod-grass-grass-hemlock communities. The shrub layer here is represented by nitrebush (*Nitraria schoberi*). The shore part is formed by meadow broad-leaved grasses such as wood small-reed (*Calamagrostis epigeios),* creeping meadow foxtail (*Alopecurus arundinaceus* Poir.) and blackgrass (*Juncus gerardii* L.) meadows are located along the shore in saline depressions.

Coastal woody-shrub vegetation is represented by willows (*Salix spp*.) and russian olives (*Elaeagnus angustifolia* L.). In shallow water of the canal an almost continuous row of lesser bulrush (*Typha angustifolia* L.) can be found.

The surface of the water surface of the canal is occasionally covered with small patches of common duckweed (*Lemna minor* L.). No protected or endangered species were found.

7. Forest belt by the railway

The tree composition of the forest belt intended for snow retention on the windward side of the road is mainly composed of siberian crab apple (*Malus baccata* L. Borkh), tatar maple (*Acer tataricum* L.), boxelder (*Acer negundo* L.), siberian elm (*Ulmus* spp.). The shrub layer is mainly represented by golden currant (*Ribes aureum* Pursh.). No protected or endangered species were found.

The flora species identified during the June 2023 vegetation survey and their classification status are listed in Table 6.22.

Table 6.22 Flora species identified during the June 2023 vegetation survey; boxes marked with green indicate the presence of the species in the respective location

Family	Family	Species	Common name	IUCN/Red Book	1. New WWTP site	2.Bioponds	3.Sludge beds	4.Bukpa River	5.Forest belt behind the Bukpa River	6.Discharge canal	7.Forest belt by the railway
Tree layer	Rosaceae	*Malus baccata* L. Borkh	Siberian Crab Apple	LC							
	Pinaceae	*Pinus sylvestris* L.	Scots Pine	LC							
	Ulmaceae	*Ulmus spp.*	Siberian Elm	LC							
	Aceraceae	*Acer negundo* L.	Boxelder	LC							
	Elaeagnaceae	*Elaeagnus angustifolia* L.	Russian Olive	LC							
	Sapindaceae	*Acer tataricum* L.	Tatar Maple	LC							
Shrub layer	Fabaceae	*Caragana arborescens* Lam.	Siberian peashrub	LC							
	Tamaricaceae	*Tamarix ramosissima* Ledeb.	Salt cedar	LC							
	Nitrariaceae	*Nitraria schoberi* L.	Nitrebush	LC							
	Grossulariaceae	*Ribes aureum* Pursh.	Golden Currant	LC							
	Salicaceae	*Salix spp*	Willows	LC							
Herbaceous layer	Asteraceae	*Acroptilon repens* (L.) DC	Russian Knapweed	LC							
		Arctium tomentosum Mill.	Woolly burdock	LC							
		Carduus nutans L.	Musk thistle	LC							
		Cirsium vulgare (Savi) Ten.	Spear thistle	LC							
		Inula britannica L.	British yellowhead	LC							
		Lactuca serriola L.	Prickly lettuce	LC							
		Lactuca tatarica (L.) C.A. Mey.	Blue lettuce	LC							
		Artemisia absinthium L.	Common wormwood	LC							
		Artemisia abrotanum L.	Southern wormwood	LC							
		Artemisia austriaca Jacr.	Austrian wormwood	LC							
		Picris hieracioides L.	Hawkweed oxtongue	LC							
		Tripleurospermum inodorum (L.) Sch. Bip.	Scentless false mayweed	LC							
		Eryngium planum L.	Blue eryngo	LC							
		Xanthium strumarium L.	Rough Cocklebur	LC							
		Onopordum acanthium L.	Cotton Thistle	LC							
		Achillea millefolium L.	Yarrow	LC							
		Tragopogon spp.	Goatsbeard	LC							
	Poaceae	*Leymus ramosus* (Trin.) Tzvelev	Grass	LC							
		Aeluropus littoralis (Gouan.) Parl.	Grass	LC							
		Alopecurus arundinaceus Poir.	Creeping Meadow Foxtail	LC							
		Agropyron pectinatum (M. Bieb.) P.Beauv.	Crested Wheat Grass	LC							
		Stipa Lessingiana Trin. & Rupr,	Lessing feather grass	LC							
		Elytrigia repens (L.) Nevski	Couch Grass	LC							
		Phragmites australis (Cav.) Trin. Ex Steud.	Common Reed	LC							
		Hordeum jubatum L.	Foxtail Barley	LC							
		Neotrinia splendens	Chee Grass	LC							
		Calamagrostis epigejos (L.) Roth	Wood Small-Reed	LC							
	Brassicaceae	*Lepidium latifolium* L.	Perennial Pepperweed	LC							
		Berteroa incana (L.) DC.	Hoary Alyssum	LC							
	Cannabaceae	*Cannabis sativa* L. var. *Spontanea* (Vavilov)	Wild-Hanf	LC							
	Amaranthaceae	*Bassia scoparia* (L.) A.J. Scott	Ragweed	LC							

Family	Family	Species	Common name	IUCN/Red Book	1. New WWTP site	2.Bioponds	3.Sludge beds	4.Bukpa River	5.Forest belt behind the Bukpa River	6.Discharg e canal	7.Forest belt by the railway
		Halimione verrucifera (M.Bieb.)	Atriplex verrucifera	LC							
		Atriplex tatarica L.	Saltbush	LC							
		Chenopodium album L.	Lamb's quarters	LC							
		Suaeda acuminata (C.A. Mey) Moq		*LC*							
		Amaranthus albus L.	Common Tumbleweed	LC							
		Amaranthus retroflexus L.	Red-root Amaranth	LC							
	Plumbaginaceae	*Limonium gmelinii* (Willd.) Kuntze	Siberian statice	LC							
	Iridaceae	*Iris scariosa* Willd. ex Link	Iris scariosa	LC							
	Fabaceae	*Glycyrrhiza uralensis* Fisch. ex DC.	Chinese liquorice	LC							
	Rubiaceae	*Galium verum* L.	Lady's bedstraw	LC							
	Plantaginaceae	*Plantago major* L.	Broadleaf plantain	LC							
	Polygonaceae	*Rumex confertus* Willd.	Russian dock	LC							
	Urticaceae	*Urtica dioica* L.	Common Nettle	LC							
	Solanaceae	*Solanum dulcamara* L.	Bittersweet	LC							
	Typhaceae	*Typha angustifolia* L.	Lesser Bulrush	LC							
		Typha latifolia L.	Broadleaf Cattail	LC							
	Onagraceae	*Epilobium hirsutum* L.	Great Willowherb	LC							
	Araceae	*Lemna minor* L.	Common Duckweed	LC							
	Haloragaceae	*Myriophyllum verticillatum* L.	Whorled leaf water milfoil	LC							
	Convolvulaceae	*Convolvulus arvensis* L.	Field Bindweed	LC							
	Juncaceae	*Juncus gerardii* L.	Blackgrass	LC							

IUCN: International Union for Conservation of Nature conservation status
LC: Least Concern

In summary, the vegetation within and around the WWTP site is typical for habitats which are heavily disturbed by human activities.

The main vegetation area which will be directly affected by the Project is the proposed WWTP site, which in addition to the existing site, comprises an approximately 12.75 ha land plot which will be transformed to an industrial (WWTP) area. On this land plot no rare or endangered species were found during the survey in June. However, the characteristics of the land plot indicate that it could be suitable as a habitat for certain rare and protected species which can only be identified during early spring. The suspected species are ephemerals and ephemeroids whose life cycle runs rapidly immediately after snowmelt.

Therefore, despite the relatively low likelihood of identifying protected ephemerals and ephemeroids within the WWTP area, a spring survey focusing on the potential presence of the endangered *Tulipa patens*, *Adonis vernalis* L. and *Pulsatilla patens* (L.) Mill. within the WWTP site is required, with the objective to rule out their presence or, should they be identified, plan for effective mitigation and/or offsetting measures to ensure 'no net loss' of biodiversity. The survey should cover the WWTP site and the areas affected by overhead transmission line relocations and underground cable installations.

Other surveyed areas (outside the WWTP site) show low to moderate species diversity with no presence of rare or endangered species. Those areas are not expected to be directly impacted by the project, but could experience indirect disturbance during the construction phase in the form of noise, etc.

Conclusion on receptor sensitivity - Flora

The main vegetation area directly affected by the Project is the proposed WWTP, comprising an approximately 12.75 ha of a mix of steppe, depressions, and waste land, that will the transformed to an industrial (WWTP) area and the relocation of power lines on the periphery of the WWTP site. The area is characterised by significant anthropogenic impact on vegetation and the dominant species being weeds such as Austrian wormwood and southern wormwood. No rare of protected species were identified during flora surveys in June 2023. However, as the habitat could be suitable for protected ephemerals and ephemeroids species (although with low likelihood) whose life cycle runs rapidly immediately after snowmelt, the flora receptor sensitivity is tentatively and conservatively considered **medium to high** until it has been confirmed otherwise in spring 2024. In the absence of these species, the sensitivity of flora habitats affected by the project is low.

6.1.10 Biodiversity – Fauna (wildlife)

As for vegetation impacts, the area and potential fauna habitats directly affected by the WWTP project is limited to WWTP site, which largely includes the existing site (already affected), plus the 12.75 ha new area to the east from the existing site, which can be considered a greenfield area. Also, potential rehabilitation of the sludge pond area can be associated with temporary disruption of wildlife. The bioponds and adjacent areas will not be directly affected.

Potential indirect impacts include downstream aquatic habitats where effluents are discharged, including the bioponds and in particular the natural Sokyr River.

Hence, the fauna baseline studies have focused on:

- Terrestrial and avifauna around the existing and new WWTP sites, including existing sludge beds and area around the bioponds.
- Benthic fauna (hydrobiological) study of the Sokyr River around the discharge point from the bioponds, with focus on invertebrate indicator species.

Terrestrial and avifauna

The Integrated Biodiversity Assessment Tool (https://www.ibat-alliance.org) shows no areas designated for protection within a radius of 100 km. The nearest key biodiversity area: Kultansor and Tatysor Lakes is located 100 km west of the Project site. The Sokyr River does not cross this lake system.

A fauna and habitat survey was conducted by a qualified zoologist, on 29 June 2023, in parallel with the Flora survey discussed above. The area surveyed consisted of the WWTP site, the 12.75 land plot for the new WWTP, bioponds, sludge beds, forest belt northeast of the WWTP site, area along the Bukpa river and along the discharge channel to the Sokyr River. A buffer of 1km around WWTP objects for the fauna and habitat survey was applied.

A total of 48 bird species were recorded. In general, the area of bioponds and associated discharge channels is a nesting habitat for some rare species such as northern porchad and ferruginous duck (vulnerable (VU) and near threatened (NT)), northern lapwing, black-tailed godwit and black-winged pratincole (NT). In addition, 2 juvenile wandering Dalmatian Pelicans (VU) and 2 adult demoiselle cranes (the Kazakhstan Red Book Category V ‘Recovered Population’) were observed, probably nesting in the steppe surrounding the WWTP.

On the dried bioponds, lapwings with nesting behaviour were seen in high numbers. Similarly, on the sludge beds lapwings with nesting behaviour were also present, but in considerably smaller numbers. Rare bird species were not found in the adjacent forest belt.

The observed diversity of terrestrial animals in the general area is low despite presence of various habitats like the Bukpa River and tree plantations. No mammals and only a few marsh frogs were observed in the whole area surveyed. Insects were not surveyed. Excrements or food remains of mammals or reptiles were not noted during the survey.

The land plot for the new WWTP does not appear to accommodate rare species; only a small number of birds was observed here.

Nests of vultures and kestrels were recorded on power lines of 35 kV power and above, located at the SE corner of the WWTP. Remains of 4 rooks and magpies were found under 6 and 10 kV power lines, with pin insulators.

The WWTP area with its various ponds and channels presents an artificially created habitat for particularly wetland bird species. Such habitats include water filled bio-ponds as lakes; dry bioponds as floodplain meadows; water channels as rivers and sludge beds as marshy meadows. The avifauna has adapted well to these habitats. Some species are expected to be present all year round because of warm water flowing from the WWTP suppresses ice formation.

The two tables below present the different species found at the areas surveyed.

Table 6.23 Mammals, reptiles and amphibians observed in and around the WWTP area

Common name	Latin Name	Point	Quantity	Record type	Details
Marsh frog	*Pelophylax ridibundus*	4	4	Sound	on the discharge channel
		5	3		

Table 6.24. Summary of bird species observed in the surveyed area habitats.

Order	Common Name	Latin Name	IUCN	KZ	Bio-ponds	Sludge Beds	Chan-nel	Woods pasture	WWTP	Bukpa River	Total
Anseriformes (goose like)	Ruddy Shelduck	*Tadorna ferruginea*			4						4
	Common shelduck	*Tadorna tadorna*			8						8
	Gadwall	*Anas strepera*			51		11				62
	Green-winged Teal	*Anas crecca*			5						5
	Garganey	*Anas querquedula*			29						29
	Northern Pochard	*Aythya ferina*	VU		127			7			134
	Ferruginous duck	*Aythya nyroca*	NT	I	62						62
	Tufted Pochard	*Aythya fuligula*			4						4
Pe	Dalmatian Pelecan	*Pelecanus crispus*	VU	II	2						2
	Great Carmoran	*Phalacrocorax carbo*					2		1		3
Ci	Great egret	*Casmerodius albus*					2	1		2	5
	Gray Heron	*Ardea cinerea*			4		1				5
Po	Great Crested Grebe	*Podiceps cristatus*			2						2
	Black-necked Grebe	*Podiceps nigricollis*			26						26
Fa	Common Kestrel	*Falco tinnunculus*			1				1		2
	Western marsh harrier	*Circus aeruginosus*								2	2
Gr	Demoiselle crane	*Anthropoides virgo*		V	2						2
Charadriiformes (shore birds)	Black-winged Stilt	*Himantopus himantopus*			27	5					32
	Black-capped Avocet	*Recurvirostra avosetta*			16						16
	Northern Lapwing	*Vanellus vanellus*	NT		69	12				3	84
	Black-tailed Godwit	*Limosa limosa*	NT		44						44
	Spotted redshank	*Tringa erythropus*			4						4
	Common redshank	*Tringa totanus*			18						18
	Marsh Sandpiper	*Tringa stagnatilis*			6						6
	Gren Sandpiper	*Tringa ochropus*			25	28				3	56
	Wood Sandpiper	*Tringa glareola*			2						2
	Black-winged Pratincole	*Glareola nordmanni*	NT		6						6
	Caspian gull	*Larus cachinnans*			2						2
	Mew Gull	*Larus canus*				1					1
	Black-headed Gull	*Larus ridibundus*			20	13	3	22	7	22	87
	Common tern	*Sterna hirundo*			67		4				71
	White-winged tern	*Chlidonias leucopterus*			2						2
Col	Rock Pigeon	*Columba livia*						20	4		24
Ap	Common swift	*Apus apus*						11			11
Passeriformes (sparrow like)	Sand Martin	*Riparia riparia*			6		15				21
	Barn Swallow	*Hirundo rustica*				2					2
	Yellow Wagtail	*Motacilla flava*			17	9					26
	Bluethroat	*Luscinia svecica*			2	3	2	1	6		14
	Siberian stonechat	*Saxicola maurus*			15						15
	Northern Wheater	*Oenanthe oenanthe*							4	4	8
	Booted warbler	*Iduna caligata*			6	1	2		3		12
	Black-billed Marpie	*Pica pica*			3	1		14	7	3	28
	Jackdaw	*Corvus monedula*							6		6
	Rook	*Corvus frugilegus*			4	23		62	16	43	148
	Hooded Crow	*Corvus cornix*			2	3		3	9		17
	House Sparrow	*Passer domesticus*				15			7		22
	Three Sparrow	*Passer montanus*			18	30			15		63
	Ortolan Bunting	*Emberiza hortulana*					3				3
	Total				708	146	45	141	86	82	1208

Types of presence in the study area:	Passing by	Resident/wintering	Breeding	Breeding nearby

Orders:

Pe: Pelicaniformes (pelican like) Ci: Ciconiformes (stork like) Po: Podicipediformes Fa: Falconiformes (falcon like)

Gr: Gruiformes (crane like) Col: Columbiformes (pigeon like) Ap: Apodiformes

IUCN – International Union for Conservation of Nature conservation status: NT – near threatened; VU – vulnerable
KZ – The Kazakhstan Red Book categories: I - disappearing population of less than 50 birds; II - catastrophically rapidly depleting population that may lead to disappearance; V – previously endangered fully recovered population that requires monitoring and is exempt from commercial hunting.

The following table lists the number of birds observed in the different areas surveyed.

Table 6.25 Number of birds observed from the vantage points

Date 29.06.2023		**Start End: 06:30 - 15:08**
Weather change		10-23°C
Winds		W 3-4 m/sec
Cloudiness		60-0%
Rainfall		Dry
Route 1 Green belt and pasture east of the WWTP		**Start End: 06:30-07:24**
Birds NESTING AND LIVING in the FORESTRAINING AND PASTURE AREA		
Bluethroat	*Luscinia svecica*	1
Jackdaw	*Corvus monedula*	4
Black-billed Marpie	*Pica pica*	12
Hooded Crow	*Corvus cornix*	3
BIRDS NESTING ONLY IN NEARBY AREAS		
Black-headed Gull	*Larus ridibundus*	22
Rock Pigeon	*Columba livia*	20
Rook	*Corvus frugilegus*	7
Great egret	*Casmerodius albus*	1
Northern Swift	*Apus apus*	11
Northern Pochard	*Aythya ferina*	7
Route 2 SLUDGE PILES AND GREEN BELTS NORTH OF THE WWTP		**Start End: 07:27-08:04**
BIRDS NESTING AND LIVING ON THE WWTP		
Bluethroat	*Luscinia svecica*	4
Common Kestrel	*Falco tinnunculus*	1
Jackdaw	*Corvus monedula*	2
Three Sparrow	*Passer montanus*	15
Black-billed Marpie	*Pica pica*	4
Hooded Crow	*Corvus cornix*	4
Booted warbler	*Iduna caligata*	2
BIRDS NESTING ONLY IN NEARBY AREAS		
Black-headed Gull	*Larus ridibundus*	7
Black-billed Marpie	*Pica pica*	2
Hooded Crow	*Corvus cornix*	5

Rock Pigeon	*Columba livia*	4
Great Carmoran	*Phalacrocorax carbo*	1
Rook	*Corvus frugilegus*	8
Route 3 SLUDGE BEDS		**Start End: 08:25-09:09**
BIRDS NESTING AND LIVING ON THE BEDS		
Northern Lapwing	*Vanellus vanellus*	12
Black-winged Stilt	*Himantopus himantopus*	5
Booted warbler	*Iduna caligata*	1
Bluethroat	*Luscinia svecica*	3
Three Sparrow	*Passer montanus*	30
Yellow Wagtail	*Motacilla flava*	9
BIRDS NESTING ONLY IN NEARBY AREAS		
Hooded Crow	*Corvus cornix*	3
Rook	*Corvus frugilegus*	23
Black-billed Marpie	*Pica pica*	1
Black-headed Gull	*Larus ridibundus*	13
Barn Swallow	*Hirundo rustica*	2
Mew Gull	*Larus canus*	1
House Sparrow	*Passer domesticus*	15
PASSING BY BIRDS		
Gren Sandpiper	*Tringa ochropus*	28
Route 4 BIOPONDS		**Start End: 09:20-11:25**
BIRDS NESTING AND LIVING ON PONDS		
Northern Lapwing	*Vanellus vanellus*	69
Black-winged Stilt	*Himantopus himantopus*	27
Booted warbler	*Iduna caligata*	6
Three Sparrow	*Passer montanus*	14
Yellow Wagtail	*Motacilla flava*	17
Black-headed Gull	Larus ridibundus	20
Ruddy Shelduck	Tadorna ferruginea	4
Black-tailed Godwit	Limosa limosa	44
Great Crested Grebe	Podiceps cristatus	2
Common tern	Sterna hirundo	67
Black-necked Grebe	Podiceps nigricollis	26
Common shelduck	Tadorna tadorna	8
Black-capped Avocet	Recurvirostra avosetta	16
Black-winged Pratincole	Glareola nordmanni	6
Gray Heron	Ardea cinerea	2
Bluethroat	Luscinia svecica	2
Siberian stonechat	Saxicola maurus	15
Tufted Pochard	*Aythya fuligula*	2
Northern Pochard	*Aythya ferina*	67

Ferruginous duck	Aythya nyroca	30
Garganey	*Anas querquedula*	29
Gadwall	Anas strepera	26
Common redshank	*Tringa totanus*	18
Marsh Sandpiper	*Tringa stagnatilis*	6
BIRDS NESTING ONLY IN NEARBY AREAS		
Black-billed Marpie	Pica pica	3
Demoiselle crane	Anthropoidea virgo	2
Great egret	Casmerodius albus	1
Common Kestrel	Falco tinnunculus	1
Gray Heron	Ardea cinerea	2
Hooded Crow	Corvus cornix	2
Rook	Corvus frugilegus	4
Caspian gull	*Larus cachinnans*	2
Tufted Pochard	*Aythya fuligula*	2
Northern Pochard	*Aythya ferina*	60
Ferruginous duck	Aythya nyroca	32
Gadwall	Anas strepera	25
White-winged tern	Chlidonias leucopterus	2
PASSING BY BIRDS		
Green-winged Teal	*Anas crecca*	5
Dalmatian Pelecan	*Pelecanus crispus*	2
Spotted redshank	*Tringa erythropus*	4
Gren Sandpiper	*Tringa ochropus*	28
Wood Sandpiper	*Tringa glareola*	2
Route 5 DISCHARGE CHANNEL to Sokyr River		**Start End: 11:28-12:30**
BIRDS NESTING AND LIVING ON THE CHANNEL		
Booted warbler	*Iduna caligata*	4
Gadwall	Anas strepera	11
Ortolan Bunting	Emberiza hortulana	3
Sand Martin	Riparia riparia	15
Bluethroat	*Luscinia svecica*	2
Booted warbler	*Iduna caligata*	2
BIRDS NESTING ONLY IN NEARBY AREAS		
Black-headed Gull	Larus ridibundus	3
Great Carmoran	*Phalacrocorax carbo*	2
Common tern	Sterna hirundo	4
Gray Heron	Ardea cinerea	1
Great egret	*Casmerodius albus*	2
Common Kestrel	*Falco tinnunculus*	4
Route 6 FOREST BELT NEAR THE RAILWAY		**Start End: 12:57-13:15**
BIRDS NESTING AND LIVING IN THE FOREST BELT NEAR THE RAILWAY		
Rook	*Corvus frugilegus*	55
Black-billed Marpie	*Pica pica*	2

Route 7 THE AREA FOR NEW WWTP		Start End: 13:23-13:43
BIRDS NESTING AND LIVING ON WWTP		
Northern Wheater	Oenanthe oenanthe	4
Bluethroat	*Luscinia svecica*	2
Booted warbler	*Iduna caligata*	1
BIRDS NESTING ONLY IN NEARBY AREAS		
House Sparrow	*Passer domesticus*	7
Rook	*Corvus frugilegus*	8
Black-billed Marpie	*Pica pica*	1
Point 8 BUKPA RIVER UPSTREAM WWTP		**Start End: 13:57-14:02**
BIRDS NESTING AND LIVING ON BUKPA river		
Northern Wheater	Oenanthe oenanthe	2
Black-billed Marpie	*Pica pica*	2
BIRDS NESTING ONLY IN NEARBY AREAS		
Rook	*Corvus frugilegus*	43
Route 9 BUKPA RIVER ALONG BIOPONDS TO WEST GREEN BELT TREE PLANTATION		**Start End: 14:12-15:08**
BIRDS NESTING AND LIVING ON BUKPA river		
Northern Wheater	Oenanthe oenanthe	2
BIRDS NESTING ONLY IN NEARBY AREAS		
Western marsh harrier	Circus aeruginosus	1
Great egret	*Casmerodius albus*	2
Northern Lapwing	*Vanellus vanellus*	3
Black-billed Marpie	*Pica pica*	1
Common Kestrel	*Falco tinnunculus*	1
Black-headed Gull	Larus ridibundus	22
PASSING BY BIRDS		
Gren Sandpiper	*Tringa ochropus*	3

In summary, no mammals and only a few marsh frogs were observed in the whole area surveyed. Insects were not surveyed. Excrements or food remains of mammals or reptiles were not noted during the survey.

A total of 48 bird species were recorded. Out of these, northern porchad and ferruginous duck (VU and NT), northern lapwing, black-tailed godwit and black-winged pratincole (NT) are listed in the IUCN red list. In addition, 2 adult demoiselle cranes (the Kazakhstan Red Book Category V ‘Recovered Population’) were observed. None of these were observed within the site of the proposed WWTP infrastructure. In general, the biponds, sludge ponds and water channels adjacent to the WWTP constitute a nesting habitat for various and partly protected bird species. The WWTP site itself (existing and new) is a heavily disturbed pasture area that supports little wildlife and has poor fauna biodiversity, hence is not considered an important fauna habitat and has **low sensitivity** as a receptor. Considering the adjacent areas also in the context of potential project impacts, the sensitivity can be seen as low to medium.

Benthic fauna (hydrobiological Study) for Sokyr River – summary

No published data on the macrozoobenthos of the Sokyr River were identified.

The macrozoobenthos of the Sokyr River was surveyed on 29 June from 11:00 to 16:00 along the central axis of the river, avoiding backwaters, kinks, and vegetation-shaded areas. Samples were taken at 8 stations spaced 500m apart (see Figure 6.36).

Laboratory processing of samples was carried out by counting and weighing method and using available manuals to determine the species' taxonomic classification[27]. The Shannon-Weaver (H′) information indices for biomass and Piel (e) were used to assess community structure. The first index indicates the level of biodiversity of the river community. The full hydrobiological report, including survey methodology and other information sources is included Annex 4 herewith.

The key findings of the hydrobiological survey are summarized below.

The macrozoobenthos of the Sokyr River in June 2023 was represented by insects (8 taxa), barnacles, worms - nematodes, oligochaetes and leeches (Table 6.26).

Only larvae of chironomid mosquitoes of the subfamily Chironominae were consistently found in the benthos. A high frequency of occurrence was recorded for Oligochaetes, Chironomid mosquitoes of Cricotopus and Tanypodinae, the subfamily Orthocladiinae.

The highest number of species was found on station 7 and the lowest on station 1.

Figure 6.36 Overview sampling stations in the Sokyr river. Sampling station 1 being upstream from the discharge point from the WWTP (and Bukpa river) and the remaining stations are downstream.

[27] Narchuk E.P., Tumanov D.V. (Editors of the volume). Definer of freshwater invertebrates of Russia. -V.4. Two-winged insects. SPb. - 2000. - 998 p..

Accordingly, the highest value of the Shannon-Weaver index was found on station 5 and the lowest on station 1 (Table 6.27).

Table 6.26: Taxonomic composition and frequency of occurrence (%) of macrozoobenthos organisms.

Group	Family	Frequency of occurrence
Worms	Nematoda gen.sp.	25
	Oligochaeta gen.sp.	87.5
	Hirudinea gen.sp.	12.5
Crustacean	Ostracoda gen.sp.	25
Insects	Ceratopogonidae gen.sp.	12.5
	Cricotopus sp.	87.5
	Orthocladiinae gen.sp.	62.5
	Chironomus sp.	100
	Polypedilum sp.	75
	Chironomini gen.sp.	100
	Tanytarsini gen.sp.	87.5
	Tanypodinae gen.sp.	12.5

Downstream from Station 1 to Station 3, diversity increases and then fluctuates slightly Figure 6.37. The number of benthic animals varied from 300 (st.1) to 21600 (st.8) individuals/m², biomass – from 460 (st.6) to 48930 (st.8) mg/m² (Table 6.27). Insect larvae were the absolute dominants of quantitative development of macrozoobenthos, with the proportion in abundance ranging from 62% to 100% and in biomass from 48% to 100%. Chironomid larvae of the family Chironominae dominated among the insects. The biomass of oligochaetes was high at station 5.

In the studied sections there are two-point areas with minimal quantitative benthos development (st.1, 6) and two with maximum - st.3 and 8 (Figure 6.38).

Table 6.27: Structural indicators of macrozoobenthos at 8 stations of the Sokyr River.

Indicator	1	2	3	4	5	6	7	8
Number of species	2	6	9	7	8	6	10	7
Population, animals/m²	300	2600	19250	6500	10050	950	18100	21600
Biomass, g/m²	550	3100	48930	8500	4600	460	13275	10875
Shannon-Weaver index, H′	1	2.19	2.21	2.03	2.70	2.25	2.48	2.24
Pielu index, e	1	0.85	0.70	0.72	0.90	0.87	0.75	0.80

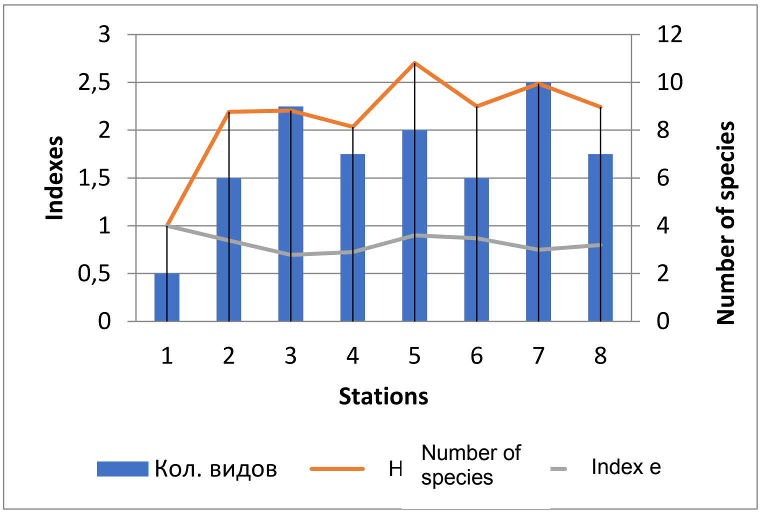

Figure 6.37: Dynamics of macrozoobenthos indicators Sokyr River.

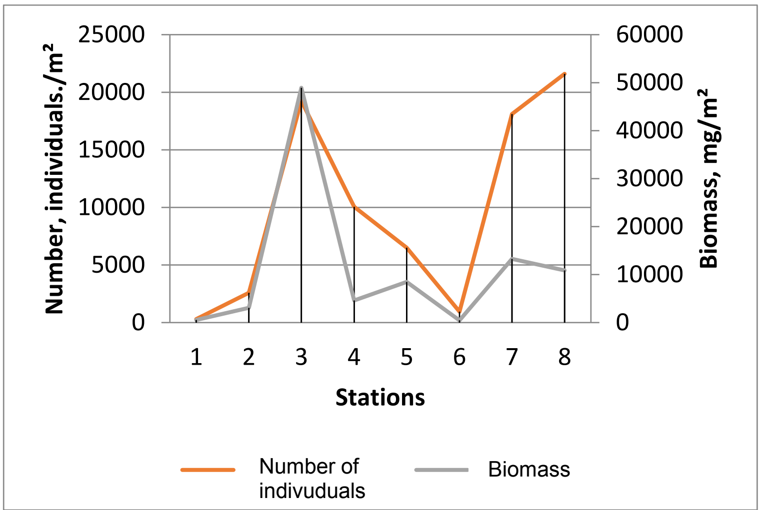

Figure 6.38: Dynamics of numbers and biomass of macrozoobenthos of the Sokyr River

Table 6.28 Macrozoobenthos numbers (ind./m²) in the Sokyr River.

Point	Vermes	Crustacea	Insecta	Bcero
1	0	0	300	300
2	750.00	0	1850	2600
3	2150.00	0	17100	19250
4	2150.00	0	7900.00	10050
5	1750.00	750.00	4000	6500
6	100.00	200.00	650	950
7	6300.00	0	11800	18100
8	850.00	0.00	20750	21600

Table 6.29 Macrozoobenthos biomass (mg/m²) Sokyr River.

Point	Vermes	Crustacea	Insecta	Всего
1			550	550
2	1050.00		2050	3100
3	3005.00		45925	48930
4	1700.00		2900	4600
5	4000.00	400.00	4100	8500
6	50.00	100.00	310	460
7	5610.00		7665	13275
8	500.00		10375	10875

Discussion

The studied section of the Sokyr River is characterised by rather homogeneous environmental conditions. The composition of benthic fauna is characteristic of water bodies with low flow - practically standing water bodies - Oligochaete worms and Chironomid mosquitoes are predominantly present.

One of the main limiting factors affecting the development of benthic fauna in low-flow watercourses is the oxygen regime. The presence of a large amount of organic matter may cause oxygen deficiency which favours the development of organisms that tolerate little oxygen concentrations, such as the Oligochaetes and Chironomus mosquitos.

The observed dynamics of quantitative indicators of benthic fauna show a sharp increase in numbers and biomass at point 3 - below the discharge of treated wastewater. Here, large larvae of Chironomus mosquitos are found in abundance. These conditions indicate the influence of wastewater discharge through nutrient input. This is also supported by the overall downward trend and gradual recovery of the figures after station 3 until station 6. After point 6 a significant increase in numbers is noticed albeit, with a much smaller increase in biomass. Reasons for the very low measured biomass and number of individuals at stations 1 and 6 remain unclear – measurement errors are one possible reason.

In terms of species diversity, the findings are less clear, and it is not possible to draw conclusions related to the impact of discharge from the effluent channel on the species diversity. Based on the number of species and other diversity indicators, the diversity appears to increase below the discharge point, which one would typically not expect. However, it is possible, given the low flow in the river (which appeared stagnant in places and signs of eutrophication were noted by high mass of water plants) and what appears as low baseline species diversity, that the increased inflow from the effluents creates somewhat more favourable conditions downstream. Further monitoring is needed to map the trend with more accuracy.

Recommendations

To further monitor the condition of benthic communities downstream of treated wastewater discharge, sampling is recommended according to the following scheme:

Point 1 - background. needs to be moved downstream further from the vehicles river crossing area.
Point 3 - the greatest influence of sewage water
Point 8 - in the recovery zone.

A mandatory condition for the correct comparison of monitoring stations with the background is the identity of benthic sediments and the degree of overgrowth of higher aquatic vegetation.
The analysis of the taxonomic composition of macrozoobenthos of the studied section at this stage of research does not allow to identify indicators of pollution. The use of ABC-curve method and W-statistics is suggested for assessment of ecological condition.

In terms of monitoring, sampling: Annual monitoring for the first three years and then stop if there are clear results of improvement of presence of indicator species. If results are not clear and suggesting a clear improvement in water quality and biodiversity conditions, then determine the appropriate frequency of monitoring after the first 3 years.

Conclusion on receptor sensitivity - Fauna

- **Terrestrial and avifauna around the WWTP site**: The proposed WWTP site is not diverse in fauna and no mammals and reptiles, their tracks, borrows, excrements or food remains were noted during the fauna survey in June 2023. 48 bird species were observed during the survey, around the existing and proposed WWTP site, sludge ponds, bioponds and associated discharge channel to the Sokyr river. Six species with IUCN status as either vulnerable (VU) or near threatened (NT) were seen in the biopond area and one of these (Northern Lapwing, NT) also around the sludge beds. Additional one species (two individuals) registered in the Kazakhstan red book (Demoiselle Crane, V) was seen in the biopond area. The biopond area will not be affected by the project. No rare or threatened species were found within the site directly impacted by WWTP infrastructure. Overall, the fauna habitat within the WWTP site directly affected is considered of low sensitivity, although due to the presence of the sensitive or rare species around the bioponds, a more conservative approach is to consider it of **medium sensitivity**. Special care should be taken during the construction phase.

- **Sokyr river aquatic benthic fauna**: The hydrobiological study indicates that the river has homogenous environmental conditions and is characterised by the low flow of the river, which appeared stagnant in places. Hence, the predominant species are Oligochaete worms and Chironomid mosquitoes, which are adapted to low oxygen and high organic matter environments. Species diversity is lowest at the surveyed baseline point, but increases somewhat further downstream, which is somewhat surprising and the reasons for which are unknown (could be measurement error at the baseline, or that increased river flow from effluents originating from the bioponds somehow enables higher species diversity). A spike in biomass and number of individuals at point 3 below the effluent discharge point, can likely be explained by the increased inflow of nutrients. Further monitoring is required to understand the ongoing dynamics. Overall, however, the biological conditions in the studied part of the river appear rather poor, and the sensitivity of the benthic fauna in the river is considered **medium.**

6.1.11 Access road infrastructure

The existing and proposed WWTP site is accessed via an approximately 5 km gravel road from the western part of Karaganda city and passing through an industrial area before entering the WWTP site (Figure 6.39).

The road passes by but not through the Kir-zavod 3-4 residential area, which is located north of the WWTP and between the WWTP and the industrial area on the western outskirts of Karaganda City.

The immediate access road from the WWTP is 750 meters before joining with the road that continues towards the Kir-zavod 3-4 area, and the industrial area to the north-east, and then Karaganda City.

The access road from the industrial area to the WWTP (as marked in dark blue on Figure 6.39) is primarily used by the WWTP. Local residents do not use this road, except on rare occasions. There is another road passing through the Kir-zavod 3-4 residential area (Figure 6.39), which is also accessible from the north. The residents have expressed that they do not want that road to be used, but rather the road passing past the village (Figure 6.39).

Figure 6.39 The dark blue line shows the access road to the WWTP. This road is mainly used by the WWTP. The light blue line indicates the further access to the Karaganda City, passing an industrial area. The total distance from the WWTP to the city (blue lines) is approximately 4.7 km. The access road passes by the Kir-zavod 3-4 residential area. The road through that area (red line) will not be used for heavy transport to the WWTP, hence will not be affected by the project. The railway Junction 737 residential area is also indicated on the map, since its residents have expressed concerns that a new road in that area could be affected by the project. However, access to the WWTP does not pass through the Railway Junction 737, hence its roads will not be affected. KS is responsible for maintaining the access road from the WWTP until the Bukpa River crossing, after which the road is the Karaganda city authorities' responsibility.

Local authorities are responsible for maintenance of the access road from the city to after (and including) the bridge over Bukpa river. The WWTP responsibility for the access road extends from the bridge over the Bukpa River and to the WWTP. Before that it is under the city council responsibility.

During visits to the WWTP site as part of the ESIA work, the access road was in reasonable condition, although showing some signs of erosion, and in a state that can be used for heavy machinery.

During normal WWTP operations, the traffic to the WWTP is expected to be limited, however heavy traffic on the road will increase during construction of the proposed WWTP, as further discussed in the impact assessment section.

A new road within Railway Junction 737 (see location on Figure 6.39) was built in summer 2023. Residents were concerned that logistics during construction period can destroy their new road. However, this road is not part of the access road to the WWTP and will not be affected by the project.

Conclusion on receptor sensitivity – access road infrastructure

There is an existing access road from the Karaganda City to the WWTP site that runs through an industrial area and passes by the Kir-zavod 3-4 residential area (but not through it). The road appeared in a moderate condition at the time of the ESIA site visit, showing some signs of erosion after the winter and snow melt. It is expected to undergo regular maintenance to sustain current traffic levels, and temporary increase in traffic associated with the WWTP construction. The sensitivity is considered **low.**

6.1.12 Solid and hazardous waste management infrastructure

Waste infrastructure in Karaganda City

Karaganda city has several solid and hazardous waste processing facilities. Most recycled and utilized products are tyres, fluorescent lamps, biological waste, medical waste, wooden packaging, household appliances. Domestic waste is collected by the licensed companies throughout the city and taken to the guarded and fenced landfill located in the Northern Industrial Area of the city, which is located 15.6km north of the WWTP.

There are 3 landfills which accept construction waste, LLP “GorComTrans”, LLP “Karaganda Recycling”, LLP "Gordorservis-T" of Temirtau. The landfills of these companies do not just accept construction waste, but also sort it. Some of the construction waste may get a second life as some sorted fractions can be transferred to specialised organisations for recycling. Two companies are engaged in recycling of construction waste: "Kazakhstan Waste Management Operator" LLP and “Ecolider” LLP.

Solid and hazardous waste generation and management at the existing WWTP

The site visits conducted by Sweco in 2023 as part of the ESIA process for the proposed WWTP indicated that overall levels of housekeeping appeared quite good.

KS has a waste management program for 2022 – 2031 with measures aimed at reducing the impact of waste on the environment. It logs the volume and disposal method and reports to the regional environmental protection department on 21 types of waste it generates. Eight types of waste are hazardous: mercury lamps, batteries, oil, oiled rags, oil filters, oiled sand, used varnish and paint containers and sweepings from the territory.

The main non-hazardous waste is active sludge that accumulates to around 40 000 m^3 per year on 16.48ha of 21 sludge beds. In 2021, an attempt was made to dispose this sludge at the Karaganda CHP-3 ash ponds recultivation where a layer of soil is placed over dried pond. Around 39 870 m^3 of sludge was disposed in this way. However, no further requests for sludge came from the CHPs. Storage of sludge at the WWTP site has taken place since 1979 but is as such not permitted, and the company pays a fine annually for this reason.

The other non-hazardous wastes are generated in much smaller amounts. These are paper, sanitation trucks hoses, office waste and equipment, worn-out tires, welding electrode ends, ash and slag, construction waste, glass, metal dust and scrap metal. KS does not have a landfill and is not licensed to dispose waste and only allowed 6 months storage of waste for accumulation and drying purposes. The waste and responsibility for it is passed to appropriate licensed waste transporting or disposal companies according to the contracts.

Table 6.30: Types and quantities of hazardous waste generated at Karaganda Su based on permit (source: Karaganda Su)

Type of waste	**Method of disposal**	**Maximum possible accumulation volume for 6 months, tonnes**
Oiled rags	Karaganda Su has a contract with the «K-service 2020» LLP for disposal this type of waste. Disposal method is high-temperature incinerators	0.15 tonnes
Oiled filters	Karaganda Su has a contract with the "Kazakhstan Waste Management Operator" LLP for transport and disposal this type of waste.	0.432 tonnes
Used oil	Karaganda Su has a contract with the «Kazakhstan Waste Management Operator» LLP for disposal this type of waste.	4.5 tonnes
Car batteries	Karaganda Su has a contract with the « Kazakhstan Waste Management Operator» LLP for disposal of this type of waste. Disposal method -manual battery disassembly and recovery of recyclable materials. All recyclable materials are transferred to third parties.	0.675 tonnes
Used mercury lamps	Karaganda Su has a contract with the « Kazakhstan Waste Management Operator» LLP for disposal of this type of waste. Disposal method is demercurization .	0.225 tonnes
Worn out tires	Karaganda Su has a contract with the « Kazakhstan Waste Management Operator» LLP for disposal of this type of waste. Disposal method - manual battery disassembly and recovery of recyclable materials. All recyclable materials are transferred to third parties.	6.75 tonnes

KS does not generate the following type of waste: *PCBs*[5]*, hydraulic equipment,* and ***Asbestos.*** Disposal of office equipment is carried out under an agreement with a licensed company.

Conclusion on receptor sensitivity – waste infrastructure

Non-hazardous and hazardous waste from KS facilities is collected by service providers for treatment or disposal. There is a domestic solid waste landfill 15.6 km to the north from the WWTP and 3 landfills in the city which accept construction waste. Although not highly developed, there is some recycling infrastructure in the city and a couple of waste companies are engaged in and accept construction waste for sorting and further recycling of some fractions, through specialised recycling providers. There is general risk of illegal dumping of collected waste, including construction waste. The construction phase incl. demolition of parts of the existing WWTP will generate substantial amounts of particularly demolition waste, although small volumes in the context of the whole city. The sensitivity of the solid waste infrastructure to deal with waste from the WWTP is considered **medium to low.**

6.1.13 Water supply infrastructure

The WWTP is connected to the water mains with metered supply. The WWTP is not considered a significant consumer of potable water, which is limited to domestic use and cleaning purposes.

Conclusion on receptor sensitivity – water supply system

The sensitivity of the water supply infrastructure in the context of the project is considered **low.**

6.1.14 Energy supply infrastructure (heat and electricity)

The current WWTP is connected to the regional electricity grid via a 35kV overhead line that is connected to the onsite 35/10/0.4kV substation. Karaganda Regional Electricity Company manages the grid.

The following tables provides the details of power consumption for the WWTP and sewage pump stations (SPS). The annual energy consumption in 2022 for the WWTP was *approx.* 15.6 million kWh/year, which was similar over the years 2017-2019 (approx. 15 million kWh/year). Based on the current average pollution load of *approx.* 500,000 population, the specific power consumption is *approx.* 30kWh/year.

In 2022 the annual energy consumption of the SPS was about 7 million kWh/year (6.6 million kwh/year in 2022).

Table 6.31 *Annual power consumption(kWh) for Karaganda WWTP broken down into its main functions*

Infrastructure	Power Consumption (2022) (kWh/year)
WWTP (total)	**15 605 620**
Main pumping station	3 689 525
Block air pumping station	11 360 147
Double drum boiler house	555 947

Table 6.32: Annual power consumption (kWh) for Karaganda WWTP and Sewage Pump Stations (SPS) (2022)

Infrastructure	Power Consumption (2022) kWh/year
WWTP	15 605 620
SPS Total	6 604 178
SPS 10	219 900
SPS 1	498 708
SPS 13	3 906 072
SPS 7	1 721 318
SPS Orbita	97 960
SPS (small) Almaly, Burovaya, Ledovaya, 2,3,4, kungei, kuzembaeva	160 220
Grand Total	**22 209 798**

For comparison, the total electricity consumption of KS as an organisation was roughly 77 million kWh/year in 2021-2022.

Table 6.33 Annual power consumption (kWh) for Karaganda SU (2021-2022) (Source: Karaganda Su)

	2021	2022
KS power consumption (kWh/year)	77,470,208.00	77,448,875.00

It was informed that Karaganda Su tries to reduce its own energy consumption and implements the following measures:

- Installation of LED lights and switches with light and movement detectors for outdoor illumination.
- Installation of heating timers on the shower water tanks.
- Changing the heating rods in the electrical heating system boilers to more efficient ones, resulting in lower energy costs.

It is understood that electricity consumed by Karaganda Su is sourced and provided through the national power grid. Electricity generating sources in Karaganda are primarily coal based. There is a solar plant in Saran (location: (49°48'38.39"N 72°52'19.12"E) which is believed to deliver max 100MWac to the grid. At a national level, Kazakhstan electricity generation is primarily fossil fuel based (coal ca. 70%, natural gas ca. 20%, hydro 9%, other renewables <1%)[28].

In terms of **heat supply**, the existing WWTP relies on electrical boilers on site to heat the on-site building facilities.

The new WWTP will be using the same substation, although some modifications can be expected.

The proposed WWTP will include anaerobic digestion (AD) of sludge to produce biogas, which will be turned into heat and electricity with an on-site combined heat and power (CHP) plant. This will reduce the dependency on external power sources to operate the proposed WWTP.

Conclusion on receptor sensitivity – energy supply infrastructure

The existing WWTP is connected to the established municipal energy supply system via the electricity grid. It has been informed that heating of buildings is also via electricity, using electric boilers. With the new WWTP and AD, heat from the biogas fuelled CHP can be used to heat WWTP facilities, hence reducing the consumption of electricity required for heating.

Hence, the sensitivity of the energy supply system in the context of this Project is considered **low.**

6.2 Socio-economic and Land Use Situation

This section gives an overall description and analysis of the current socio-economic situation in Karaganda City, which is considered the wider area of influence of the Project. This is followed by a presentation of further details about the socio-economic and land use situation in the anticipated PAI, *i.e.,* in the areas relatively close to both the existing and planned new WWTP.

6.2.1 Population and development plans for Karaganda City

Population and households

28 Source: International Energy Agency: https://www.iea.org/countries/Kazakhstan

Figure 6.40: Map of Karaganda City (red line is for Kahzybek bi District; black line is for Alikhan Bokeikhanov District; red dots indicate the six residential areas)

Karaganda City is divided into two districts: Kazybek bi and Alikhan Bokeikhanov, which are subsequently divided into smaller micro-districts. According to the explanatory document of the Karaganda City Development Plan for 2021-2025, issued by the City Akimat, the city has six residential areas: Novy Gorod, Prishakhtinsk, Yugo-Vostok, Maikuduk, Sortirovka and Fedorovka. There is an industrial area attached to each residential area. Currently, there are no plans to expand the city borders to include other villages or districts.

According to official data provided by the National Bureau of Statistics, as per the beginning of 2022, the city of Karaganda had a population of 502,964, of which 54% were women and 46% were men. This gender difference is similar to the population composition generally seen in urban areas of Kazakhstan. The higher share of women is due to their prevalence in older age groups.

The population of Karaganda City has fluctuated somewhat during the period 2010-2022, with an average increase of 0.53% per year. However, in 2018 and 2019, Karaganda City experienced a slight population decrease, as shown in the table below. According to the Karaganda Development Strategy until 2050, prepared by the Ministry of Industry and Infrastructure Development under the national Committee for Construction and Housing and Communal Services, one of the main reasons for the slowdown in population growth is the possibility of obtaining better quality education and a higher income by moving to a more prosperous region. Additionally, there has been a decrease in the birth rate.

Table 6.34: Population development in Karaganda City, 2010-2022

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Population	470,759	475,206	478,952	484,510	492,162	497,825	499,330	501,222	499,663	497,930	497,954	501,095	502,964
Growth (%)		0.94	0.79	1.16	1.58	1.15	0.30	0.38	-0.31	-0.35	0.005	0.63	0.37

Source: National Bureau of Statistics, Department of Statistics of Karaganda region: Socio-economic passport of Karaganda Region and Consultant's calculations

The population development in Karaganda City is closely related to migration levels. The table below shows that Karaganda City had a positive migration balance from 2011-2015, but has since had a predominately negative migration balance, meaning more people are moving away from the city (emigrating) than moving to the city (immigrating). Comparatively, net migration for Karaganda Region remained negative from 2011-2022. The levels of both immigration and emigration have increased during the 12-year period for the city as well as the region, indicating a somewhat increased population mobility.

Table 6.35: Registered Migration 2011-2022 for Karaganda City and Karaganda Region

	Karaganda City			Karaganda Region		
Year	**Immigration**	**Emigration**	**Net Migration**	**Immigration**	**Emigration**	**Net Migration**
2011	12,969	11,968	1,001	27,598	30,804	-3,206
2012	11,632	11,068	564	24,625	28,762	-4,137
2013	13,007	11,097	1,910	26,031	29,515	-3,484
2014	16,668	13,075	3,593	33,176	36,038	-2,862
2015	15,160	13,589	1,571	32,436	36,684	-4,248
2016	15,367	16,626	-1,259	*1,124	*1,888	*-764
2017	17,495	20,233	-2,738	44,340	56,025	-11,685
2018	10,063	17,116	-7,053	37,581	49,180	-11,599
2019	18,742	22,236	-3,494	53,697	64,967	-11,270
2020	18,700	18,341	359	41,761	50,650	-8,889
2021	17,245	17,381	-136	35,529	45,906	-10,377
2022	18,076	17,167	909	31,770	37,218	-5,448

**The data is available only for January-March*
Source: National Bureau of Statistics, Department of Statistics of Karaganda region: Dynamics of the main socio-economic indicators for Karaganda for 1991-2022

Data on the number of households are normally collected during population censuses, based on which the average household size is calculated for the different regions of Kazakhstan. The last census was conducted by the Bureau of National Statistics in 2021, and the final results of the census are due to be published in 2023. The Household Living Standards Measurement Sample Survey showed that there were 2,321,978 households in Kazakhstan in 2021, with an average household size of 3.4 persons. However, no relatively recent data appear to be available about the number of households or household size for Karaganda City. Data from the National Bureau of Statistics indicate an average household size of 3.1 persons for Karaganda Region. It is assumed that this figure is based on the population analysis prepared in 2019 by the Ministry of the National Economy in collaboration with UNFPA. Karaganda Region covers both urban and rural areas. The calculation of the population with access to piped wastewater services in Karaganda City indicates that the average household is around 2.73 persons (see section 6.2.6 below).

According to the National Bureau of Statistics, in 2022, the city had 30,904 residential buildings. Out of these, 22,699 were individual houses and 8,205 were multi-storey apartment buildings. There was a total of 202,038 apartments in these multi-storey apartment buildings, as shown in the table below.

Table 6.36: Number of residential buildings in Karaganda City, 2017-2022

	2017	2018	2019	2020	2021	2022
Individual houses	21,550	21,535	21,682	21,802	22,065	22,699
Multi-storey apartment buildings	8,133	8,301	8,309	8.316	8,246	8,205
Total number of apartments	189,693	190,433	192,129	193,889	196,108	202,038

Source: National Bureau of Statistics: Annual records of residential buildings in Karaganda Region

Main economic activities and development plans

Historically, Karaganda City has been an industrial city with a well-developed industrial infrastructure. According to the Karaganda City Development Plan for 2021-2025, the city's economy is dominated by the processing industry (69.3%) and the supply of electricity, gas, steam, hot water, and air conditioning (24.5%). The main forms of employment are within growth areas and sectors in the city, such as industrial zones, the special economic zone “Saryarka”[29] , enterprises of metallurgical and mechanical engineering, food production, chemical and pharmaceutical clusters. According to the City Development Plan, the city's economy has generally had a positive development trend. This is due to measures taken at the state level to support the economy through state and government programmes, such as: "Nurly Zhol", "Nurly Zher", "Regional Development Program for 2020-2025", and the “Employment Roadmap for 2020 – 2021”. The City Development Plan also outlines plans to construct 18,500 new apartments between 2021-2025.

A relatively limited number of tourists and other visitors stay overnight in the city, amounting to a total of 129,315 registered visitors in 2022. The city had 90 registered accommodation facilities (hotels of various categories of comfort, motels, summer house zones, rest houses and other facilities) in 2022, with approximately 2,778 beds. The table below shows the development in accommodation facilities and visitors over the last thirteen years. Noticeably, there was a sharp decrease in the number of visitors in 2020, which can be attributed to the Covid-19 pandemic.

Table 6.37: Accommodation facilities and visitors registered in the city of Karaganda, 2009-2022

Year	Number of accommodation facilities, units	Number of rooms, units	Number of employees in accommodation facilities	Visitors served, persons	One-time capacity, beds
2009	48	770	-	153,298	1,630
2010	50	1,303	-	112,271	2,629
2011	-	1,363	-	139,949	2,781
2012	-	-	-	-	-
2013	53	1,056	-	119,667	1,707
2014	50	1,096	-	120,284	1,787
2015	57	1,179	680	112,364	1,992
2016	67	1,295	-	103,279	2,180
2017	76	1,471	773	117,673	2,451
2018	82	1,481	754	125,175	2,628
2019	81	1,476	717	155,337	2,635
2020	77	1,372	528	88,835	2,524
2021	75	1,353	518	117,547	2,512
2022	90	1,404	609	129,315	2,778

[29] The main specialisation of "Saryarka" is metallurgy, production of finished metal products, mechanical engineering, production of rubber and plastic products. By the end of 2018, enterprises of the machine-building and construction materials industry operated on the territory of the Saryarka FEZ, namely Bemer Armatura LLP, Izoplus Central Asia LLP, Nau-Ken Temir LLP, Recycling Company LLP, Seven Refractories Asia LLP ”, LLP“ Perspektiva.kz ”, LLP“ OUTLOOK ”.

Source: Karaganda 2050 Development Strategy program and Bureau of Statistics

There is no peak season for visitors to stay in Karaganda City. This means that on average there was around 354 visitors per day throughout the year of 2022 (129,315 overnight visitors spread equally over 365 days), or 177 visitors per day, if each visitor was assumed to have had a two-night stay. In 2022, there was an increase in the number of rooms and beds available (1,404 and 2,778, respectively), which indicates that the city's tourism industry is returning to pre-Covid 19 levels. It could also indicate that the city may have slightly more visitors than those officially registered. According to the Development Plan of Karaganda Region for 2021-2025, there are no current plans to develop tourism further in Karaganda City.

Population projections for Karaganda City

The Karaganda Development Strategy until 2050, prepared by the Ministry of Industry and Infrastructure Development under the national Committee for Construction and Housing and Communal Services, includes three population projection scenarios, based on the population in 2019 and assumptions about the demographic development of the city, as shown in the table below.

Table 6.38: Official population projection scenarios for Karaganda City

Scenario	2019	2025	2030	2050	Assumptions
Expected	497,930	534,358	557,074	653,552	In the expected scenario, the total life expectancy and the total fertility rate remain unchanged at the level of the base year 2019, the migration balance is +2,680 persons per year.
Pessimistic	497,930	505,696	506,698	505,829	In the pessimistic scenario, the total life expectancy and the total fertility rate remain unchanged at the level of the base year 2019, the migration balance will be negative with 1,177 persons leaving the city every year.
Optimistic	497,930	545,543	582,287	1,014,602	In the optimistic scenario, the total life expectancy is gradually increasing and in 2050 will be 84 years, the total fertility rate is gradually increasing and will be 2.8 by 2050, the migration balance is positive, up to 2030 +3,953 people per year, from 2031 to 2050 the balance migration will be +13,590 people per year.

Source: Development Strategy for Karaganda until 2050

The official expected population scenario projection appears to be on the high side. The Feasibility Study conducted by Sweco in 2020-2021 for the Wastewater Treatment Modernisation Programme in Karaganda City therefore proposed to use the following three growth scenarios (low, expected, high), which are based on the population development over the last 10 years and the development plans for the city. The assumptions for the three growth scenarios are explained in the table below.

Table 6.39: Population growth rate scenarios and assumptions for Karaganda City

Scenario	Average Annual Population Growth	Assumptions
Low	-1%	The net migration out of the city will continue and perhaps increase over the coming years, due to limited new job opportunities in the city.
Expected	0.5%	New industries will be established in Karaganda City and/or existing industries will expand and create additional jobs. This will attract more people to move to Karaganda City. There will therefore be a small net migration into the city.
High	1%	Additional new industries will be established in Karaganda City and/or existing industries will expand and create additional jobs. This will attract more people to move to Karaganda City. There will therefore be a somewhat higher net migration into the city.

Source: Sweco Feasibility Study (2021)

The three population growth scenarios are shown in the table below. The expected growth scenario gives **a population of approximately 510,500 in 2025 (end of PIP) and approximately 550,200 in 2040 (end of LTIS).**

Table 6.40: Population growth scenarios for Karaganda City, Sweco Feasibility Study, 2021

	Option 1 – Low	**Option 2 – Expected**	**Option 3 – High**
Year	**Population when -1% annual increase**	**Population when 0.5% annual increase**	**Population when 1% annual increase**
2020	497,954	497,954	497,954
2025	**473,549**	**510,528**	**523,355**
2030	450,341	523,419	550,051
2035	428,269	536,636	578,109
2040	**407,280**	**550,187**	**607,599**

Source: Sweco Feasibility Study (2021)

Ethnic groups in Karaganda Region

Data from the Department of Statistics for Karaganda Region from 2022 shows that 47.63% of the population in Karaganda city are of Kazakh origin, 38.54% of Russian, 2.72% of Ukrainian, 2.36% of German, 2.55% of Tatar and the remaining of other origin.

There are no indigenous people in Karaganda needing special attention according to the EBRD performance requirement (PR) 7.

6.2.2 Household income and expenditure levels

The National Bureau of Statistics has no statistical data available on household income, expenditure, and poverty for individual cities, nor does the Karaganda City Akimat have such data available. The National Bureau of Statistics has, however, such data for the regional level, and the data for Karaganda Region will therefore be compared to national-level data in the following table.

The table below lists the average income levels per capita for 2015-2022 for Karaganda Region. These are nominal income figures and thus include inflation. Data are not available separately for urban areas of Karaganda Region.

Table 6.41: Average nominal income per capita in Karaganda Region, 2015-2022 (KZT/capita/month)

Area	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Karaganda Region	66,841	71,905	82,300	94,738	106,481	130,552	140,882	167,337
Kazakhstan	67,321	76,575	83,710	93,135	104,282	116,126	130,616	154,417

Source: National Bureau of Statistics, based on data reported by enterprises and other organisations

There has been a steady increase in the average income per capita in 2015-2022, both in Karaganda Region and generally in Kazakhstan. Between 2018-2022, the average income in Karaganda Region was slightly higher than in Kazakhstan generally.

The table below shows the average income data per capita for the lowest and highest deciles in Karaganda Region. Income data are not available for other deciles.

Table 6.42: Average income per person in Karaganda Region for deciles 1 and 10, 2016-2021 (KZT/capita/month)

Decile	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Decile 1	19,785	21,018	23,598	25,277	27,037	31,667
Decile 10	124,057	138,835	156,805	169,848	189,239	221,558

Source: National Bureau of Statistics

The two tables below list the average expenditure levels per capita and per household for 2015-2022 for urban areas of Karaganda Region, Karaganda Region and at national level. These data are based on surveys in urban areas of Karaganda Region and thus include inflation. Expenditure data include the value of own products used for own consumption. The data indicate that expenditure on both a per capita and per household basis is higher in urban Karaganda than at regional and national level. However, a comparison of the available income and expenditure data shows that, across all levels, the average income per capita has been higher than average expenditure over the last six years, suggesting that the average household has been able to make savings.

Table 6.43: Average expenditure in urban areas of Karaganda Region per capita, 2015-2022 (KZT/capita/month)

Area	2015	2016	2017	2018	2019	2020	2021	2022
Urban areas of Karaganda Region	49,145	53,269	59,743	65,875	73,236	77,973	90, 382	105,779
Karaganda Region	46,208	50,259	56,288	62,489	68,894	74,730	86,118	101,463
Kazakhstan	38,502	41,847	46,319	51,198	55,791	59,701	67, 440	77, 602

Source: National Bureau of Statistics

Table 6.44: Average expenditure in urban areas of Karaganda Region per household, 2015-2022 (KZT/household/month)

Area	2015	2016	2017	2018	2019	2020	2021	2022
Urban areas of Karaganda Region	138,470	150,090	173,919	195,939	218,480	236,267	274,464	316, 081
Karaganda Region	139,121	148,592	171,077	193,119	214,028	234,023	269,363	310, 573
Kazakhstan	130,627	142,182	159,260	173,869	189,533	202,704	230,441	265,867

Source: National Bureau of Statistics

Per capita expenditure data is not available by decile for Karaganda Region, but only at national level, as shown in the below.

Table 6.45: Average expenditure per capita in Kazakhstan by decile, 2015-2021 (KZT/capita/month)

Decile	2015	2016	2017	2018	2019	2020	2021
Decile 1	16,633	18,057	19,544	21,382	23,223	25,246	28,906
Decile 2	21,396	23,292	25,072	27,675	29,973	32,101	36,383
Decile 3	24,835	27,052	29,248	32,253	34,526	36,829	41,227
Decile 4	28,202	30,722	33,215	36,300	39,010	41,477	46,254
Decile 5	31,953	34,721	37,512	40,772	43,958	46,674	51,772
Decile 6	36,111	39,293	42,661	46,267	49,944	53,049	58,756
Decile 7	41,353	44,836	49,006	53,124	57,359	61,159	67,942
Decile 8	48,279	52,229	57,483	62,628	67,426	72,426	80,551
Decile 9	58,946	63,821	71,008	78,071	84,322	89,951	100,923
Decile 10	93,735	101,921	115,252	128,255	139,043	150,018	172,569

Source: National Bureau of Statistics

According to the National Bureau of Statistics, the 10% of the population with the highest expenditure (decile 10) had an average per capita expenditure that was six times higher than the 10% of the population with the lowest income (decile 1). For each of the lowest three deciles, the average monthly expenditure per capita increased by an average of 10% per year between 2015-2021.

6.2.3 Educational levels, including in technical fields

Data on educational level are available at national level (Kazakhstan) and for Karaganda Region, but not separately for Karaganda City.

Statistics from the National Bureau of Statistics show that for the period 2012-2021 the net enrolment ratio in primary and secondary education was around 100%, both at national level (Kazakhstan) and in Karaganda Region. The table below shows the gross enrolment rate in higher education from 2012-2021 for the national level and Karaganda Region. This enrolment rate is defined as the ratio of the number of students, regardless of age, enrolled in technical and vocational education (ISCED-5), as well as higher education for the total population aged 18-22 (ISCED 6-8). Throughout the period 2012-2021, the gross enrolment rate in higher education has remained higher in Karaganda Region than at national level.

Table 6.46: Gross enrolment rate in higher education for Karaganda Region and Kazakhstan (%)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Karaganda Region	62.03	58.48	56.90	55.35	56.51	61.14	67.95	68.93	66.03	64.88
Kazakhstan	53.39	50.90	48.37	48.44	51.14	54.29	60.73	66.98	64.07	62.64

Source: National Bureau of Statistics

The table below lists the total number of technical, vocational, and post-secondary students for the last five years for the national level and in Karaganda Region. In 2022/2023, students enrolled in engineering, manufacturing, and construction constituted 21% (national level) and 28% (Karaganda Region) of the total number of technical, vocational, and post-secondary students. The table indicates a substantially higher number of students enrolled in engineering, manufacturing, and construction courses in 2022/2023 at national level, compared to in previous years. It is assumed that the reason for this is a change to the definition of this category, in terms of broadening the number of study programmes included.

In 2022/2023, women constituted 48% of the total technical, vocational, and post-secondary students at national level and 54% in Karaganda Region. In this same year, women constituted 19% (national level) and 18% (Karaganda Region) of the students in engineering, manufacturing, and construction. The percentages of female students are relatively similar in the previous four years.

Table 6.47: Number of technical, vocational, and post-secondary students in Kazakhstan and Karaganda Region

	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023
Kazakhstan					
Total students (of which female)	489,818 (f: 229,044)	475,443 (f: 222,351)	477,539 (f: 226,110)	494,042 (f: 235,375)	526,909 (f: 251,159)
Students in engineering, manufacturing, and construction (of which female)	27,211 (f: 4,853)	25,742 (f: 4,731)	24,645 (f: 4,576)	15,467 (f: 2,956)	108,935 (f: 20,385)
Karaganda Region					
Total students (of which female)	40,085 (f: 18,643)	38,244 (f: 17,637)	38,083 (f: 17,937)	39,007 (f.18,335)	38,014 (f: 20,440)
Students in engineering, manufacturing, and construction (of which female)	9,377 (f.: 2,552)	1,355 (f.: 205)	7,861 (f.: 2,150)	10,668 (f.: 2,322)	10,765 (f: 1,905)

Source: National Bureau of Statistics and Consultant's calculation

6.2.4 Labour force, employment, and unemployment

Total labour force, employment, and unemployment data

The following table shows that the population in the economically active age group (16-59.5 years for women and 16-63 years for men) is relatively similar across local, regional, and national levels, accounting for 63% of the total population in Karaganda City, 64.8% in Karaganda region and 68.7% at the national level. The level of unemployment is also similar at the three levels, whilst the youth unemployment rate is higher in Karaganda City (4.9%) and Karaganda Region (4.5%) than at national level (3.8%).

Unemployment figures should, however, be used with caution, as people must register as unemployed and accept the jobs provided by the job centre before they are able to receive unemployment benefits. However, not everyone without a job wants to take the jobs provided by the job centre (for example, as street cleaners and road construction workers) and/or do not want to receive unemployment benefits and therefore do not register as unemployed.

Table 6.48: Key indicators of the labour market: Karaganda City, Karaganda Region, and Kazakhstan, 2022

Population in economically active age of 16-59.5 years (female), 16-63 years (male) (% of total population)	Employed population			Unemployed population	Unemployment rate	Youth unemployment rate (aged 15-28)
	Total	Wage-earners	Self-employed			
Karaganda City						
246,216 (63.0%)	233,781	196,037	37,744	12,435	5.1%	4.9%
Karaganda Region						
559,605 (64.8%)	534,829	466,464	68,365	24,776	4.4%	4.5%
Kazakhstan						
9,429,809 (68.7%)	8,971,539	6,847,300	2,124,239	458,270	4.9%	3.8%

Source: National Bureau of Statistics

As shown in the table below, in 2022, more men than women were registered as being in employment in Karaganda City, both as wage-earners and self-employed. The total unemployment rate was 5.1%, with a higher rate for women (6.3%) than for men (3.9%). Similarly, the youth unemployment rate was substantially higher for women (6.5%) than for men (3.6%).

Table 6.49: Key indicators of the labour market in Karaganda City, 2022, by gender

Population in economically active age of 16-59.5 years (female), 16-63 years (male) (% of total population)	Employed population			Unemployed population	Unemployment rate	Youth unemployment rate (aged 15-28)
	Total	Wage-earners	Self-employed			
Total						
246,216 (63%)	233,781	196,037	37,744	12,435	5.1%	4.9%
Men						
130,053 (74.3%)	124,950	100,092	24,858	5,103	3.9%	3.6%
Women						
116,163 (53.8%)	108,831	95,945	12,886	7,332	6.3%	6.5%

Source: National Bureau of Statistics

As of 2022, the situation in Karaganda Region and at national level is similar to that of Karaganda City, with the data showing that there is a higher unemployment rate for women than for men. The following two tables include registered employment and unemployment data for Karaganda Region and the national level, respectively.

Table 6.50: Key indicators of the labour market in Karaganda Region, 2022, by gender

Population in economically active age of 16-59.5 years (female), 16-63 years (male) (% of total population)	Employed population			Unemployed population	Unemployment rate	Youth unemployment rate (aged 15-28)
	Total	Wage-earners	Self-employed			
Total						
559,605 (64,8%)	534,829	466,464	68,365	24,776	4.4%	4.5%
Men						
298,154 (74,0%)	290,047	247,481	42,566	8,107	2.7%	2.3%
Women						
261,451 (56,8%)	244,782	218,983	25,799	16,669	6.4%	7.2%

Source: National Bureau of Statistics

Table 6.51: Key indicators of the labour market for Kazakhstan, 2022, by gender

Population in economically active age of 16-59.5 years (female), 16-63 years (male) (% of total population)	Employed population			Unemployed population	Unemployment rate	Youth unemployment rate (aged 15-28)
	Total	Wage-earners	Self-employed			
Total						
9,224,066 (82%)	8,769,597	6,847,300	2,124,239	454,469	4.9%	3.8%
Men						
4,806,879 (85.3%)	4,599,145	3,499,310	1,173,950	207,734	4.3%	2.9%
Women						
4,417,187 (78.7%)	4,170,452	3,347,990	950 289	246,735	5.6%	4.9%

Source: National Bureau of Statistics

The table below shows that there has not been much change in the key indicators for the labour market in Karaganda Region over the last five years. The unemployment rate had only slight fluctuations between 2018-2022, ranging from 4.4% to 4.6%. Unemployment figures should, however, be used with caution, as explained above.

Table 6.52: Key indicators of the labour market in the Karaganda Region 2018-2022

	2018	2019	2020	2021	2022
Population in economically active age of 16-59.5 years (female), 16-63 years (male) (% of total population)	685,354 (64.9%)	678,947 (64.6%)	672,465 (64.2%)	673,392 (64.5%)	559,605 (64.8%)
Employed population (% of total economically active population)	653,987 (95.4%)	648,934 (95.6%)	641,775 (95.4%)	643,356 (95.5%)	534,829 (95.6%)
Employees (% of total employed population)	595,556 (91.1%)	592,869 (91.4%)	575,509 (89.7%)	562,955 (87.5%)	466,464 (87.2%)
Self-employed (% of total employed population)	58,431 (8.9%)	56,065 (8.6%)	66,266 (10.3%)	80,361 (12.0%)	68,385 (12.8%)
Unemployed population (% of total economically active population)	31,367 (4.6%)	30,013 (4.4%)	30,690 (4.6%)	30,036 (4.5%)	24,776 (4.4%)
Economically inactive population/persons not included in the labour force (% of total population)	371,110 (35.1%)	371,827 (35.4%)	375,129 (35.8%)	370,108 (35.5%)	303,542 (35.2%)

Source: National Bureau of Statistics

Employment in the Construction Sector

The National Bureau of Statistics does not have separate employment data for Karaganda City, but only for the urban areas of Karaganda Region. Karaganda City is classified as an urban area of Karaganda Region. In 2022, 34,450 persons in urban areas of Karaganda Region were employed in the construction sector, which constituted 8% of the total workforce. This is slightly higher than the percentage of the workforce in Karaganda Region (6.7%) and at national level (7.3%) engaged in the construction sector. Industry (mining and manufacturing) was the economic sector in urban and all areas of Karaganda Region that employed the highest percentage of the workforce (22.7% and 24.6%, respectively), which is significantly higher than the percentage engaged in this sector at national level (12.4%). The table below includes workforce figures for other economic sectors that engaged higher percentages of the workforce in Karaganda City than is the case for the construction sector.

Table 6.53: Workforce engaged in selected economic sectors in Kazakhstan and Karaganda Region, 2022

Economic sector	Workforce in urban areas of Karaganda Region		Workforce in Karaganda Region		Workforce in Kazakhstan	
	Persons	**% of total workforce**	**Persons**	**% of total workforce**	**Persons**	**% of total workforce**
Total workforce	428,964	100%	559,605	100%	8,971,500	100%
Selected sectors						
Construction	**34,450**	**8%**	**37,853**	**6.7%**	**658,905**	**7.3%**
Industry (mining and manufacturing)	97,233	22.7%	137,812	24.6%	1,121,200	12.4%
Wholesale, retail trade, repairs vehicles	75,955	17.7%	84,336	15.1%	1,497,900	16.7%
Education	41,753	9.7%	59,625	10.7%	1,142,300	12.7%

Source: National Bureau of Statistics and Consultant's calculation of % of total workforce

No gender disaggregated workforce data are available solely for the construction sector, but such data are available for the industry and construction sectors combined, as shown in the table below. In Karaganda City, 47% of the total workforce in the industry and construction sectors were women in 2022, which is also the case for Karaganda Region, while the national level is significant lower (27%). Most of the total workforce were registered as wage earners, with 80% in Karaganda City, 83% in Karaganda Region and 87% at national level.

Table 6.54: Workforce in industry and construction sectors by gender, Karaganda Region and Karaganda City, 2022

Total workforce			**Wage earners**			**Other categories of the employed population**		
Total	**Men**	**Women**	**Total**	**Men**	**Women**	**Total**	**Men**	**Women**
Karaganda City								
246,216	130,053	116,163	**196,037**	100,092	95,945	**37,744**	24,858	12,886
Karaganda Region								
559,605	298,154	261,451	**466,464**	247,481	218,983	**68,365**	42,566	25,799
Kazakhstan								
1,780,060	1,301,837	478,223	**1,541,514**	1,123,337	418,177	**238,546**	178,500	60,046

Source: National Bureau of Statistics

KS staffing level

As of February 2023, KS employs 1,623 staff, of which 41% are women and 59% men. The management team consists of 6 men and 3 women. The vast majority of staff is engaged in the water supply and treatment services, sales and service management.

The following table shows the main KS units and staff engaged in wastewater services.

Table 6.55: Overview of main KS departments/units and staff engaged in wastewater services

KS Department/Units*	**Total staff**	**Men**	**Women**	**% of Women**
Wastewater Department (wastewater network, incl. repair work)	234	154	80	34%
Wastewater treatment plant (WWTP)	105	43	62	59%
TOTAL	**339**	**197**	**142**	**42%**

Source: Karaganda Su
** The operation and maintenance of wastewater pumping stations are the responsibility of the Department of Water Supply and Treatment Services*

According to KS, there had been no dismissals in the last three years to reduce staffing levels. If considered necessary or beneficial to reduce the number of staff in a particular working area, then the employees concerned would be offered other jobs within the company, in accordance with the Labour Law.

Employment platform

Kazakhstan has a digital employment platform: www.enbek.kz (often referred to as EBT), which is used by both jobseekers and employers. Information about vacancies can be posted on the platform and job seekers can upload applications or CVs to the platform. The platform is updated daily with information from employers, jobseekers, the state database operated by employment centres, private employment agencies, and other online employment platforms (governmental website: www.egov.kz).

6.2.5 Poverty and vulnerability levels

In 2022, 3.8% of the population in Karaganda Region lived below the official subsistence level, which is defined as the minimum level of income to buy food and goods but may not include payment for services such as utility bills[30]. The table below shows that the percentage of the population living below the subsistence level is generally higher at national level than in Karaganda Region and has been so over the whole period of 2015-2022.

Table 6.56: Percentage of population in Karaganda Region below the subsistence level 2015-2022

Area	2015	2016	2017	2018	2019	2020	2021	2022
Karaganda Region	1.5%	1.3%	1.6%	2.3%	2.5%	3.0%	3.7%	3.8%
Kazakhstan	2.7%	2.6%	2.6%	4.3%	4.3%	5.3%	5.2%	5.2%

Source: National Bureau of Statistics

The table below lists the subsistence and poverty criteria per capita for Karaganda Region (including urban and rural areas). In 2019-2022, the poverty criteria was set as 70% of the subsistence level, whilst it was 40-50% in previous years.

Table 6.57: Subsistence and poverty criteria per capita for Karaganda Region, 2015-2022 (KZT/capita/month)

Area	2015	2016	2017	2018	2019	2020	2021	2022
Subsistence criteria								
Karaganda Region	17,967	18,749	20,482	22,605	25,910	31,183	35,778	42,141
Poverty criteria (40% of subsistence criteria in in 2015-2017, 50% in 2018, 70% in 2019-2022)								
Karaganda Region	7,187	7,500	8,193	11,302	18,137	21,828	25,044	29,499

Source: National Bureau of Statistics and Consultant's calculations

Persons who are permanent residents of Karaganda City and have an income below the subsistence criteria are entitled to housing aid. This aid can be used to pay utility bills and for house repair works. As far as utility bills are concerned, the low-income person pays the bill and brings it to the Akimat for reimbursement.

Housing aid is also provided to low-income families to cover the costs of housing maintenance, utilities, communication services and rent. The National Bureau of Statistics has data available for national level and Karaganda Region but not for Karaganda City. Data for the latter were obtained from the Karaganda City Akimat.

Table 6.58: Number of families receiving housing aid in Karaganda City, Karaganda Region, Kazakhstan, 2018-2022

	2018	2019	2020	2021	2022
Karaganda City	2,264	1,846	1,401	1,120	1,034
Karaganda Region	4,937	4,031	2,700	2,324	2,055
Kazakhstan	68,389	54,476	37,368	32,237	28,170

Sources: Karaganda City Akimat and National Bureau of Statistics

Persons living below the poverty line are entitled to targeted social assistance, as are other vulnerable groups. As seen in the table below, the number of low-income families receiving social aid varied considerably in the period 2017-2022, in both Karaganda City and Karaganda Region.

[30] https://liter.kz/ne-sootvetstvuet-ekonomicheskim-realiyam-pochemu-prozhitochnyj-minimum-takoj-malenkij/

Table 6.59: Persons in low-income families receiving social assistance in Karaganda City and Region, 2017-2022

	2017	2018	2019	2020	2021	2022
Karaganda City	787	1,925	18,815	7,480	5,570	4,911
Karaganda Region	2,723	10,967	61,644	24,643	19,033	12,830

Source: Department for Social Aid, Karaganda City

Data were obtained from Karaganda City Akimat on the number of families and persons receiving social assistance. The City Akimat informed that social assistance is provided to low-income citizens in the form of cash benefits, measures to encourage employment, social adaptation measures (rehabilitation of persons with disabilities, etc.) and a guaranteed social package for children.

Table 6.60: Families and estimate of persons receiving social assistance, Karaganda City, 2018-2022

	2018	2019	2020	2021	2022
Karaganda City, families	448	3,966	1,673	1,285	1,119
Karaganda City, persons	1,925	18,815	7,480	5,570	4,911

Source: Karaganda City Akimat

After the death of five girls from one family in a fire in Nur-Sultan, in February 2019, protests by mothers with many children swept through several regions of the country. Hundreds of women demanded to increase state benefits, solve the housing issue, and introduce benefits for large families. Due to the protests, the authorities increased the amount of targeted social assistance, developed a program of preferential mortgages, announced a partial write-off of unsecured consumer loans, and initiated the construction of rental housing for those in need[31]. Thus, the number of persons in large families receiving social aid in Karaganda City increased 24 times in 2019 compared to 2017. However, in 2020 legislative amendments were introduced, including to the benefits for large families on state targeted social assistance. The new conditions have reduced the number of people who can apply for aid. In 2020, 7,488 persons received targeted social assistance because they had a new-born child, four or more children, or a disabled child. Other persons living below the poverty line also receive social assistance.

In 2020, during the COVID-19 lockdown, vulnerable groups (e.g., disabled persons, large families, pensioners, and other citizens receiving targeted social assistance) were particularly affected and could therefore apply for aid to cover their utility bills for two months (April-May). By August 2020, nearly 24,000 citizens had received this assistance, amounting to around KTZ 716,000,000 (equal to approximately KTZ 30,000 per person).

Veterans and other persons disabled during World War II do not pay for their supply of cold water and their wastewater services. This is based on a memorandum between the Karaganda City Council and KS, signed in 2014. In January 2021, there were 25 veterans of World War II living in Karaganda City.

Veterans and other persons who participated in World War II are also one of the vulnerable groups receiving social assistance. The table below shows the number of veterans receiving social assistance between 2018-2023, with the data indicating that theoverall number of recipients is decreasing annually.

Table 6.61: Veterans and others involved in World War II receiving social assistance in Karaganda City, 2018-2023

Period	Participants and disabled persons of World War II	Other categories equated to veterans of World War II	Home front workers assisting the military during World War II
2018	62	992	4,929
2019	54	978	4,821
2020	38	955	4,288

[31] Radio Azattyk: Economist Maksat Halyk: "The society really needs social assistance" https://rus.azattyq.org/a/kazakhstan-economy-social-help-interview/30204209.html

Period	Participants and disabled persons of World War II	Other categories equated to veterans of World War II	Home front workers assisting the military during World War II
2021	25	934	3,509
2022	14	1,085	2,494
2023	9	1,089	1,761

Source: Department Employment and Social Programmes, Karaganda City

Vulnerable groups

There are no official data on vulnerability for Proizvodstvennaye Street, Kir-zavod 3-4, and Railway Junction 737. During the FGD's held with residents in the area issues related to poverty, presence of people living with disabilities, single parents and vulnerable elderly were discussed, and participants confirm that there are four community members with disabilities or illness in Kir-zavod 3-4, and Railway Junction.

In Proizvodstvennaye Street there is only one permanent resident. Interviews with this resident revealed that some of the abundant houses in the street are occasionally used overnight by homeless persons. The resident is considered vulnerable as he does not relate to the social structures of the neighbouring residential areas, has unspecified health issues, and are the closest resident to the WWTP.

6.2.6 Access to water supply and wastewater services

KS provides water supply and wastewater services to households, industrial and other commercial entities as well as budget organisations in Karaganda City and in Aktas village. The principle of "One window" has been introduced, where existing and potential future customers can receive all information from one unit concerning the required technical specifications for connection to the water supply and sewerage networks. No fee is charged for the issuance of technical specifications, while the customer must pay the costs of materials and actual installations to the nearest connection point.

Access to water supply services

As per January 2023, KS had registered 188,044 domestic water supply customers (households), 6,924 corporate customers, and 537 budget organizations in Karaganda City. KS also supplies water to Aktas village, located outside the city border. Further information is included in the table below.

Table 6.62: KS's registered water supply customers, 2019-2023

Customer Category	Customers									
	Karaganda City					Aktas village				
	01.01.19	01.01.20	01.12.20	01.01.22	01.01.23	01.01.19	01.01.20	01.12.20	01.01.22	01.01.23
Domestic customers (households)	176,801	178,593	180,790	183,581	188,044	4,031	4,030	4,030	4,155	4,153
Corporate customers (industrial and other enterprises)	5,109	5,617	5,852	6,702	6,924	100	106	109	120	121
Budget Organizations	524	572	567	576	537	7	10	10	10	9

Source: KS Customer Department

KS has indicated that around 99% of all households in Karaganda City and Aktas are connected to the piped water supply. KS also supplies water to the small settlement of Novaya Uzenka outside of the city borders.

Access to wastewater services

Piped wastewater services

As per January 2023, KS had registered 171,890 domestic wastewater customers (households), 6,964 corporate customers, and 508 budget organizations in Karaganda City. KS also provides wastewater services to Aktas village, located outside the city border. Further information is included in the table below.

Table 6.63: KS's registered wastewater customers, 2019-2023

Customer Category	Customers									
	Karaganda City					Aktas village				
	01.01.19	01.01.20	01.12.20	01.01.22	01.01.23	01.01.19	01.01.20	01.12.20	01.01.22	01.01.23
Domestic customers (households)	162,924	163,249	165,362	168,067	171,890	3,758	3,755	3,750	3,881	3,877
Corporate customers (industrial and other enterprises)	4,732	5,193	5,394	6,736	6,964	89	90	93	116	117
Budget Organizations	497	537	530	539	508	8	11	11	11	10

Source: KS's Customer Department

The utility also provides wastewater services to a few households, budget organizations and corporate customers in the settlement of Novaya Uzenka outside of the city borders.

The Sweco Feasibility Study from 2021 estimated that 91% of the total population in Karaganda city were connected to KS's piped wastewater system.

According to the Bureau of National Statistics, about 94.1% are connected to the central sewerage system in the urban area of Karaganda Region in 2022. About 94.1% have a central sewerage system, 5.7% have toilets with individual sewerage system (septic tank) and 0.9% have pit latrines in the urban area of Karaganda Region in 2022.

Households, organisations, and commercial entities using septic tanks or latrines

KS does not provide services for emptying of septic tanks. Instead, this service is provided by private companies, which are given a drain point into the sewer, for which they pay a fixed amount per year. The utility has, however, information about the number of households, budget organisations and commercial entities in Karaganda City and Aktas village which use septic tanks or latrines, as shown in the table below. According to KS, these are all the plots which do not have piped wastewater connections.

Table 6.64: Septic and latrines in Karaganda and Aktas, 2019-2022

Customer Category	Users									
	Karaganda City					Aktas village				
	01.01.19	01.01.20	01.12.20	2021	2022	01.01. 19	01.01.20	01.12.20	2021	2022
Households	6,924	6,932	7,426	7,554	7,647	108	111	129	184	221
Corporate customers (industrial and other enterprises)	484	524	542	568	589	6	7	7	8	8

Customer Category	Users									
	Karaganda City					Aktas village				
	01.01.19	01.01.20	01.12.20	2021	2022	01.01. 19	01.01.20	01.12.20	2021	2022
Budget Organizations	14	15	15	16	17	0	0	0	0	0

Source: KS's Customer Department

6.2.7 Water and sanitation related diseases

Statistics on water and sanitation related diseases in Karaganda City were obtained from the Department of Sanitary and Epidemiological Control of Karaganda Region. The Department provided information on infectious and parasitic diseases in Karaganda over the past 7 years: salmonellosis, shigellosis (Sh. Flexneri, Sh. Sonei), rotavirus enteritis, enterovirus infection, ascariasis, trichocephalosis, enterobiasis, hymenolepiasis, opisthorchiasis and viral hepatitis A. The statistics are shown in the table below.

Table 6.65: Registered incidences of water and sanitation related diseases, Karaganda City, 2016-2022

Disease	Incidences per 100,000 persons						
	2016	2017	2018	2019	2020	2021	2022
Salmonellosis	7.3	5.9	12.2	13.7	7.6	2.6	6.7
Shigellosis (Sh. Flexneri, Sh. Sonei)	1.7	1.9	1.1	1.6	-	-	-
Rotavirus enteritis	12.7	14.6	8.7	7.9	7.3	7.2	10.9
Enterovirus infection	7.1	7.8	7.4	17.5	0.5	0.5	7.9
Ascariasis	21.9	19.5	16.4	15.0	9.9	12.8	16.6
Trichocephalosis	-	-	-	-	-	0.2	-
Enterobiasis	15.5	17.2	17.0	15.7	4.2	2.8	4.9
Hymenolepiasis	-	-	-	-	-	-	-
Opisthorchiasis	0.4	-	0.2	-	0.2	0.2	-
Viral hepatitis A	3.8	7.8	15.3	3.9	2.1	1.6	1.2

Source: Department of Sanitary and Epidemiological Control of Karaganda Region

The incidence rates per 100,000 persons for all diseases mentioned above have fluctuated over the last seven years, with nearly all having slightly or considerably decreased in 2022 compared to 2019 (pre-Covid 19), except for rotaviral enteritis.

National-level data on a number of water and sanitation-related diseases has been provided by the Kazakhstan Republic Department of Sanitary and Epidemiological Control, as seen in the table below.

Table 6.66: Registered incidences of infectious diseases in Kazakhstan Republic, 2018-2022

Disease	Incidences per 100,000 persons				
	2018	2019	2020	2021	2022
Salmonellosis	7.13	5.99	2.70	2.63	5.04
Shigellosis	3.39	3.51	0.98	1.06	4.98
Ascariasis	7.13	6.67	4.78	4.92	6.74
Enterobiasis	54.77	41.96	20.17	20.36	26.15
Hymenolepiasis	0.12	0.07	0.03	0.05	0.12
Opisthorchiasis	3.96	3.11	1.98	1.78	2.64

Hepatitis A	4.85	3.23	2.68	0.77	1.65
Dysentery	3.44	3.56	0.98	1.09	5.02
Oxytosis	54.95	50.82	37.28	39.04	52.44
Trichocephaliasis	-	0.01	0.01	0.04	0.01

Source: Kazakhstan Republic Department of Sanitary and Epidemiological Control and Consultant's calculation of incidences per 100,000.

The incidence rates per 100,000 persons for all diseases mentioned above have fluctuated over the last five years at national level, with most having decreased between 2018 and 2022. However, in 2022, the incidence rate for shigellosis and dysentery showed a slight increase compared to 2018 levels. Notably, all disease rates were significantly lower in 2020 and somewhat lower in 2021, with the COVID-19 pandemic being a possible reason for this.

It should be noted that the mentioned diseases are as likely to be caused by poor hygiene, e.g., not washing hands before handling food or storing water in dirty containers, and/or by infected food, as to be caused by poor water quality, and/or poor sanitary situations.

6.2.8 Traffic accident levels

At the time of preparing this report, statistics on traffic accidents in the city of Karaganda were available for the first six months of 2023, and are compared with the data from the same period (January-June) in 2022 in the table below. The data were obtained from the Department of Housing and Communal Services, Passenger Transport and Roads of Karaganda City and show that in the first six months of 2023, a total of 39 traffic accidents were registered, in which 10 people were killed and 40 were injured to varying degrees of severity. This is a 22% decrease in the total number of traffic accidents compared to the year prior (n=50, 2022). Similarly, the number of deaths and injuries caused by traffic accidents in 2023 decreased by 38% and 7%, respectively, compared to 2022 levels.

Table 6.67: Number of road traffic accidents, killed, and injured in the city of Karaganda for 2022-2023 and % ratio

Region	**2022 (Jan-June)**			**2023 (Jan-June)**			**% ratio**		
	Road traffic accident	Fatalities	Injured	Road traffic accident	Fatalities	Injured	Road traffic accident	Fatalities	Injured
Karaganda city	50	16	43	39	10	40	-22%	-38%	-7%

Source: Department of Housing and Communal Services, Passenger Transport and Roads of Karaganda city

According to the Territorial Police Departments of Karaganda City, 5 traffic accidents were registered in the Mikhailovsky district (where the new WTTP is located) in the first six months of 2023, in which 2 people were killed and 6 people were injured.

6.2.9 Gender-based violence and harassment

There do not appear to be any specific policies or legislation in relation to gender-based violence and harassment in the workplace in Kazakhstan. In December 2022, the Ministry of Labour and Social Protection (MLSP) published an article on their website about gender-based violence and harassment in the workplace[32]. This mentions that as part of the consideration of Kazakhstan's ratification of the International Labour Organization's Convention No. 190, the MLSP together with the UN Entity for Gender Equality and the Empowerment of Women "UN Women" conducted a study to examine the level and root causes of violence and sexual harassment in the workplace in Kazakhstan. A sociological survey was conducted with the participation of 1,340 women and 208 heads of organisations. Around 13% of women

[32] The website of Ministry of Labour and Social Protection: "MLSP prepared proposals to eradicate violence and harassment in the workplace", https://www.gov.kz/memleket/entities/enbek/press/news/details/483686?lang=ru

surveyed reported experiencing violence and harassment in the workplace and 10% of employers had received letters from abused women. No cases of physical violence were reported in the survey. The most frequent types of harassment/violence mentioned by survey participants were unpleasant touching, flirting, courtship, attempts to kiss (17%), inappropriate jokes about sexual topics (16%), comments and gestures of a sexual nature (16%).

According to two-thirds of the women surveyed, it is mainly supervisors who behave in this way. The remaining participants mentioned their colleagues and clients as offenders, which was confirmed by their employers. According to the latter, colleagues and clients are more likely to harass women, especially in small and medium-sized businesses, mainly in the service, catering, and trade sectors.

More than 80% of respondents suggested that the legislative prohibition of gender-based violence and harassment in the workplace and strengthening of legal protection for survivors would be useful.

According to its website, MLSP has – based on the above-mentioned survey – prepared proposals for additions and amendments to several legislative and regulatory acts aimed at eliminating violence and harassment in the workplace, including the Labour Law of Kazakhstan. However, according to the Women, Business and Law Index 2023, Kazakhstan has no legislation on sexual harassment in employment and there are no criminal penalties or civil remedies for sexual harassment in employment.

The prevalence of domestic violence is indicative for the Project risk related to gender-based violence and harassment. According to the Interior Ministry, the police annually receive more than 100,000 domestic violence complaints. The latest available data from 2017[33], shows a prevalence of lifetime physical and/or sexual intimate partner violence in Kazakhstan at 16.5%[34], physical and/or sexual intimate partner violence in the last 12 months at 4.7%[35], and lifetime non-partner sexual violence at 1.5%[36]. Under Kazakhstan's current laws, including the 2009 law on Prevention of Domestic Violence, domestic violence is not a stand-alone criminal offense. In September 2020, a draft law on Combating Domestic Violence, which would have strengthened protections for women survivors of family abuse, passed its first reading in parliament. However, in January 2021, it was withdrawn[37]. Intimate partner violence is generally prevalent across the region in part because of regressive gender norms, with many men and women finding that domestic violence is acceptable under certain circumstances, as indicated in Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) conducted in Central Asia countries, including Kazakhstan[38].

6.2.10 Residential areas and economic activities in vicinity of existing WWTP

The following are the closest residential areas to the WWTP.

Railway Junction 737

According to residents of Railway Junction 737, the settlement has approx. 34 families. Most residents used to work in the railway sector, but today people work in different fields. Children go to schools #10 and #84, which are located on the other side of railway. The shop, pharmacy and hospitals are also located on the other side of railway. Most residents have lived in the area for more than 10-15 years and are families

[33] UN Women Global Database on Violence against Women, based on data from the Statistics Committee of the Ministry of National Economy. 2017. Sample Survey on Violence Against Women in Kazakhstan. Astana, Kazakhstan: Statistics Committee of the Ministry of National Economy of Republic of Kazakhstan.
[34] Proportion of ever-partnered women aged 18-75 years experiencing intimate partner physical and/or sexual violence at least once in their lifetime.
[35] Proportion of ever-partnered women aged 18-75 years experiencing intimate partner physical and/or sexual violence in the last 12 months.
[36] Proportion of women aged 18–75 years experiencing sexual violence perpetrated by someone other than an intimate partner since age 15.
[37] Human Rights Watch, 2023. Revise draft laws to better protect women.
[38] World Bank, 2022. Reducing the prevalence of gender-based violence in Europe and Central Asia requires changing the norms that support it.

or pensioners. Distances taken from Google Earth indicate that the closest house is located approximately 530m east of the proposed new WWTP.

Further information about the settlement is included in the information from the focus group discussions (FGDs) in section 7.3 below.

Kir Zavod 3-4 settlement

According to residents of the settlement, about 324 people live here, including 64 children (under age 14), 31 pensioners, and 4 disabled people. People work in different fields in Karaganda city and have their own small garden to grow vegetables and fruits for themselves. Distances taken from Google Earth indicate that the closest house is located approximately 800 m of north side of the proposed new WWTP.

Further information about the settlements is included in the information from the FGDs in section 7.3 below.

Industries close to the WWTP

There are several industries located within a radius of 1-2 km from the existing and the proposed new WWTP. The table below lists these industries, their main production, and their distance to the site of the new WWTP.

Table 6.68: Industries located within a radius of 1-2 km from the new WWTP

Name of Industry	Main Production	Distance to New WWTP Area
IP “MetalWork”	Metalworking, providing services for the manufacture, repair, and processing of metal products (Source: metal-work.kz).	1 km east of the new WWTP area
Karaganda Boiler Plant LLP	Production of highly efficient automated long burning boilers (Source: kotlyzavod.kz).	1.3 km east of the new WWTP area
Kurylysmet LLP	A subsidiary of ArcelorMittal Temirtau JSC. Repair of mining and transport, electrical equipment. Production and repair of spare parts (Source: https://shymkent.hh.kz/employer/3805439).	1.4 km east of the new WWTP area.
Common Market Corporation	Transport company (Source: https://www.common.kz/main.php?mod=about-hist).	1.4 km east of the new WWTP area
Keratek brick factory	Production of ceramic bricks and ceramic stone (Source: http://www.fasad-optima.kz/kirpich-stroi-keratek.html).	2.2 km north-west of the new WWTP area
KarPlaz	Production of metal products, non-standard equipment (Source: https://kz.orgpage.ru/karaganda/karplaz-too-2631425.html).	1.3 km east of the new WWTP area

6.2.11 Land use

The new WWTP is planned to be constructed east of the existing WWTP, located partly within the existing WWTP site and partly within a 12.75 ha extension of the site towards the east from the existing site. The 12.75 ha land allocated to the new WWTP consist of two plots of land, a plot of 9.1555 ha with the cadastral number #09-142-176-057, and a plot of 3.8 ha with the cadastral number #09-142-176-058. Both land plots are state-owned land. According to the city Land Management Department the land is not under any lease agreement or informally used. The latter is in line with Sweco’s observation during the field visit in March 2023, where there were no indications of informal use of the two plots The Karaganda City Akimat issued Resolution No. 30/29 on 5 April 2023 to grant the Department of Housing and Communal Services, Passenger Transport and Highways of Karaganda City the right to use the land for #09-142-176-057, while a resolution is still pending for plot #09-142-176-058.

An overview of the land plot is provided in Figure 3-2 in section 3.1.

The overhead power lines to be relocated along the northern and eastern boundaries of the new WWTP site will be on state reserve land. The Feasibility Study (2023) proposes the introduction of underground cables. Further information about the relocation of the overhead power lines is included in section 3.3.5.

6.2.12 Cultural heritage

In June 2023, the Department of Housing and Communal Services, Passenger Transport and Highways of Karaganda city confirmed in a letter the absence of historical and cultural heritage of significance at the proposed location of a new WWTP (200 m east of the existing WWTP).

In July 2023, the Department of Culture, Archives, and Documentation of Karaganda Region provided a list of all the registered cultural heritage sites in Karaganda City, including their locations. According to this list, the cultural heritage closest to the proposed new WWTP site is the mass grave of 17 Soviet soldiers who died in hospitals in Karaganda between 1941-1945, located 5.2 km from the new WWTP site. The location of this monument is shown on the map below. Other registered cultural heritage sites are located in the city centre and in the north part of Karaganda City, i.e., further away from the proposed new WWTP. The absence of cultural heritage sites that are important to local residents was confirmed during FGDs undertaken in nearby communities. However, a resident of Kir-zavod 3-4 mentioned they are using a graveyard located approximately 150 meters west of current WWTP (see Figure 4-1, section 4.5.2)

Figure 6.41: Location of the mass grave of 17 Soviet soldiers and the new WWTP site. The red line indicates the distance between the monument and the new WWTP site.

Sources: Department of Culture, Archives, and Documentation of Karaganda Region and Google Earth

6.2.13 Schools, health clinics, and other social facilities in vicinity of the WWTP

The school located closest to the existing and proposed new WWTP is in the Bolshaya Mikhaylovka micro-district, whilst the closest medical centre is in Fedorovka micro-district. Both the school and the medical centre are located north-east of the new WWTP. The school is approximately 1.8 km and the medical centre approximately 3.8 km from the proposed new WWTP. The above distances are taken from Google Earth.

The Karaganda City Akimat has informed that the city has 105 (units) medical institutions, of which 82 are private (including 39 consultative and diagnostic polyclinics, 18 inpatient facilities, 14 polyclinics, 8 dental polyclinics, and 3 haemodialysis centres) and 23 are State-run (7 inpatient facilities, 6 polyclinics, 2 dispensaries, 2 sanatoria, 1 specialised emergency medical care centre, 1 blood centre, 1 dental polyclinic, 1 child care centre, and 2 others). There are 3,762 doctors and 6,667 paramedical staff working in medical entities in the city.

6.3 Media Search

This section summarises the findings of an online mass media search conducted in February 2023 for this ESIA.

6.3.1 Wastewater

In 2017-2019, several large newspapers including Tengrinews.kz , Inbusiness.kz, Zakon.kz, Novoetv.kz [1],[2],[3],[4] published articles about the foul odour emanating from Karaganda wastewater treatment facilities. The smell was particularly poignant for residents of Noviy Gorod, Mikhailovka, Bolshaya Mikhailovka station and Kir-zavod 1-2 district of Karaganda when the wind blew in a south-westerly direction. Karaganda Su (the company responsible for the WWTP) responded in these same media articles, stating that the smell comes from the settling tanks of the aeration station, where under the influence of climatic factors, a natural process of sludge oxidation and the release of hydrogen, sulphide, methane, and nitrogen results in an unpleasant smell. The company also noted that the foul smell worsened when the sludge beds were cleaned, especially when the wind speeds were high (10-15m/sec), which happens around 6% of the time and is thus a relatively frequent occurrence. Because replacement of the sludge beds' drainage system in 2017 did not lead to any improvement, the company avoided cleaning the sludge beds when the wind was blowing towards the residential area.

In 2019, after a wastewater collector collapsed under one of the streets, media outlets Astanatv.kz [5] and Novoetv.kz[6] started a discussion about sewage network renovation. They advocated for new methods of pipe replacement, which don't cause damage to the street surface. Through the media, Karaganda Su admitted that the city's sewage network had reached an 80% deterioration and required replacement, and that using the open trench method would cause major disruption and damage to streets surfaces. Directional drilling under the streets would not cause this disruption and would thus be the most optimal solution, but the cost could not be afforded by the Company. The inclusion of a directional drilling set in the next modernisation programme (KZT800 000 000) would solve this problem, but this would increase the tariffs significantly.

Breakages of the sewage network occur regularly. The last breakage in February 2023 resulted in sewage flowing into the Bukpa River that runs to the reservoir and is a favourite resting place for the city's residents [7]. This event instigated an unscheduled inspection of Karaganda Su by the Sanitary and Epidemiological Office. The Company responded, stating that the elimination of such breakages required a renovation of the whole network, which could cost as much as KZT100 000 000 000. Although Karaganda has the highest water tariffs in the country, they are not sufficient to maintain the sewage system. Between 2009-2018, the Company reconstructed 14% of the sewage networks; 61 km at its own expense of KZT1 900 000 000, and 20 km at a cost of KZT1 600 000 000, covered by the Government Budget. Nurly Zhol, a state programme, allocated KZT4 500 000 000 to repair another 18 km of networks. In addition, the company borrowed KZT12 000 000 000 from the state between 2013-2018. To account for this expenditure, the Company proposed setting up a public investigation commission.

In the Orbita district in 2020, new pumping units were installed in the sewage pumping stations SPS-1, located near the Stroiplastmass plant and the Orbita sewage pumping station[8]. The new pumping units reduced electricity consumption by 40% and 20%, respectively. In addition, the pump house and amenity

rooms were also given an overhaul. Modernisation of the pumping stations reduced costs and therefore made it possible to purchase diesel generators, which were installed at the pumping stations SPS-10 (Sortirovka district), SPS-1, SPS-Orbita and SPS-7. All sewage pumping stations have buried equipment.
Karaganda Su has implemented an investment programme within the framework of the approved tariff estimate, which includes a number of large-scale measures to modernise equipment and improve efficiency, and resulted in reduced losses in drinking water supply in 2021[9]. During the period 2016-2020, a total of KZT 7 151 100 000 was allocated to these investments. In 2020, investments in the totalling KZT 755 200 000 were disbursed. The Company has developed a new five-year investment programme for the years 2021-2025, which was approved for a total amount of KZT 8 325 359. The investments for 2021 amounted to KZT 469 420 and included the overhaul of water supply networks on B. Khmelnitsky Street and Respublika Avenue, which have already been completed. The investment programme for 2022 was approved to the amount of KZT 1 072 018, with the plan to overhaul 7 km of water supply networks and 2.8 km of sewer networks. In 2023, there are plans to overhaul 14.1 km of water supply networks, 2.5 km of sewer networks, as well as the replacement of stop valves at BOS-1. The investment program for 2024 is approved to the amount of KZT 2 237 138, whilst KZT 2 949 692 has been allocated for 2025. These projects will improve the quality of water and wastewater services for several thousand people in Karaganda[10].

6.3.2 Water

In 2013, inadequate chlorination of piped water resulted in many complaints about the colouring and bad smell of both hot and cold water. Water deterioration in summer was attributed to algae growth in the 470 km-long Satpayev Canal, which brings potable water from the Irtysh River intake near Pavlodar [11]. To improve the situation, Karaganda Su constructed a carbonisation shop in the water preparation plant at the end of the Satpayev Canal, at an expense of KZT 80 000 000. This cost was partially covered by the reduction in energy consumption that had resulted from the plant substation renovation which had cost KZT 331 800 000. In June 2022, a large algae blooming in the Canal caused another influx of complaints but no additional actions were taken by Karaganda Su[12].
Some complaints were received about the water quality when new pipes were constructed, or the old pipes repaired. The Company responded by requesting that residents call them directly and state their address, so that the company could identify which parts of the network were causing the problem and take appropriate action. [13]

7 STAKEHOLDERS AND CONSULTATION DURING THE ESIA

7.1 Local governance structure and key institutions

Karaganda City is part of Karaganda Region, and some of the departments under the Akimat of Karaganda Region play an important role in relation to this Project as explained further below.

Several departments under the Akimat of Karaganda City are key stakeholder for this Project. Karaganda Su, which is the proponent of this Project, is a limited liability company, with 51% municipal and 49% private ownership, and reports to the Karaganda City Akimat through the Department of Public Utilities, Passenger Transport and Highways of Karaganda.

Important state, regional and city departments for this Project include:

Table 7.1: Important regional and city departments and their roles in relation to this Project

State, Regional and City Departments	Role in relation to Project
State Departments	
Balkhash-Alakol Basin Inspection	Compliance with legislation, e.g., on approvals related to the Sokyr river and Bukpa river.
Bureau of National Statistics	Collecting and compiling statistics on, among others, population, and socio-economic aspects.
KazHydromet	Statistical information about air quality, data from Hydropost.
Karaganda City Police Department	Collecting information about, among others, traffic safety and accidents.
Akimat for Karaganda Region	
Energy and Communal Department of Karaganda Region	Compliance with legislation, e.g. on approvals.
Department of Natural Resources and Regulation of the Use of Natural Resources	Compliance with legislation, e.g. on approvals for MPC for atmosphere air.
Department of Culture, Archives and Documentation of Karaganda Region	Registering and listing cultural heritage, approval to build new WWTP.
Department of Land Relations	Compliance with legislation, e.g. on approvals.
Karaganda Region Department for Coordination of Employment and Social Programmes	Number of Ukrainian refugees
Akimat for Karaganda City	
Department of Public Utilities, Passenger Transport and Highways	KS, a 51% municipal-owned enterprise, reports to the Karaganda City Akimat through this department. Compliance with legislation, e.g. on approvals.
Land Management Department	Compliance with legislation, e.g. on approvals.
Department of Employment and Social Programmes of Karaganda city	Statistical number about different type of population
Internal Policy Department of Karaganda city	Collecting information about NGOs
Department of Architecture and Urban Planning of Karaganda city	General plan and projects of Karaganda City
Office of the Akim of the district of Kazybek bi of Karaganda city	The district where WWTP is located
Department of Land Relations	Compliance with legislation, e.g. on approvals
CSO/NGOs	
Ecocenter	Collecting information on environmental concerns
EcoMusey	Collecting information on environmental concerns

Karaganda City is divided into two districts: Kazybek bi District and Alikhan Bokeikhan District. The Akimats of the two districts, which are the lowest administrative level in Karaganda City, report to the Akimat of

Karaganda City. The responsibilities of the district Akimats include, among others, implementation of the state employment policy, assessment of the need for social assistance in accordance with local regulations and provision of support to low-income and large families, door-to-door public awareness raising in relation to health and social support. The two district Akimats are expected to support KS with organisation of public meeting(s) during the public disclosure of the ESIA package.

7.2 Community-level stakeholders

The table below lists community-level stakeholders, particularly those that live relatively close to the WWTP. Residents in Karaganda City more generally are also key stakeholders, as they will benefit from the improved wastewater treatment resulting from the Project.

Table 7.2: Community-level stakeholders in residential areas relatively close to the site of the proposed WWTP

Community-level stakeholders	Population	Distance to WWTP
Residents in the settlement of Railway Junction 737	34-40 families	530 m east of the new WWTP
Residents in Kir-zavod 3-4 settlement	324 persons	800 m north-west of the new WWTP
Residents on Proizvedstyannya street	1 person	505 m north of the WWTP
IP "MetalWork"		1 km east of the new WWTP area
Karaganda Boiler Plant LLP		1.3 km east of the new WWTP area
KarPlaz		1.3 km east of the new WWTP area
Kurylysmet LLP		1.4 km east of the new WWTP area.
Common Market Corporation		1.4 km east of the new WWTP area
Residents in Karaganda City		Other residents in Karaganda City than those mentioned above are located relatively far away from the WWTP.

7.3 Stakeholder meetings

7.3.1 Individual meetings with the households nearest to the WWTP

In March 2023, meetings were conducted with a total of 5 individuals living in houses located on Proizvodstvennaya Street, Petrovskogo Street and Railway Junction 737. Participants noted that most of the residents living in the area are elderly/retired people or families with children.

The main issue that was raised is the foul smell emanating from the WWTP, which, according to residents, worsens in the warmer months of the year. The smell is sometimes so bad that residents cannot open their windows to ventilate their houses or hang the clothes outside to dry, and parents try to dissuade their children from playing outside in the yard. One resident also complained that KS had ruined a street in the area whilst removing human waste and mentioned that manholes are sometimes left open by KS. The resident notes, however, that KS is usually quick to respond and fix the open manholes if complaints are made. Participants shared that most households in the area have connection to electricity, water, and sewerage services, but some families cannot afford water services and thus remain unconnected.

Overall, noise and vibrations from the WWTP does not seem to be a problem. Some residents reported hearing a continuous, whistle-like hum of around 2kHz on quiet nights, but this noise is dampened by the louder sounds of the nearby trains and railway.

7.3.2 Stakeholder meeting in March 2023 during the scoping phase

During the scoping phase of the ESIA, a meeting was conducted with the following stakeholders on 1 March 2023: Department of Natural Resources and Regulation of Use of Natural Resources, Department of Emergency Situations of Karaganda Region of the Ministry of Emergency Situations of the Republic of Kazakhstan, and KS.

The location of the new WWTP, odour prevention from the WWTP and green spaces around the WWTP were the main topics discussed during the meeting.

7.3.3 Focus group discussions in September 2023

Three focus group discussions (FGDs) were held in September with residents living relatively close to the existing WWTP, i.e., in Railway Junction 737 and Kir-zavod 3-4 village. The table below shows the characteristics of the participants in the three FGDs.

Table 7.3: Overview of FGDs

№	FGD participants	Description
1	FGD with 8 residents (2 women and 6 men) from Railway Junction 737.	Participants were from both low-income and middle-income households and included young women, men with children and elderly women, men. Participants lived relatively close to the creek/Sokyr river .
2	FGD with 11 residents (2 men and 9 women) from Kir-zavod 3-4.	Participants were from both low-income and middle-income households and included young men, women with children and elderly women, men. Participants lived relatively close to the creek / Sokyr river.
3	FGD with NGO and activists.	Participants were from Karaganda city Eco museum and activists.

Focus group discussion at the settlement of Railway Junction 737

FGDs were held with 6 men and 2 women at a resident's house in Junction 737. Staff from KS provided support in arranging the FGD.

Participants in the FGD explained that residents of the settlement grow vegetables (potatoes, carrots, onions, cucumbers, tomatoes, aubergine, pepper, etc.) on their garden plots for their own use and keep cattle, horses, sheep, goats, pigs, breed chicken, and geese. The residents do not use the river water for irrigation and do not use the land in or around the settlement for recreational purposes. According to FGD participants, there are no recreational areas near the river. The land near the WWTP is mainly used for cattle grazing by peasant and farming households. Many residents work in other parts of Karaganda City. There were reported to be no poor families in the settlement, but there are people with disabilities of different categories. There are different ethnic groups in the settlement. There are no shops, the closest shop is located on the other side of the railway. The new road was built in the summer 2023. Residents were concerned that logistics during construction period could destroy their new road.

The unpleasant smell from the existing WWTP was highlighted both by women and men in the FGD. They experience a strong smell, particularly between the spring and autumn and in windy weather. In these periods, they did not want to open their windows and their laundry had to be dried at home (meaning inside the house). They mentioned that they are mostly acclimatized to the smell, but it is uncomfortable to invite guests to the Junction. An elderly man mentioned he has headache because of the smell. Some residents have allergies, nausea, and dizziness. They mentioned that the smell from the WWTP had a negative impact on residents generally in the settlement and particularly on people with respiratory diseases and on children. Sick family members are mainly cared for by women. They do not have any desire to use sludge as fertilizer.

FGD participants expressed the hope that the construction and subsequent operation of the new WWTP would have the following main benefits for them:

- The unpleasant smell from the WWTP would disappear (most important)
- Residents in the settlement can get jobs during the construction of the new WWTP.

FGD participants emphasized that several people in their settlement would be interested in employment during the construction period. There are unemployed men and women in the settlement, who want to get jobs as drivers, handymen, mechanics, security guards, technicians, fitters etc.

There was not much interest in being consulted. It will be sufficient for them to know the general design of the project and the operation of the new WWTP. They were also keen to hear more about the construction timelines. They requested to be informed via telephone through the contact points.

FGD participants mentioned that they have received some information about the existing and the WWTP through the media. Other channels of communication in the settlement are through a community "WhatsApp" chat group, community activists. The FGD participants hoped to receive more information in the future via WhatsApp and via social media (Instagram, Facebook).

Focus group discussion at the settlement of Kir-zavod 3-4

One FGD was conducted with 9 women and 2 men at the Children's playground north of the settlement. Staff from the KS provided support in arranging the FGD.

FGD participants explained that mostly retired people live in the settlement. There are also some younger housewives, and some younger men who work in other parts of Karaganda City. Residents grow vegetables (potatoes, carrots, onions, cucumbers, tomatoes, aubergines, peppers, etc.) for their own use. The villagers do not use river water for irrigation and do not use the land in or around the settlement for recreational purposes. The land near the WWTP is mainly used for cattle grazing. There were reported to be no poor families in the settlement and no people with disabilities. Residents buy their goods in other parts of Karaganda City.

Participants complained that due to the constant, strong and unpleasant smell in the whole settlement, especially at night and in windy weather, it is impossible to open windows, and laundry must be dried inside the house. Furthermore, it is embarrassing for them to invite guests to their houses. It is very difficult for people with respiratory diseases, it is difficult for them to walk outside. The smell was also reported to have a negative impact on children. Sick family members are mainly cared for by women.

FGD participants hoped that the construction and subsequent operation of the new WWTP would be beneficial for them, including most importantly that the strong and unpleasant smell would disappear. Residents were concerned that during construction vehicles can go through the settlement, they showed strong desire that such vehicles should not use the road in the settlement.

Some residents in the small settlement were reported to be interested in employment during the construction of the new WWTP. There are unemployed men and women, who want to work as handymen and technicians. Most residents work in the city, and it takes more time for them to go to work and they would like to work near their houses.

Information about the operation of the existing WWTP and about the new WWTP is obtained through the media. Other communication channels are a general "WhatsApp" chat group in the settlement. There is also an individual/community activist who is contacted by residents (called "Minzilya"). Any meetings and other gatherings of residents are informed through her by phone. The FGD participants hoped to receive more information about the plans for the new WWTP through "WhatsApp", through social networks and through her.

Participants were interested in participating in consultations concerning the detailed design and the construction of the new WWTP and asked to be informed via Minzilya by phone. As there is no Public House, school, and other administrative buildings in the settlement, they request that any information should be hung in the local shop.

Focus group discussion with NGOs

One FGD was conducted with 2 women and 2 men online in Microsoft Teams. Participants said that many reports are received from activists and residents about leaks and spills near Karaganda Su and uncontrolled discharges into the Sokyr River, which are exceeding the norms and volume. Participants stated that they believe the odour is mainly related to the pig farm located 3.5-5km southwest and west from the residential areas. They do not have actual data about health problems of residents in the area.

Participants expressed interest in questions relating to actual construction, and whether a new WWTP will be built or the existing WWTP repaired so that capacity includes peak times and flood seasons. The conflicting information in the media was mentioned, with the internet stating the design capacity as 232,000 m^3/day, whereas the Karaganda Su website shows the actual capacity as 169,000 m^3/day, same as on the EBRD website. NGOs proposed to repair the old WWTP and build a new one nearby, to enhance the capacity. They requested information about the technical part of the project prior to the public hearing, such as the technology used for the WWTP, the advantages and disadvantages of location of the new WWTP (including why different location far from the current WWTP is not considered), the precise information about the capacity (including what this figure is based on and whether it covers flood and peak days), the difference between old and new technologies. They did not have information about the land, forest fund, or vulnerable people near the WWTP. They mentioned that people will be interested in employment during construction, and that they do not consider that sludge could be used as fertilizer. Participants emphasized that people need to be informed prior to the public hearing.

8 PROJECT IMPACTS AND OPPORTUNITIES FOR ENHANCEMENT

8.1 Physical and Natural Environment impacts

This section describes the positive and negative impacts that the proposed WWTP Project is assessed to have on the physical and natural environmental receptors described in the baseline section of this ESIA report, as well as key impacts related to energy consumption, supply chains and communal infrastructure.

The following table provides an overview of the receptors described in the baseline chapter and their assessed level of sensitivity in the context of the Project.

Table 8.1: Sensitivity of assessed receptors related to physical and natural environment

Receptor	Assessed sensitivity
Physical and natural environment	
Topography and landscape	Low to medium
Geology, geomorphology and soil	Low
Global climate – impacted by GHG emissions	Medium to high
Climate in Karaganda (past and predicted future) – relevant to project's climate resilience	Low (location's sensitivity to climate change impacts)
Surface and Groundwater	
Around the WWTP site	Low to medium
Bioponds and discharge channel to Sokyr	Low to medium
The Sokyr river	Medium
Ambient air quality	Medium to high
Ambient noise levels	Low
Biodiversity – Flora	Tentatively medium to high (subject to additional flora studies in spring 2024 to rule out the presence of specific protected ephemerals and ephemeroids species). In the absence of protected species, the sensitivity of flora habitats affected by the project is low.
Biodiversity – Fauna	
Terrestrial and avifauna	Medium
Sokyr river benthic fauna	Medium
Access road infrastructure	Low
Waste management infrastructure	Low to medium
Water supply infrastructure	Low
Energy supply infrastructure	Low

8.1.1 Impacts on landscape and topography (*incl.* visual impacts)

Pre-construction and Construction Phase activities

The construction phase of the proposed new WWTP will involve the following key site preparation activities affecting landscape and topography within the Project site:

- Excavations
- Trenching and backfilling
- Removing vegetation and topsoil to make space for buildings and other WWTP infrastructure
- Construction of WWTP infrastructure and associated administrative buildings
- Relocation of sections of the overhead transmission lines currently passing through the land plot for the new WWTP site and connection with the substation of the existing WWTP
- Decommissioning of the existing WWTP and sludge ponds.

The construction of the new WWTP will take place largely within the existing WWTP site, which is already affected by WWTP activities and infrastructure, and within a 12.75ha site extension to the east and south of the current WWTP. The 12.75ha can be considered a greenfield area, although it is already influenced by human activities and by the proximity to the WWTP.

In terms of the new 12.75ha area, the activities will change the appearance of the site from current greenfield to an industrial use site. In terms of visual impacts, this will bring WWTP facilities at most 80m further to the east in direction of the residential areas in Karaganda city.

Hence, the impact on topography and site appearance related to WWTP infrastructure is **direct, negative** and **long-term** but is **limited** to the new WWTP site which is an area of *approx.* 12.75ha directly adjacent to the current WWTP site.

With regards to relocation of overhead transmission lines (see section 3.3.5), the impact occurs outside the periphery of the WWTP site but is considered mostly positive as several existing 6 kV overhead transmission lines will be dismantled and instead inserted as underground cables, hence reducing the visual impacts.

Visual impacts are restricted to the surroundings from where the WWTP can be seen, which contains residential areas approximately 550m to the east from the proposed new WWTP structures, and approximately 1 km to the north-east. The residential area likely to be most affected by visual impacts of the new WWTP is the **Railway Junction 737,** where approx. 34-40 families live in 17-20 houses. The junction is located 530m to the east from the border of the new WWTP site (approx. 610m to the existing site). These residents clearly observe the existing WWTP from both the 1 and 2-floor houses. Other residential areas to the east are located behind the railway line and are mostly shielded from the WWTP by green belts which have been planted along the railway line.

The **magnitude of the impact on topography and landscape is considered low to medium,** with limited change in topography and loss of greenfield site characteristics that do not adversely affect the integrity of a significant area. The overall impact significance is a combination of sensitivity of the receptor and the impact magnitude (see section 4.6). Given the **low sensitivity** of the receptor, the **overall impact on landscape and topography is considered as being of minor negative significance**. The magnitude of the increased **visual impact** from bringing WWTP infrastructure 80m closer to residents in Railway Junction 737 is considered low to medium, and the overall impact significance is therefore assessed to be **moderate and negative.**

In terms of **decommissioning of the existing WWTP**, the plan is to dismantle most of the existing WWTP once the new WWTP has started operating (see chapter 3.53.5). However, some elements of the existing WWTP will be kept for use in emergency situations, such as the existing primary settlement tanks. As the existing WWTP infrastructure is mostly located behind the proposed new WWTP infrastructure, when seen from Karaganda City, the impacts from this, are considered negligible, yet positive.

In terms of the existing sludge pond area, which is almost 30ha, no plans have been presented relating to how these will be closed or rehabilitated. Hence, in parallel with detailed design of the WWTP**, it is required that a plan will be developed for the closing and rehabilitating the part of the existing sludge pond area** that is not needed for emergency purposes. This should reflect plans to, as a minimum, clean the area of existing sludge, and measures to rehabilitate the area to its original natural condition, as further outlined in the mitigations table below and as also included in the separate ESMP. Rehabilitation of the sludge pond area provides an opportunity to eliminate odour impacts from the existing site and to offset the negative landscape and land use impact of converting from the greenfield to an industrial use area for the new WWTP.

Operation and maintenance activities

The main Project impacts affecting landscape and topography occur during the construction phase and then remain unchanged during the operational phase, with exception of ongoing landscaping and maintenance of the site and surroundings, which are considered to have insignificant impacts.

Closure and Decommissioning

The impacts of future decommissioning of the proposed WWTP would have potential negative impacts like those identified for the construction activities in general, e.g., related to potential contamination of soil, surface water, groundwater, air, and noise impacts. Waste materials, in particular aggregates and scrap metal, should be managed to ensure maximal reuse or recycling at end of life in accordance with the waste hierarchy. All planned closure of facilities and infrastructure should be carried out appropriately to prevent the closed site from constituting a risk for humans and animals.

Mitigation measures

The following mitigation measures should be implemented and have been included in the ESMP to avoid and minimise the identified impacts on landscape, topography, including visual impacts.

Table 8.2: Mitigation measures related to landscape and topography.

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
Expansion of the WWTP site to the East	• Increased visual impacts experienced at the Railway Junction 737 residential area	• Detailed design of the WWTP to propose and design mitigation measures to reduce the visual impact of the WWTP as experienced by the Railway Junction 737 residents. The type of mitigation should be designed in consultation with the residents and may include the planting of a green belt along the border of the WWTP to shield the residents from a view of the WWTP infrastructure.
Excavation and levelling of the site	• Change in topography. • Change of site appearance from greenfield to industrial use. • Removal of topsoil and vegetation.	• Detail design and site layout and grading plan in a way that minimises earthwork and limits change to topography (pre-construction). • Separate excavated topsoil from other excavated material and store in a designated area for use in site rehabilitation of e.g., sludge pond area. • Create a buffer zone of native vegetation, trees, and shrubs around the WWTP. • Integrate landscaping and green spaces within the WWTP site, using native vegetation. • Implement thoughtful lighting design to reduce the visibility of the WWTP during night-time hours.
Construction of WWTP infrastructure	• Change of site appearance from greenfield to industrial use.	
Decommissioning of existing WWTP and sludge ponds	• Rehabilitation of parts of existing WWTP area and sludge ponds.	• Demolish and remove unsafe structures and dispose of demolition waste in a responsible manner. Clean the site of lose debris and solid waste / litter. • In collaboration with relevant authorities, develop a **plan for deconstructing or demolishing existing WWTP structures and for closing and rehabilitating the part of the existing sludge pond area** that is not required for emergency purposes. Plan activities in terms of cleaning, landscaping, and replanting native vegetation, and potential restoring of natural drainage patterns within the area. This plan should also reflect (but not be limited to): o Community safety arrangements. o Monitoring of surface water quality, geological and ground water conditions in the area affected by the sludge facilities.

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
		○ A system for drainage water disposal to treatment as long as needed, up to the time of the facilities conservation or remediation. ○ Develop conservation and remediation measures. ○ Provide regular progress reporting on the plan implementation to lenders and other key stakeholders.
Operation phase		
Ongoing site maintenance and landscaping	• Visual appearance of the WWTP site	• Maintain a buffer zone of native vegetation, trees, and shrubs around the WWTP as well as landscaping and green spaces within the WWTP site, using native vegetation.

Summary of residual impacts

The following table summarises the assessed pre-mitigation impacts, and residual impacts considering successful implementation of the above mitigation measures.

The overall impact significance of the **WWTP construction** related to landscape and topography as well as visual impacts following mitigation measures is considered **Negative – Negligible**. The impact of demolishing parts of the derelict structures of the existing WWTP and rehabilitating **the existing WWTP site and existing sludge pond area** is considered to have a **neutral to minor positive** landscape impact. Additional operation phase impacts are considered negligible.

Table 8.3: Summary of impacts on landscape and topography, pre-mitigation and residual (post-mitigation).

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Low (medium for visual impacts)**	
Pre-construction and construction		
Spatial extent	*Limited*	*Limited*
Duration	*Long-term*	*Long-term*
Magnitude of impact	*Medium*	*Low*
Overall impact significance	Minor - Negative (Existing WWTP site, transmission lines and sludge pond rehabilitation: Minor – Positive)	Negligible – Negative (Existing WWTP site, transmission lines and sludge pond rehabilitation: Minor – Positive)
Operation phase		
Spatial extent	*Limited*	*Limited*
Duration	*Long-term*	*Long-term*
Magnitude of impact	*Low*	*Low*
Overall impact significance	Negligible – Negative	Negligible – Negative

Summary of positive impacts and opportunities for environmental enhancement

Despite changes in the site appearance from greenfield to industrial in nature, the Project also comes with an opportunity to improve the appearance of the existing WWTP site by removing highly derelict infrastructure and rehabilitating parts of the existing sludge pond area, which would constitute a positive landscape impact and support biodiversity habitats. It also comes with the opportunity to further build staff capacity in good housekeeping and environmental protection, keeping a clean site without litter, with the aim to improve overall site appearance and wellbeing of workers.

8.1.2 Impacts on geology and soil

Pre-construction and Construction Phase activities

The excavation and land preparation activities affecting topography and landscape (discussed above) impact geology and soil in a similar manner. Also, removing vegetation exposes soil to potential erosion from both wind and rain. The excavation activities and land clearance for WWTP structures will change the appearance of the site extension adjacent to the current WWTP site from current greenfield to an industrial use.

The impacts on the local geomorphology and soils are direct and **long-term** although the geographic extent of the necessary pre-construction and construction activities is **limited** and restricted to the WWTP site itself and the periphery of the site where the overhead powerline masts will be relocated and underground cables installed.

Additionally, the following construction **activities** involve risks related to **contamination and/or disturbance of soil** and groundwater if not adequately managed:

- Excavations and ground disturbance
- Trenching and backfilling, such as for pipeline installations
- Removing vegetation and topsoil to make space for buildings and other WWTP infrastructure.
- Operation of vehicles and machinery
- Haulage activities
- Material handling
- On-site fuel and chemical storage
- Construction equipment maintenance within the construction site
- Generation of solid waste (construction waste, worker household waste and hazardous waste)
- Decommissioning of existing WWTP and rehabilitation of sludge ponds
- Risk of unplanned events and natural disasters, which in turn can increase the risk of spillages of oils, chemicals, sludge, etc.

These construction activities involve the on-site storage and use of diesel fuelled heavy vehicles, associated use of oils and lubricants as well as various building materials and chemicals, paints etc. If accidentally released into the environment, these chemicals can affect soil quality and biology, and potential groundwater quality (impacts discussed in a separate section below) if released in sufficiently large quantities. Such accidental impacts would be **direct** and the likelihood of them occurring is **possible to likely.** In terms of **magnitude**, the impact can be low to high depending on the scope of accidental chemical release. That said, it is considered unlikely that large quantities of fuel or chemicals will be stored on site, given the proximity to Karaganda City where majority of vehicles can be fuelled and serviced. The duration of the risk is **medium-term**, during the full construction phase, and the geographic extent of potential soil contamination would be **limited** to the point of release within the WWTP site itself or local if occurring during transport activities to and from the site.

Additionally, removing vegetation exposes soil to erosion from wind and rain, hence calling for **careful soil erosion and sediment runoff planning and control** throughout the construction phase.

Overall, the **impact magnitude** of the listed activities on geology and soil is determined as **medium and negative**. Given the low sensitivity of the receptor, the un-mitigated **overall impact is considered of minor significance**.

In terms of **decommissioning of the existing WWTP**, as discussed in previous sections, the plan is to demolish and remove most of the exiting WWTP structures and keep components such as the primary sedimentations tanks, which can be used for emergency purposes in case of issues with the new WWTP. Building **demolition activities** are associated with risk of contamination of nearby soil if chemicals and other contaminants from debris and other demolished parts are released into the environment, hence requiring careful demolition management (see mitigation measures below).

No plans have been provided for rehabilitation of the sludge pond area. As also reflected the previous section, **a plan must be developed for cleaning, closing, and rehabilitating the area** to avoid the risk of future contamination of soil and water resources in the area. **Sludge bed closure and rehabilitation** may in the short term involve ground disturbance and alteration of the current topography but is considered **positive in the medium and long term** as land will be brought to its original state.

Operation and maintenance activities

In particular the following WWTP operation and maintenance activities can result in contamination of soil and the underlying geological substructures.

- Haulage activities (transport to and from the site)
- Ongoing landscaping and ground disturbance
- Pipeline installation and maintenance
- Chemical storage and handling
- Stormwater management
- Effluent Discharge
- Sludge management

The Plant operation will involve some ongoing **heavy transport activities** to and from the site, including the transport of chemicals used in the WWTP process and transport of treated sludge for application on nearby fields and/or for long term storage, entailing the risk of accidental spillages from vehicles.

While **ongoing landscaping and site maintenance** may result in ground disturbance, the scope of this activity is considered minimal and the **impact negligible**. Similarly, pipeline maintenance may require excavations within the WWTP site and around incoming pipelines, although the extent of this impact will be limited to the pipeline trench within the WWTP site, which is an area that has already been impacted.

Chemical storage and handling is an aspect that requires careful consideration and management to avoid accidental spillages into soils within or during transport to the WWTP site. Main chemicals may include coagulants used in the WWTP process, oils and lubricants used for machinery, and paints and other chemicals used for maintenance of facilities with the site.

Sludge management is a key aspect of WWTP operations and a potentially important cause of soil, surface, and groundwater contamination if not properly managed. The new WWTP will include anaerobic digestion to stabilise the raw sludge coming from the WWTP and abolish the use of the current sludge ponds to stabilise and dry the sludge. This will have a **positive impact in terms of reduced risk of soil and water contamination** compared to the current situation and will furthermore reduce the release of GHGs from the WWTP. The proposed sludge management and associated impacts related to sludge management are discussed in more detail in the section on surface and groundwater below, and in the section on climate impacts.

Application of poorly treated **WW effluents** and/or sludge on land, e.g., for irrigation and fertilizer, can negatively impact soil quality and its fertility, for example through accumulation of salts or pollutants in the soil. The current WWTP effluent quality is not suitable for use for irrigation due to its inadequate quality, whereas the new WWTP will treat effluents to highest standards, making it suitable for irrigation purposes. This issue of effluent and sludge quality is discussed in more detail in the section on surface and groundwater impacts below, and in a dedicated section on opportunities related to sludge and effluent reuse.

Additionally, **adequate stormwater management** within the WWTP site is important to prevent soil erosion and to avoid the uncontrolled release of potentially contaminated stormwater into the environment, soil, or water courses.

Overall, the routine operation phase activities and accidental incidents can lead to impacts on soil and geology that are **direct** and the likelihood of them occurring is **high** in the absence of robust mitigation and management measures. In terms of magnitude, the **impact is medium to high** depending on the quantity of accidental chemical release. The duration of the risk is **long-term**, during the full operation phase although impacts (if they materialise) may be short-term, and the spatial extent of potential soil contamination could be either **limited**, with regards to spillages within the WWTP site, but could be **local to regional** in cases where contaminated sludge and/or effluents were applied to land outside the WWTP area. As reflected in the baseline section, historic sludge does not contain heavy metals exceeding EU sludge directive standards, hence the risk of soil contamination from sludge application is limited. Nonetheless, this would need ongoing monitoring. In an un-mitigated scenario, the overall magnitude of soil impacts is considered medium, resulting in an **overall impact of moderate negative significance,** i.e., if left unmitigated or poorly managed.

Closure and Decommissioning activities

The negative impacts that may occur during decommissioning of the new WWTP are similar to those identified for the construction activities in general, e.g., relating to the potential contamination of soil, surface water, groundwater resources, ambient air, and noise impacts. Waste materials, in particular aggregates and scrap metal, should be managed to ensure maximal reuse or recycling at end of life in accordance with the waste hierarchy. Any planned closure of facilities and infrastructure should be carried out appropriately to prevent the closed site constituting a risk for humans and animals.

Mitigation measures

The following mitigation measures should be implemented and have been included in the ESMP to avoid and minimise the identified impacts on soil and geology with focus on reducing soil contamination.

Table 8.4: Mitigation measures related to soil and geology.

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
Excavations, trenching and backfilling. Stormwater management	• Ground and soil disturbance. • Vegetation removal and associated risk of soil erosion.	• Implement controlled excavation practices to minimise soil disturbance. • Separate excavated topsoil from other excavated material and store in a designated area for reuse. • Careful management of excavated materials to reduce wash out. • Develop and implement an **erosion and sediment control plan** with measures to prevent soil erosion and sediment runoff during construction and operation. This can involve techniques such as installing silt fences, sediment basins, or sediment traps, as well as implementing proper stormwater management practices.
Operation of vehicles and machinery, incl. haulage activities	• Risk of spillages of contaminants from vehicles, oils, etc. affecting soil quality.	• Implement spill prevention and control measures. • Include spillage reaction and clean-up procedures in **emergency plans** and train relevant staff in their use.

Activity	Impact or risk	Mitigation measures
Material handling and on-site fuel and chemical storage	• Risk of spillages of contaminants from chemical handling and storage on site.	• Minimise the on-site storage of fuel on site. Above ground storage tanks to be located on impermeable and bunded surface with appropriate oil traps installed. • Only store chemicals in dedicated storage areas with adequate bunding to prevent release to external environment. • Staff handling chemicals should receive appropriate training to avoid and react to potential spillages. • Include spillage reaction and clean-up procedures in emergency plans and train relevant staff in their use.
Construction equipment maintenance and cleaning within the construction site	• Risk of spillages of contaminants from construction vehicles and other machinery.	• Endeavour to service equipment off-site at dedicated service points. When servicing needs to take place on site, only do this on impermeable and bunded surface with appropriate oil traps installed.
Generation of solid waste (construction waste, worker household waste and hazardous waste)	• Potential release of solid and hazardous waste streams into the environment, negatively affecting soils and ecosystems.	• Solid and hazardous waste generated shall be collected at dedicated collection points within the construction site and stored in closed containers. • Waste sorting to prioritise reuse and recycling in line with what options are available locally. • Provide staff training (including to contractors) focusing on eliminating littering and to follow waste sorting and collection procedures. • Conduct regular cleaning of litter within the site in line with good housekeeping.
Decommissioning of existing WWTP and sludge ponds, and rehabilitation of sludge ponds	• Potential release of contaminants from demolition activities and/or from rehabilitation of sludge ponds.	• Conduct pre-demolition audits prior to commencing any demolition activities to identify any potential contaminants such as asbestos, PCBs, lead based paints, fuels, solvents, cleaning agents, heavy metals, etc. Remove these contaminants prior to further demolition. • Construction debris which cannot be safely reused or recycled on-site is to be removed immediately from the site and disposed of in an appropriate manner according to local regulations. Temporary storage only on impermeable areas without to avoid the risk of leaching into nearby soils. • Karaganda Su to develop a **plan for decommissioning and rehabilitation of the sludge pond area**, including amongst other: • Sludge ponds to be emptied of sludge and cleaned prior to being filled and covered with top-soil and revegetated. • Any potential plastic lining in the sludge ponds to be removed prior to rehabilitation of the land.
Operation phase		

Activity	Impact or risk	Mitigation measures
Transport activities	• Risk of spillages of contaminants from vehicles, oils, etc. affecting soil quality.	• Implement spill prevention and control measures. • Include spillage reaction and clean-up procedures in emergency plans and train relevant staff in their use. • Minimise vehicle maintenance and refuelling on site.
Ongoing landscaping Pipeline installation and maintenance involving excavations	• Ground and soil disturbance	• Implement controlled excavation practices to minimise soil disturbance. • Separate excavated topsoil from other excavated material and store in a designated area for reuse.
Chemical storage and handling	• Risk of accidental spills into soils	• Minimise the on-site storage of fuel on site. Above ground storage tanks to be located on impermeable and bunded surface with appropriate oil traps installed. • Only store chemicals in dedicated storage areas with adequate bunding to prevent release to external environment. • Staff handling chemicals should receive appropriate training to avoid and react to potential spillages. • Include spillage reaction and clean-up procedures in emergency plans and train relevant staff in their use.
Stormwater management	• Inappropriate stormwater management can result in contaminants from the WWTP site entering nearby soil.	• Develop and implement an **erosion and sediment control plan** with measures to prevent soil erosion and sediment runoff during construction and operation. This can involve techniques such as installing silt fences, sediment basins, or sediment traps, as well as implementing proper stormwater management practices.
Effluent Discharge	• Effluents of poor quality can negatively affect soil quality if applied on fields etc.	• **Monitor effluent quality** to ensure that strict standards are met applicable for effluent reuse (see section below on surface and groundwater impacts)
Treated sludge management (storage and application on fields)	• Sludge containing contaminants can negatively affect soil quality where it is stored, and/or where it is applied on land as fertilizer.	• **Monitor sludge quality** to ensure that strict standards (incl. EU standards) are met with regards to potential reuse of AD digested and dried sludge for agricultural purposes (see further discussion in section below on surface and groundwater impacts)

As a general measure, Karaganda Su and its contractors should maintain a registry of all environmental incidents and accidents, their causes and how they were dealt with, to inform continuous improvement efforts.

Summary of residual impacts

The overall impacts related to soil and geology mainly relate to risk of soil contamination from construction and operation phase activities. The risk of such impacts materialising can be effectively minimised with proper mitigation, management, and monitoring measures as outlined above.

The following table summarises the assessed pre-mitigation impacts, and residual impacts considering successful implementation of the above mitigation measures.

Table 8.5: Summary of impacts on soil and geology, pre-mitigation and residual (post-mitigation).

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Low**	
Pre-construction and construction		
Spatial extent	*Limited to local*	*Limited to local*
Duration	*Medium term risk (short-term impacts)*	*Medium term risk (short-term impacts)*
Magnitude of impact	*Medium – negative*	*Low - negative*
Overall impact significance	Minor – Negative	Negligible – Negative
Operation phase		
Spatial extent	*Limited to local*	*Limited to local*
Duration	*Long term risk (short to long term impacts if materialised)*	*Long term risk (short term impacts if materialised)*
Magnitude of impact	*Medium*	*Low*
Overall impact significance	Moderate - negative	Negligible - negative

8.1.3 Impacts on **climate and climate change aspects**

The impacts related to climate and climate change are assessed from two perspectives:

- The **impact the project will have on climate and climate change**, in the form of GHG emissions,
- The potential climate related **impacts on the Project and its resilience** to climate change risks.

GHG impacts the project will have on climate and climate change

During the **construction phase**, the use of construction machinery and heavy vehicles will result in direct CO_2 emissions. These have not been quantified but are expected to be relatively insignificant in the context of the overall Project.

The construction of the WWTP also requires substantial amounts of building materials, including concrete and steel, which come with embodied GHG emissions associated with the production of the materials and components needed. The embodied carbon in building materials has not been assessed for this Project. However, a lifecycle assessment (LCA) study for Wastewater systems presented in the journal Nature[39] gives an indication of the order of magnitude carbon footprint at the different lifecycle stages of a central wastewater treatment plant, including the construction vs. the operational stages, as reflected in the following figure. Although not specific to this Project, the study indicates that the lifecycle construction stage related GHG footprint of a central wastewater treatment plant is 752 kg CO_2e/FU (FU: functional unit, which is 1 PE, assumed life cycle of the system: 30 years), which is equivalent to roughly half of the use stage footprint, which can be seen as significant. Assuming this ratio applies to the Karaganda WWTP, and assuming the estimated use stage emissions of 24,700 tons CO_2e/year (discussed below) and a lifespan of 30 years, the embodied construction related footprint could be in the order of magnitude 370,000 tons CO_2e, or approx. 12,300 tons CO_2e /year. (Calculating based on the approx. 500,000 PE capacity and 752 kg CO_2eq/PE, gives a similar result of close to 376,000 tons CO_2e over the assumed design lifetime of 30 years.) A longer WWTP lifespan than 30 years would result in relatively lower annual embodied emissions. It is important to note that these estimates are not specific to the Karaganda project in relation to the construction context, and variations from project to project can be expected. Hence, the estimate should

[39] Model of Carbon Footprint Assessment for the Life Cycle of the System of Wastewater Collection, Transport and Treatment | Scientific Reports (nature.com)

only be taken as a crude indication of the possible order of magnitude, in the absence of a project specific carbon footprint assessment.

From: Model of Carbon Footprint Assessment for the Life Cycle of the System of Wastewater Collection, Transport and Treatment

Element of system	Unit	Construction stage	Use stage	End-of-life stage	All stages, total
Septic tanks	kg CO_2 eq/FU	440.[illegible]	[illegible]	[illegible]	[illegible]
Household wastewater treatment plants	kg CO_2 eq/FU	292.77	[illegible]	[illegible]	540.46
Sewerage systems	kg CO_2 eq/FU	308.[illegible]	182.64	−24.05	466.[illegible]
Central wastewater treatment plant	kg CO_2 eq/FU	752.22	1 373.91	−395.78	1 730.05
				Total	3 280.62

Figure 8.1 Results of comparative analysis LCA of the system of wastewater collection, transport and treatment. The results for a central wastewater treatment plant are highlighted) Carbon footprint is provided per functional unit (FU) which is 1 PE. (Source: Table 9 Results of comparative analysis LCA of the system of wastewater collection, transport and treatment. (nature.com))

In line with good practice and green building principles, and as included in the ESMP, a project specific carbon footprint assessment should be conducted based on the treatment plant's detailed design, including an assessment of the carbon embodied in the building materials and remaining lifecycle stages. The outcome can be used to inform design initiatives to further bring down the GHG footprint of the overall project.

During the ESIA site visit, it was noted that some elements of the existing WWTP have been recently acquired, such as one of the sedimentation tank scrapers (see picture on the front page). Hence, the ESMP includes an action to conduct an early pre-demolition audit (to feed into the detailed design and procurement process) with the aim to identify and create an inventory of existing WWTP components which could be incorporated into the detailed design of the new WWTP and then reused, reducing the need for new procurements, lowering costs and carbon footprint. This could include more recently acquired elements such as newer primary and/or secondary sedimentation tank scrapers.

The majority GHG impacts of the WWTP Project relate to the **operation phase** and are related to the following activities:

- GHG emissions from the **WWTP process** and associated sludge handling.
- **Electricity consumption** for operating the WWTP.
- **On-site generation of electricity (and heat**) that compensates for external energy demand, e.g., related to the anaerobic digestion and biogas generation.

The proposed WWTP will include anaerobic digestion of the sludge. The intention is to utilise the digested sludge for agriculture, although a detailed plan for that process is yet to be finalised.

The following approximate gross electrical energy consumption estimate has been provided for the WWTP by Aquarem (2023):

- Total electricity consumption of the WWTP of approx. **16.9 million kWh/year, of which:**
    - **Electricity consumption of the WWT lines is**: 38460 kWh/day, equivalent to 14 million kWh/year (assuming operation for 365 days)

- **Electricity consumption of the AD / biogas plant**: 7990 kWh/day, equivalent to 2.9 million kWh/year.

The above gross power consumption estimate of 16.9 million kWh/year for the proposed plant is similar or slightly higher than the electricity consumption of the existing WWTP, which has been reported as *approx.* 15.6 million kWh/year in 2022 and in the range of 15 million kW/year in the years 2017-2019 (Source: KS). Despite modern and presumably more efficient equipment, it appears reasonable that the gross power consumption will increase somewhat as the new WWTP will have more features, including dewatering, drying and AD process, which are not part of the existing WWTP. Also, 16.9 million kWh/year is equivalent to approximately 33.8 kWh/PE/year, which appears consistent with energy benchmarks for large WWTPs of >100,000 m^3/day capacity, many of which range from approx. 25-45 kWh/PE/year[40].

Electricity from the on-site biogas CHP can be used to reduce the demand for grid electricity for meeting the gross electricity consumption. Aquarem (FS, 2023) provided the following breakdown of the energy output from the CHP generation from biogas:

- Quantity of produced biogas: 21991 m^3/day.
- Quantity of energy emitted by combustion in co-generators, including 131 949,52 kWh/day
  - thermal energy: 65,974.76 kWh/day
  - electric energy: 50,140.82 kWh/day (equivalent to 18.3 million kWh/year)

Based on the abovementioned estimates from Aquarem, the WWTP could cover all its electricity demand by on-site generation from biogas, rendering it carbon neutral in terms of scope 2 emissions.

It has not been possible for Sweco to verify the above estimations from Aquarem, however, and the underlying assumptions are not known. It appears that that the estimates for biogas generation may be in the higher end, and consequently also the estimated energy output. Aquarem has indicated in a separate correspondence that the estimated electricity savings from the AD generated electricity are 44%, without providing the underlying assumptions, which would equal savings of approx. 7,436,000 kWh/year (44% of 16.9 million kWh).

Previous Sweco estimates for the AD output (Sweco FS, 2021) were more conservative and only based on sludge from the primary tanks as inputs to the digester and excluding the volumes of activated sludge from the secondary settlement tanks (secondary sludge is less efficient than primary sludge for biogas generation). The Sweco estimate gave 3.5 million kWh/year electricity from 4266 m^3 biogas/day. Adding contribution of secondary sludge to the estimation, results in the following:

- Total energy production of 66,888 kWh/day from 10,290 m^3/day biogas. Resulting in:
  - Electrical power production of: 23,405 kWh/day or 7,688,543 kWh/year (at 35% generator efficiency and 90% operational time).
  - Heat energy production of: 26,753 kWh/day or 8,788,360 kWh/year (at 40% generator efficiency and 90% operational time).

The above estimation indicates a power generation potential of a similar order of magnitude as the Aquarem 44% electricity savings estimate.

Hence, to estimate the potential Scope 2 GHG emissions (from purchased electricity) associated with the project, the following assumptions have been applied):

- Estimated WWT gross electricity consumption of 16.9 million kWh/year (as indicated above).
- Contribution of 7.688 million kWh/year electricity from the AD as estimated above.

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[40] See for example a study of 200 Italian WWTPs, indicating a range between approx. 24-44 kWh/PE/year (in 25th to 75th quartiles respectively, mean of 36.7 kWh/PE/year for large WWTPs. Source: Benchmarking of energy consumption in municipal wastewater treatment plants – a survey of over 200 plants in Italy | Water Science & Technology | IWA Publishing (iwaponline.com)

Table 8.6: On-site energy generation and consumption associated with the WWTP and AD. The AD generation assumptions are based on Sweco's estimation (Feasibility study, 2021) whereas the estimated power consumption is based on information from Aquarem.

Parameter	2027 (PIP+2y)
Population serviced by WWTP	500,000 persons
WWTP influent (m^3/day)	100,000
Primary sludge flowrate to AD (m^3/day)	312
Secondary sludge flowrate to AD (m^3/day)	225
Biogas generated (m^3/day)	10290
AD CHP electricity generated (kWh/year) (operational 90% of the year)	7,688,690
Net WWTP grid energy consumption (kWh/year) taking into account on-site biogas/CPH generation	9,211,310
Gross electricity consumption (kWh/year) (before subtracting power from biogas)	16,900,000

With regards to the scope 1 emissions from the WWTP process, the GHG comparison uses emission factors for carbon footprint of wastewater processes, based on EIB's carbon footprint methodologies[41] assuming:

- **Current WW process**: Secondary treatment without anaerobic digestion of sludge. Sludge disposal: Land use without further treatment
- **Proposed WW process**: Tertiary treatment (nitrogen, phosphorus removal) with anaerobic digestion. Sludge disposal: Land use without further treatment.

The GHG estimation is provided in the following table. It reflects the WWTP only, and excludes improvements in WW pumping stations, which are included in Sweco's Feasibility study (2021).

[41] EIB Project Carbon Footprint Methodologies. Methodologies for the assessment of project greenhouse gas emissions and emission variations. V.11.3. January 2023 (Annex 6)

CO2 emissions reduced		Baseline (2022)	Projected after implementation completion*	Units
Scope 1 emissions from wastewater processes				
	Population	500,000	500,000	Estimated number of people served (2027)
	PE	455,250	455,250	average flowrate per day * BOD concentration /60g per capita.day
	Emission factor for Carbon footprint wastewater treatment (CFWW)**	0.014[a]	0.01[b]	a. Secondary treatment without anaerobic digestion of sludge b. Tertiary treatment (nitrogen, phosphorus removal) with anaerobic digestion
	Emission factor for Carbon footprint sludge disposal (CFSD)**	0.075[a]	0.034[b]	a. Sludge disposal: Land use without further treatment b. Sludge disposal: Land use without further treatment
	Scope 1 emissions from WW processes	40,050	19,800	tons CO2e/yr
Scope 2 emissions from power generation for project components				
	WWTP power consumption	15,600	16,900	MWh/yr
	WW collection power consumption	0	0	MWh/yr (not included in the ESIA scope)
	AD Biogas CHP electricity generated	-	7,689	MWh/yr
	Combined net consumption for WW services	15,600	9,211	MWh/yr
	Electricity grid emission factor***	0.532	0.532	tons CO2/MWh
	Scope 2 emissions from power generation	8,299	4,900	tons CO2e/yr
Total CO2e				
	Scope 1 + Scope 2	48,349	24,700	tons CO2e/yr
Difference in CO2e due to PIP			**23,649**	**tons CO2e/yr**

* Two years after full disbursement of loan (2027)
** EIB Project Carbon Footprint Methodologies. Methodologies for the assessment of project greenhouse gas emissions and emission variations. V.11.3. January 2023 (Annex 6)
*** Grid emission factors for economies in the EBRD regions (Grid+emission+factors_2022 1.pdf)

Figure 8.2: Estimated GHG emissions from the WWTP and improvements compared to the current situation, based on assumptions from Sweco's previous feasibility study (2021) and estimated power consumption for the WWTP based on Aquarem (FS, 2023)

The above estimations and assumptions, indicate that the scope 1 and 2 GHG emissions associated with the project will be **approximately 24,700 tons CO_2e/year, a reduction of 23,649 tons CO_2e/year** compared to the current emissions of 43,349 tons CO_2e/year, a reduction of almost 50%.

The above calculations are assuming no leakages of biogas from the AD facility. However, it is noted that leakages of biogas (which is a potent GHG gas) from AD facilities can significantly undermine and remove the GHG benefits of the AD process, and in worst case turn them into net-emitters of GHGs. Therefore, it is essential that KS adopts and implements strict procedures to control and mitigate potential gas leakages from the facility.

The significance of the climate emission impacts (construction and operational phases) has been assessed following the ESIA methodology described in chapter 4.6. Based on this, impact significance is a function of sensitivity of the receiving environment and the scale of impact magnitude. Further to this, the impact magnitude is a function of several factors, including intensity and direction of change, spatial extent and duration of the impact.

In the context of GHG emissions, the receiving environment is the global climate system, which sensitivity overall can be seen as high due to global warming/climate change, with limited ability to absorb increased GHG emissions. In terms of vulnerabilities of human receptors to climate change in the regional to local context of Karaganda, the sensitivity can be seen as being somewhat lower, as Karaganda as such is not assessed to be highly exposed to the impacts of climate change (e.g., flooding, water stress and droughts) (refer to discussion in chapter 6.1.5). Nonetheless, in the context of the impact assessment, the **receptor sensitivity is considered high** as the impacts of climate change are felt globally.

In terms of direction of change, the following is found to apply:

- Construction related climate emissions are a **negative** impact as these are additional (increase) in emissions compared to the baseline, which (for the most part, as renovation also results in some emissions) would not occur in the absence of the project.

- Operational related climate impacts (although negative as such) are **positive** compared to the current (baseline) situation, as the operational GHG emissions from the proposed project will be lower than from the existing WWTP, which would continue to operate in the baseline (do nothing) scenario.
- As the operational emission reductions are higher than the (crudely estimated) construction related emissions on an annual basis, the **overall net impact is considered positive**.

In terms of magnitude of the impact (prior to mitigation), the following factors have also been considered:

- The estimated emission levels in the context of national or regional levels:
  - The project emission levels have been assessed crudely as 12,000 CO_2/year[42] embodied in the WWTP construction and as 24,700 tons CO_2/year from operations, resulting in a relatively substantial reduction of 23,649 tons CO_2e/year. This would constitute a net positive lifecycle impact of approx. 11,650 tons CO_2e/year reduction.

  - At the national level, the annual GHG emissions of Kazakhstan were 271 million tonnes CO_2e in 2022[43]. In this context, the level of WWTP related emissions (and reduction) can be considered of low significance.

  - At the local/regional level of Karaganda, no official data could be identified. However, anecdotal information based on dialogue with local experts, indicate this may be of an order of magnitude 4-5 million tonnes/year. In this context the emissions and net reduction can be considered of low significance.

- Emissions relative to industry benchmarks:
  - Construction related impacts (scope 3): Unmitigated, we would expect similar impacts as for similar WWTP construction projects in the local context (not better nor worse). However, with the required mitigation measures outlined below, these impacts could be lowered further by applying measures based on circular economy principles, which can also be cost saving.
  - Operational emissions (Scope 1 and 2): We find the current design (Aquarem, 2023) to be in line with what could be expected from other modern similar sized WWTPs equipped with AD in the national context, which is a relatively substantial improvement from the current situation. However, in the absence of systemic mitigation and management, there is a risk that some of these benefits would be lost (e.g. in case of methane leakages).

Based on the above, the following GHG emission related impact significance levels have been assigned, in the absence of mitigation measures:

- **Construction phase**: **Overall negative impacts of moderate to major significance**. This is based on high sensitivity of receptor and low to moderate magnitude of emissions, which are low in the national context and somewhat higher (although arguably still low) in the regional/city context. The duration of emissions is prior to (supply chain related) and during the construction phase (although the impacts are longer lasting). The WWTP design is in line with modern WWTP of similar type but does not consider green building principles nor does it make efforts to reuse existing WWTP components to the extent possible.
- **Operational phase: Overall positive impacts of moderate to major significance.** This is based on high sensitivity of the receptor and low to moderate magnitude of emission reductions as compared to the national and local/regional emission levels, which however are long-term.
- **Overall net impacts:** For the project as a whole (construction and operation), the impacts on climate change are considered positive and of moderate to major significance. This is considering that

[42] The construction related emissions have been crudely estimated based on factors in academic LCA literature, assuming a WWTP lifespan of 30 years. Hence, this could be considered a conservative estimate, e.g. where longer lifespans would mean lower annual emissions. The lifecycle GHG emissions from the Karaganda WWTP should be assessed during the detailed design stage to further inform design measures aiming to minimise the GHG footprint of the project.
[43] Kazakhstan: CO2 Country Profile - Our World in Data

operational emission reductions substantially exceed the increase in emissions associated with the WWTP construction (mindful of the limitations of the construction stage assessment as discussed above). Efforts to lower the construction related GHG footprint at the detailed design stage, including design for durability etc., will further increase the positive net impact.

In light of the above impacts, steps should be taken to explore options to reduce the embodied carbon footprint associated with construction through green design measures. This also underlines the general value of extending lifetime of built WWTP structures, when possible, rather than building entirely new ones. The option of renovating parts of the existing WWTP has been suggested, but has not been considered in detail or pursued further as discussed in chapter 3.73.7 on project alternatives. In line with good practice and green building principles, and to get a comprehensive view of the overall GHG emission of the project over its lifecycle, a project specific carbon footprint assessment should be conducted as part of the treatment plant's detailed design, including an assessment of the carbon embodied in the building materials and the use stage. The outcome should be used to inform design initiatives to further bring down the GHG footprint of the overall project. The required mitigation measures are outlined below.

Mitigation measures related to GHG emissions

The following mitigation measures should be implemented and have been included in the ESMP to minimise GHG emissions **related to detailed design (pre-construction) and operation** of the proposed WWTP project.

Table 8.7: Mitigation measures related to GHG emissions

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
Selective deconstruction of existing WWTP	• Enable reuse of existing components to reduce overall carbon footprint (scope 3)	• Conduct an early pre-demolition audit (to feed into the detailed design and procurement process) with the aim to identify and create an inventory of existing WWTP components which could be incorporated into the detailed design of the new WWTP and then reused. This could include more recently acquired elements such as newer primary and/or secondary sedimentation tank scrapers.
Detailed design of WWTP process (pre-construction)	• Energy consumption and associated GHG emissions	• Incorporate energy-efficient design principles into the treatment plant layout and infrastructure. • Optimize the plant's footprint to reduce energy requirements for pumping, aeration, and other processes. • Conduct a comprehensive carbon footprint assessment of the treatment plant's detailed design and operation, including emission embodied in building materials. The outcome can be used to inform design initiatives to further bring down the GHG footprint of the overall project.
Detailed design of AD and biogas facilities (pre-construction)	• Leakage of methane biogas from AD system, pipes, and storage tanks.	• Install an advanced gas monitoring and detection system to continuously monitor methane levels and potential leakages. • Install a flare or combustion system to burn off excess or unused biogas, ensuring complete combustion and preventing uncontrolled methane emissions.
Operation phase		

Activity	Impact or risk	Mitigation measures
Operation of WWTP	• Energy consumption and associated GHG emissions.	• Adopt and implement energy management systems to monitor and optimize energy usage throughout the plant. • Provide training and awareness programs for WWT plant staff on energy conservation, GHG reduction, and sustainable operational practices.
Operation of AD and biogas facilities	• Leakage of methane biogas from AD facilities, pipes and storage tanks.	• Conduct regular inspections and audits of the biogas infrastructure and systems, incl. covers, pipelines, valves, and other equipment to identify potential leaks and implement corrective measures. • Provide training to plant staff on proper biogas handling procedures, including leak detection, emergency response, and maintenance protocols.

In terms of monitoring, KS should regularly monitor and report GHG emissions to identify areas for improvement and track progress towards emissions reduction targets. This includes monitoring of biogas system and registration of the level of potential leakages.

Summary of residual impacts related to GHG emissions

Table 8.8: Summary of climate impacts related to GHG emissions, pre-mitigation and residual (post-mitigation).

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**High**	
Pre-construction and construction		
Spatial extent	*Regional*	*Regional*
Duration	*Long term*	*Long term*
Magnitude of impact	*Medium - negative*	*Low – negative*
Overall impact significance	***Moderate to major - Negative***	***Moderate – Negative***
Operation phase		
Spatial extent	*Regional*	*Regional*
Duration	*Long term*	*Long term*
Magnitude of impact	*Medium - positive*	*Medium - positive*
Overall impact significance	Moderate to major - positive	Moderate to major - positive
Net impacts – overall project (construction and operations)		
Spatial extent	*Regional*	*Regional*
Duration	*Long term*	*Long term*
Magnitude of impact	*Medium to high - positive*	*Medium to high - positive*
Overall impact significance	Moderate - positive	Moderate to major - positive

Potential climate related impacts on the project infrastructure and its resilience to climate change (climate resilience)

Extreme weather events and unforeseen climate changes have the potential to affect projects and business continuity during both construction and operation phases. Hence, it is important to understand these risks and adopt appropriate measures to increase project resilience.

In general, climate change driven weather events have the potential to undermine investments already built, or planned, in a given water supply and sanitation project. This can span from the risk of flooding of wastewater treatment plants, pumps, and similar infrastructure, to affecting migration patterns of people, which could increase the demand of an area for a greater and better water supply. Hence, it is necessary to identify the specific climate change risks and outline the corresponding adaptation measures if needed, to reduce the negative impacts on water supply and wastewater systems.

As outlined in the baseline section, Karaganda already experiences harsh climate conditions in the form of cold winters and warm summers, regular thunder and snowstorms, with large variability between years. Although seasonal and annual variations make it difficult to conclude on climate change trends for Karaganda, the available data indicates that the region is considered likely to experience increasing temperatures within all seasons, as well as increase in precipitation within all seasons.

The location of the WWTP is considered of mild (low) sensitivity in regards of flood risk, since it is seen that extreme events should not be expected to be more frequent – and the nearby Bukpa river has a small catchment area. There is a risk that with more precipitation during winter, a higher flow could be expected when temperatures reach above zero and the snow will melt. With the expected additional precipitation over the course of a year being 20 mm more than today by 2059, the additional runoff from a single event is not expected to be large enough to be considered a risk that needs to be included in the design.

The following tables reflect generic climate change scenarios and their adverse effects and impacts on water resources and water and wastewater systems. Against the listed generic scenarios, the relevance for the proposed Karaganda WWTP site and potential adaptation measures have been assessed, for the pre-construction and construction, and operation phases, respectively.

<u>Climate risks – pre-construction and construction phase activities</u>

*Table 8.9: Generic impacts on water resources and water/wastewater systems based on climate change scenarios and their adverse effects, and their relevance for the proposed Karaganda WWTP **construction phase activities**.*

<table>
<tr><th colspan="2">Climate Change Scenario</th><th colspan="2">Adverse effect</th><th>Impact on Water Resources</th><th>Impact on Water and wastewater systems</th><th>Potential impact relevance for Karaganda <u>WWTP construction</u> and adaptation measures</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">Increasing temperatures</td><td>1.a.</td><td>Glacial/snow melt in river basins</td><td>Low water availability in summer months</td><td>River flow and flooding increases in spring. Potential damage to water and wastewater facilities</td><td rowspan="2">There is no significant surface water at or immediately adjacent to the construction site, but snow melt water can collect locally. There is need for regular site drainage and storm water management at the site but no uplift in measures due to climate change. Climate change is not expected to impact the WWTP in any significant way.</td></tr>
<tr><td>1.b.</td><td>More precipitation falling as rain instead of snow</td><td>Low water availability in summer months</td><td>River flow and flooding increases in spring. Potential damage to water and wastewater facilities</td></tr>
<tr><td>1.c.</td><td>Algae and pathogen pollution of water source</td><td>Deterioration of water quality</td><td>Additional requirements for water treatment</td><td>Not relevant for WWTP.</td></tr>
</table>

Climate Change Scenario		Adverse effect		Impact on Water Resources	Impact on Water and wastewater systems	Potential impact relevance for Karaganda WWTP construction and adaptation measures
2	Decreasing precipitation	2.a.	Reduction in surface water flow	Low water availability. Higher pollution in rivers, as sewage discharge is less diluted (higher pollution loads).	Additional requirements for water treatment	Precipitation is increasing.
		2.b.	Falling groundwater levels	Loss of water storage	Soil subsidence resulting in damages to structures (buildings, wells and pipes)	
3	Increasing precipitation	3.a.	Increased frequency of flooding	Pollution of surface water from damaged wastewater systems	Potential flooding of water and wastewater facilities	The site topography is considered mildly sensitive to flooding. Regular **site drainage and storm water management** shall be planned at the site in line with common good practice, but no uplift required due to climate change Climate change is not expected to impact the WWTP in any significant way.
		3.b.	Increased groundwater recharge and rise in groundwater table	Increased transport of contamination in soil and groundwater	Potential flooding of sub-surface structures	Studies indicated unconfined groundwater depth at the site to be relatively shallow (between 0.3-1.8 m depth depending on the season). There is a risk of increased seasonal groundwater recharge in the area. There is a need for effective site drainage, and during detailed design the need for in ground drains should be investigated, to keep the groundwater at a level that does not pose a risk to the concrete structures. However, this can be seen as standard practice during detailed design, and as such not an uplift due to climate change.
4	More extreme temperature events	4.a.	Droughts	Increased water use (*e.g.* irrigation). Higher pollution in rivers, as sewage discharge is less diluted (higher pollution loads).	Low water availability causes problems for hygiene and cleaning at waterworks	N/A for construction
		4.b.	Rapid snow melt	Loss of water storage and low water availability in summer months	Potential flooding of water and wastewater facilities	Regular site drainage and storm water management should be planned at the site, but no uplift required due to climate change.
5	More intense rainfall events	5.a.	Fluvial erosion and turbulent river flow	Greater transport of contaminants to surface waters	Additional requirements at the waterworks (sedimentation and filtration) Damage to water and wastewater facilities	More intense rainfall is not expected in the region

Climate Change Scenario		Adverse effect		Impact on Water Resources	Impact on Water and wastewater systems	Potential impact relevance for Karaganda WWTP construction and adaptation measures
		5.b.	Flash flooding	Pollution of surface water from damaged wastewater systems	Potential flooding of water and wastewater facilities	

Source: Adapted and integrated from Howard and Bartram (2010)[44], Elliot et. Al. (2011)[45] and Bates et. Al. (2008)[46].

Climate risks – operation phase activities

Table 8.10: Generic impacts on water resources and water/wastewater systems based on climate change scenarios and their adverse effects, and their relevance for the proposed Karaganda WWTP ***operation phase activities****.*

Climate Change Scenario		Adverse effect		Impact on Water Resources	Impact on Water and wastewater systems	Potential impact relevance for Karaganda WWTP operation and adaptation measures
1	Increasing temperatures	1.a.	Glacial/snow melt in river basins	Low water availability in summer months	River flow and flooding increases in spring. Potential damage to water and wastewater facilities	Could affect Sokyr river. Increased flow would increase dilution of effluents but this is not expected to be significant. No risk to WWTP site. Snow melt water can collect locally. There is **need for regular site drainage and storm water management at the site but no uplift in measures due to climate change.**
		1.b.	More precipitation falling as rain instead of snow	Low water availability in summer months	River flow and flooding increases in spring. Potential damage to water and wastewater facilities	
		1.c.	Algae and pathogen pollution of water source	Deterioration of water quality	Additional requirements for water treatment	WWTP will be equipped with water purification using drum microfilters and a UV disinfection of effluents.
2	Decreasing precipitation	2.a.	Reduction in surface water flow	Low water availability. Higher pollution in rivers, as sewage discharge is less diluted (higher pollution loads).	Additional requirements for water treatment	Precipitation is increasing.
		2.b.	Falling groundwater levels	Loss of water storage	Soil subsidence resulting in damages to structures (buildings, wells, and pipes)	
3	Increasing precipitation	3.a.	Increased frequency of flooding	Pollution of surface water from damaged wastewater systems	Potential flooding of water and wastewater facilities	The site topography is considered mildly sensitive but not prone to flooding and no increase in flood risk is projected. Regular **site drainage and storm water management** shall be planned at the site in line with common good practice, **but no uplift required due to climate change.**

44 Howard, Guy, and Jamie Bartram (2010): "Vision 2030 - The resilience of water supply and sanitation in the face of climate change Technical report." WHO Technical Report.

45 Elliot, M., Armstrong, A., Lobuglio, J. and Bartram, J. (2011): Technologies for Climate Change Adaptation – The Water Sector. T. De Lopez (Ed.). Roskilde: UNEP Risoe Centre.

46 Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., (2008): Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210 pp

Climate Change Scenario		Adverse effect		Impact on Water Resources	Impact on Water and wastewater systems	Potential impact relevance for Karaganda WWTP operation and adaptation measures
		3.b.	Increased groundwater recharge and rise in groundwater table	Increased transport of contamination in soil and groundwater	Potential flooding of sub-surface structures	Studies indicated unconfined groundwater depth at the site to be relatively shallow (between 0.3-1.8 m depth depending on the season). There is a risk of increased seasonal groundwater recharge in the area. There is a need for effective site drainage, and during detailed design the need for in ground drains should be investigated, to keep the groundwater at a level that does not pose a risk to the concrete structures. However, not an uplift due to climate change.
4	More extreme temperature events	4.a.	Droughts	Increased water use (*e.g.* irrigation). Higher pollution in rivers, as sewage discharge is less diluted (higher pollution loads).	Low water availability causes problems for hygiene and cleaning at waterworks	N/A However, improved effluent quality offers opportunities for reuse for irrigation, hence increasing drought resilience.
		4.b.	Rapid snow melt	Loss of water storage and low water availability in summer months	Potential flooding of water and wastewater facilities	City stormwater in inflow water could overload the WWTP. Emergency plan needs to include appropriate measures (bypass expected as part of design) although not considered an uplift due to climate change. Regular site drainage and storm water management should be planned at the site, although not considered an uplift due to climate change.
5	More intense rainfall events	5.a.	Fluvial erosion and turbulent river flow	Greater transport of contaminants to surface waters	Additional requirements at the waterworks (sedimentation and filtration) Damage to water and wastewater facilities	The site topography is considered mildly sensitive not prone to flooding and no increase in flood risk is projected. Regular site drainage and storm water management must be planned at the site, but not considered an uplift due to climate change. City stormwater in inflow water could overload the WWTP. Emergency plan to include appropriate measures, although not considered an uplift due to climate change.
		5.b.	Flash flooding	Pollution of surface water from damaged wastewater systems	Potential flooding of water and wastewater facilities	

Source: Same as Table 8.9.

Adaptation measures – Climate resilience

Overall, climate change is not assessed to increase the risk of flooding at the WWTP site, hence regular site drainage and stormwater solutions, as well as emergency planning, dimensioned based on historical precipitation data and local surface water conditions is considered sufficient (see further discussion below). There is a risk that groundwater levels could increase seasonally due to increased precipitation, although no sources indicate this as a specific projection for the local climate. The groundwater levels are already shallow in spring time, so it is recommended that the site and structures are designed for these levels. The levels can be monitored continuously, and if it is found that they are increasing over time, additional measures can be put in place. With the uncertainty of the change and the slow pace at which the issue would develop, it is not financially sound to construct drainage for higher groundwater levels than what is seen today.

Table 8.11: Measures related to Climate resilience

Activity	Climate impact or risk	Project adaptation measures
Pre-construction and Construction phase		
Detailed design of WWTP site and infrastructure (pre-construction)	• Flooding risk due to rapid snowmelt or extreme rain events at the site with potential impact on WWTP infrastructure	• Regular **site drainage and storm water management** infrastructure shall be designed at the site to protect infrastructure from flooding, to be effective during both construction and operation phases. There is a risk of increased seasonal groundwater recharge in the area. There is a need for effective site drainage, and during detailed design the need for in ground drains should be investigated, to keep the groundwater at a level that does not pose a risk to the concrete structures. However, this can be seen as standard practice during detailed design, and a specific uplift in required measures due to climate change, as compared to regular good practice considering local conditions and historic trends, is not found necessary. • A specific uplift in required measures due to climate change, as compared to regular good practice considering local conditions and historic trends, is not found necessary. • Construction phase emergency planning to consider response measures in case of unforeseen climate related events (e.g. storms and heavy precipitation).
Detailed design of WWTP site and infrastructure (pre-construction)	• Increased groundwater recharge and rise in groundwater table	• Regular site drainage to manage surface water. • Analysis of groundwater table – including seasonal changes – to be included in design of concrete structures and potential necessary in ground drainage to maintain a certain groundwater level. • Specific uplift in required measures due to climate change, as compared to regular good practice considering local conditions and historic trends, is not found necessary.
Operation phase		
Operation of WWTP	• Risk of rapid snowmelt or extreme rain events in Karaganda City, resulting in potential overload and flooding of the WWTP.	• Maintain regular **site drainage and storm water management** infrastructure at the site (see above). • **Detailed design and Emergency planning** to include appropriate measures in case of flood events. • Conduct training of staff in emergency measures including how to deal with flood events.

Summary of sensitivity of the project to climate change impacts

The proposed WWTP site is located near a small stream, and groundwater is present at times at shallow levels. Based on a review of existing climate change projection data and the overall site context, there is a risk of fluvial flooding, but it is not expected to increase due to climate change. Hence, regular, and effective site drainage and stormwater management based on historic precipitation and trends is considered sufficient. Since the location has been used for the WWTP for many years, anecdotal evidence of previous flooded areas can also prove useful. Although no external sources point to a risk of increased groundwater levels, it is uncertain whether the already shallow groundwater tables and the increased precipitation will lead to even higher groundwater levels. It is therefore found appropriate that regular drainage is included in the detailed design in accordance with current groundwater levels (measured throughout the year), and if the groundwater tables start to rise in the future, this will be slow change, and adaptation measures to handle more groundwater can be put in effect later on. Due to the uncertain nature of the problem, this is recommended to avoid unnecessary investments. Addressing climate related events in emergency response planning is important, as suggested above. This includes making provisions for, e.g., direct bypass of the WWTP in case of stormwater floods from Karaganda City overloading the sewers and the WWTP. All the efforts mentioned as 'regular site drainage and storm water management', as well as the analysis and design for groundwater mentioned above, and designing the plant to handle stormwater in the catchment are considered to be a basic part of any construction design. It is included in the ESMP to be included as part of detailed design and should be described in the tender for the detailed design phase, to ensure that it will be included in the final design.

8.1.4 Impacts on surface and groundwater resources

Pre-construction and construction phase activities

The construction phase activities with potential to affect surface and groundwater are typical for large construction projects and largely the same as the activities affecting geology and soil. These activities involve **risks and potential impacts related to contamination of surface and groundwater** if not adequately managed, and include:

- Excavations and ground disturbance (incl. planning thereof)
- Trenching and backfilling, such as for pipeline installations (incl. planning thereof)
- Site levelling and drainage
- Operation of vehicles and machinery
- Transport / haulage activities
- Material handling
- On-site fuel and chemical storage
- Construction equipment maintenance within the construction site
- Generation of solid waste (construction waste, worker household waste and hazardous waste)
- Water supply and wastewater from temporary on-site construction worker facilities
- Decommissioning of existing WWTP and rehabilitation of sludge ponds
- Risk of unplanned events and natural disasters, which in turn can increase the risk of spillages of ils, chemicals, sludge, etc.

Construction phase activities are limited to the WWTP site and transport to and from that site and the periphery of the site to which transmission line masts will be relocated.

As reflected in the baseline section, there are depressions in the landscape within the existing WWTP site and to the south, within an area that falls within the new extended WWTP site. These depressions carry thaw water in spring and groundwater for the rest of the year. Before excavating and levelling the site, **appropriate site drainage needs to be planned as part of the detailed design in line with good practice considering site conditions and historic climate conditions and trends** (not considered an uplift due to climate change, see previous chapter).

Water for drinking and sanitary use is sourced through the municipal water supply system. It also provides for fire-fighting water supply. Wastewater from potential temporary construction worker facilities on site can be connected to septic tanks or to the sewer of existing buildings on site and is not considered a significant issue.

It is understood that concrete will be sourced from concrete plants located in Karaganda City, and hence there will not be a dedicated concrete batching plant on-site. In case a concrete batching plant will be located on site, general spill prevention, waste and dust mitigation measures shall apply.

Other potential impacts that relate to risk of accidental release of fuels, oils, chemicals etc. to the environment are similar to those already identified for geology and soil (section 8.1.2) and require the same types of mitigation measures.

Similar to geology and soil, the overall unmitigated **impact magnitude** of the listed construction phase activities on surface and groundwater resources is determined as **medium and negative**. Given the low to medium sensitivity of the receptor, the **overall impact is considered of minor to moderate negative significance** if unmitigated.

Operation and maintenance activities

As for geology and soil, the following WWTP operation and maintenance activities can result in impacts on surface and groundwater:

- Haulage activities (transport to and from the site)
- Ongoing landscaping and ground disturbance
- Pipeline installation and maintenance
- Chemical storage and handling
- Stormwater management
- Effluent discharge
- Sludge management

The impact of the WWTP operations can be considered in the context of the following key receptors and their sensitivity, as described in the baseline section:

- **Surface and groundwater sources at and around the WWTP site (**Low to medium sensitivity)
- **The bioponds** (although these can be seen as a part of the overall WWTP process, they also serve as a habitat for various species, including some rare bird species) (low to medium sensitivity)
- **The Sokyr River** (Medium sensitivity).

At and around the WWTP site, daily operation and maintenance activities of the WWTP come with **risks of accidental release of fuels, oils, chemicals etc.** to the environment that are the same as what has been outlined above for the construction phase and require the same types of mitigation measures. Unmitigated, these impacts are considered of minor to moderate significance, and negligible subject to implementation of mitigation measures.

Primary impacts during the operation phase relate to both effluent discharge quality and sludge management, as discussed below.

<u>Effluent discharge and quality</u>

In relation to the bioponds and Sokyr river, the principal impacts of a WWTP operation on surface and groundwater are related to the **quality of treated effluents** and related impacts on the surface water receptors.

In the case of Karaganda, the existing WWTP discharges effluents to the bioponds and from there the Sokyr river. For the new WWTP, the effluent receptors will be unchanged. Currently, the effluents from the existing WWTP are of reasonably good quality with regards to BOD, COD and SS, complying with EU effluent standards, but exceed the EU requirements for nitrogen and phosphates. However, the existing WWTP does not meet the strict national MPDs for BOD, COD, and ammonium nitrogen.

The primary objective of the proposed Project is to improve effluent quality and sludge management related to the WW treatment, and to meet national and EU effluent standards, **hence the overall impact of the Project on surface and groundwater sources will be positive**.

The proposed WWTP is designed to treat on average 100,000 m^3/day of wastewater, which is also roughly the amount of effluent that will be discharged from the plant. This amounts to 36.5 million m^3/year of effluent water.

Figure 8.3 illustrates the anticipated performance and effectiveness of the proposed WWTP design, based on the Aquarem Feasibility study (2023) for the project.

Figure 8.3. Assessed performance and effectiveness of the proposed WWTP design (Source: Aquarem FS, 2023)

Expected cleaning effects after reconstruction, construction according to calculated concentrations: Scheme of a linear balance for the treatment stages of the WWTP in Karaganda

Table 4.7.

Index	Throughout the complex			Mechanical grate cleaning and sand traps		Primary radial settling tanks		Bioreactor + secondary clarifiers		Post-treatment unit		
	Concentration up to cleaning*, mg/l	concentration after cleaning, mg/l	General Effect cleaning	Concentra up to cleaning mg/l	Effect cleaned hl, %	Concentra up to cleaning mg/l	Effect cleaning ... %	Concentration up to cleaning mg/l	Effect up to cleaning %	Concentration after cleaning mg/l	Effect cleaned hl, %	concentration after cleaning mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13
suspended solids	263	5.00	98.1	263	-	263	—	184.1	94.6	10.0	50	5.00
BOD5 unclarified liquid	366	3.00	99.2	366	-	366	20	292.8	97.9	6.0	50	3.00
BODtotal unfinished liquid	439.2**	6.00	98.6	439.2**	-	439.2**	20	351.4	96.6	12.0	50	6.00
COD	514.5	30.0	94.2	514.5	-	514.5	20	411.6	95.0	40	33	30.0
Nitrogen of ammonium salts N 42.88		2.00	95.3	42.88	-	42.88	-	42.88	95.3	2.0	-	2.00
Phosphorus Phosphate P	4.5	1.14	74.7	4.5	-	4.5	-	4.5	74.7	1.14	-	1.14
	7.4	6.8	-	7.4	-	7.4	-	7.4	-	-	-	-
PO4 pH Nitrogen Nitrite, N-NO2	0.2	1.0	-	0.2	-	0.2	-	0.2	-	1.0	-	1.0
Nitrate nitrogen, N-NO3	3.2	10.2	-	0.2	-	0.2	-	0.2	-	10.12	-	10.12
dense residue	1161.1	≤1161.1	-	1161.1	-	1161.1	-	1161.1	-	≤1161.1	-	≤1161.1
Chlorides	284.3	≤284.3	-	284.3	-	284.3	-	≤284.3	-	≤284.3	-	≤284.3
Sulfates	236.4	≤236.4	-	≤236.4	-	≤236.4	-	≤236.4	-	≤236.4	-	≤236.4
Petroleum products	0.9	0.1	87	0.9	-	0.9	-	0.9	87	0.5	-	0.3
Fats	11.2	Not normal.	-	11.2	-	11.2	-	11.2	-	abs.	-	abs.
AS	1.8	0.5	72.2	1.8	-	1.8	-	1.8	72.2	0.5	-	0.5
Copper	0.029	≤0.029	-	0.029	-	0.029	-	0.029	-	≤0.029	-	≤0.029
Zinc (II)	0.05	≤0.05	-	0.05	-	0.05	-	0.05	-	≤0.05	-	≤0.05
Iron total	0.9	0.3	66.7	0.9	-	0.9	-	0.9	66.7	0.3	-	0.3
Chromium (VI)	0.001	≤0.001	-	0.001	-	0.001	-	0.001	-	≤0.001	-	≤0.001
Manganese(II)	0.006	≤0.006	-	0.006	-	0.006	-	0.006	-	≤0.006	-	≤0.006

In the feasibility study, a reservoir is a recipient of treated wastewater: discharge into the Sokyr River.

Based on the above table, it can be noted that effluent quality of BOD, SS and COD is fine and will comply with both EU and national standards. Phosphorus is sightly high at 1.14mg/l compared to EU requirements for sensitive areas (1.0mg/L). However, it is expected that the chemical system will polish this to the required levels. Total Nitrogen appears to be 13.12 mg/L (2.0 mg/l ammonia which is probably a maximum amount + 1.0 Nitrites + 10.12 mg/L Nitrates) which is slightly higher than the EU standard of 10 mg/L. Although Total Nitrogen design value appears slightly high compared to the EU standard for sensitive areas, it is expected that the annual average is likely to meet the EU standard.

The post-treatment provides additional water purification using drum micro filters and a UV disinfection station for water disinfection. Filtration provides superior parameters of wastewater treatment, and ultraviolet light (UV) system provides disinfection, hence making the effluent water suitable for reuse in the form of irrigation of crops.

Hence, based on the proposed design, the effluent quality of the new WWTP will improve the effluent quality and bring it to a level which is in line with both EU requirements for sensitive waters and the national MPDs.

The improved effluent quality will benefit the water quality in the Sokyr river, as well as in the bioponds.

In terms of potential **reuse of treated effluents for irrigation purposes**, the effluent from the new WWTP will, based on the design parameters, also comply with the EU minimum requirements for water reuse as specified in the EU's water re-use guideline[47], with regards to BOD and TSS corresponding to crop Category A, which it the highest water quality level. However, reuse of the water for agriculture must be subject to evidenced compliance with the remaining pathogen (E.Coli, Legionella, *etc.*) requirement of the EU regulation (Table 8.12) and strict monitoring requirements as outlined in the EU's water re-use guideline.

Table 8.12: EU Water Reuse Directive minimum requirements

Minimum reclaimed water quality class	Crop category	Indicative technology target	Quality requirements				
			E. coli (number/100 ml)	BOD_5 (mg/L)	TSS (mg/L)	Turbidity (NTU)	Other
A	All food crops consumed raw where the edible part is in direct contact with reclaimed water and root crops consumed raw	Secondary treatment, filtration, and disinfection	≤10	≤10	≤10	≤5	Legionella spp.: < 1 000 cfu/l where there is a risk of aerosolisation. Intestinal nematodes (helminth eggs): ≤ 1 egg/l for irrigation of pastures or forage
B	Food crops consumed raw where the edible part is produced above ground and is not in direct contact with reclaimed water, processed food crops and non-food crops including crops used to feed milk- or meat-producing animals	Secondary treatment, and disinfection	≤100	In accordance with Directive 91/271/EEC (Annex I, Table 1)	In accordance with Directive 91/271/EEC (Annex I, Table 1)		
C	Food crops consumed raw where the edible part is produced above ground and is not in direct contact with reclaimed water, processed food crops and non-food crops including crops used to feed milk- or meat-producing animals	Secondary treatment, and disinfection	≤1000				
D	Industrial, energy and seeded crops	Secondary treatment, and disinfection	≤10000				

Continuous **monitoring of effluent quality** against national and EU effluent standards will be required, to ensure that effluent standards are met and that the WWTP is operating optimally. In case of reuse of effluents from the WWTP for irrigation purposes, the water quality prior to irrigation also needs to be monitored against the EU water reuse regulation requirements.

The potential to reuse effluents for irrigation purposes is further discussed in relevant sections below.

Overall, the impact magnitude on surface and groundwater at the Sokyr river **related to the effluent** from the WWTP are assessed to be **medium and positive**, without the reuse of effluents. With reuse of effluent water and compliance with relevant EU requirements, the impact magnitude is assessed as high positive. Hence, the **overall significance of the impacts is considered moderate to major positive.**

[47] Regulation (EU) 2020/741 of the European Parliament and of the Council of 25 May 2020 on minimum requirements for water reuse. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32020R0741

Sludge amounts, quality and management

Uncontrolled or inappropriate **storage of sludge**, which is a key product of the WWTP process, can result in seepage of nutrients and/or pollutants to nearby surface and groundwater receptors.

At the existing WWTP, raw sludge is pumped to 21 sludge ponds for sun-drying, without prior stabilization or dewatering.

The proposed WWTP includes anaerobic digestion (AD) of dewatered sludge, and mechanical drying of the digested sludge, hence largely **eliminating the need for the sludge ponds**, with the exception of a few ponds which should be maintained for emergency purposes.

Related to WWTP operation, there is a general risk of situations requiring emergency shutdown of the mechanical sludge dewatering shop. In such an event, a mixture of raw sludge and excess Waste Activated Sludge from the sludge mixing tank will be discharged via pumps located in the mechanical sludge dewatering building to emergency sludge ponds in the existing sludge pond area. For this reason, 3 sludge ponds will remain as standby units due to emergency". These emergency sludge ponds are already accounted for in the preliminary design by Aquarem and **should be included in the detailed design.**

Compared to the current situation, anaerobic digestion (AD) of the sludge comes with numerous benefits, including energy generation, odour control, sludge volume reduction (up to 50% volume reduction), nutrient recovery and greenhouse gas emissions reduction. Additionally, it results in pathogen reduction. AD operates at higher temperatures and provides a more controlled environment compared to open sludge ponds. This process effectively kills or significantly reduces pathogens present in the sewage sludge, making it safer for handling and potential reuse, and reducing the risk of contamination of surrounding water receptors.

As outlined in section 3.3.4, the WWTP is estimated to generate approx. 100 m^3/day of digested and dewatered sludge (at 25% solids), which will be further dried in two high temperature drying lines. This is expected to result in approx. 50m^3/day of dried sludge at about 50% solids. Assuming a volume to weight ratio of close to 1, this equals *approx*. 50t/day of dried sludge, or *approx*. 18,250 tons/year.

The Project proposal, based on the Aquarem Feasibility Study (2023), assumes thermal drying of the digested sludge, and reuse of the digested and dried sludge as fertilizer. A covered sludge storage area on a hard surface is planned within the WWTP area, where treated and dewatered sludge can be temporarily stored, after which it can be collected and used as fertilizer for agricultural purposes and for rehabilitation of green areas.

It appears, however, that the final details of the sludge disposal are yet to be determined. It is necessary to establish contracts with off-takers (*e.g.,* farmers) regarding the sludge reuse to determine the amounts that can be used in that way and coordinate the timing of application on fields with the need for temporary storage within the WWTP site. Additionally, in case there is insufficient offtake capacity, alternative treated sludge storage solutions need to be determined. Hence, in parallel with the detailed design of the WWTP, a plan for reusing sludge needs to be developed, including alternative sludge storage options if reuse is not possible.

Opportunities to reuse sludge are discussed further in a dedicated section below.

Overall, the improved sludge management of the proposed WWTP, with AD and elimination of the use of existing sludge ponds, is considered to have positive impacts and reduces the risk of water and groundwater contamination at or around the WWTP site, compared to the current situation. This impact is long-term and considered **high positive**. Given the low sensitivity of the receptor, the **overall impact significance is moderate – positive** as compared to the current situation. Note however that in terms of future application of sludge on fields, the impact would be subject to a sensitivity analysis in each particular context to determine the appropriate use for sludge and quantities given the respective soil conditions in each case. As the off-takers of sludge are not known at this time, it is not possible to assess this impact.

Closure and Decommissioning activities

The negative impacts that may occur during decommissioning of the new WWTP are similar to those identified for the construction activities in general, *e.g.,* relating to the potential contamination of soil, surface water, groundwater resources, ambient air, and noise impacts. Waste materials, in particular aggregates and scrap metal, should be managed to ensure maximal reuse or recycling at end of life in accordance with the waste hierarchy. Any planned closure of facilities and infrastructure should be carried out appropriately to prevent the closed site constituting a risk for humans and animals and with measures in place to prevent release of contaminants into soil and water bodies.

Mitigation measures

All the mitigation measures outlined for “geology and soil” in section 8.1.2 are also applicable for protecting surface and groundwater and should also be implemented with this receptor in mind.

Further measures to be implemented to protect surface and groundwater are outlined below.

Table 8.13: Mitigation measures related to surface and groundwater, in addition to those outlined for ‘geology and soil’.

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
Site levelling and drainage	• Snow melt and groundwater in landscape depressions impacting ground stability. • Risk of contaminants coming in contact with water on site during excavation and site levelling works.	• Design and plan for appropriate site drainage for the construction site (pre-construction / final design and construction planning).
Potential on-site Concrete batching plant (Concrete is likely to be sourced from Karaganda)	• Water consumption • Potential contamination of soil and groundwater from wastewater / cleaning water.	• **If** a concrete batching plant will be located on site, make sure that all spill prevention and control measures also apply to the batching plant and are reflected in contractors’ management plans. • Implement proper water management practices to reduce water consumption and prevent contamination. • Locate the plant on a hard surface to eliminate the risk of spillages to the environment.
Operation phase		

Generation of treated effluent discharge	• Not reusing the effluents for irrigation is a poor use of the resource given that Kazakhstan is a water scarce country.
	• **Opportunity** to reuse treated effluent for irrigation on nearby fields.
		• KS to develop a **resource management and conservation plan** that, *inter alia*, includes:
		  • **A plan for reusing effluents and sludge** from the WWTP, including measures to consult relevant farmers and other stakeholders with regards to utilisation of these resources.
		  • Explore possibilities to reuse treated effluent from the WWTP for irrigation on nearby fields or forestry areas.
		  • Explore possibilities to reuse digested sludge as fertilizer on nearby fields, to reuse nutrients.
		  • Include procedures for monitoring of effluents and sludge in line with relevant EU directives.

Disposal of digested sludge	• Not reusing the digested sludge as fertilizer is a poor use of valuable nutrients. • **Opportunity** to reuse nutrients in sludge as fertiliser on nearby fields.	

Activity	Impact or risk	Mitigation measures
Disposal of digested sludge	• The plan is to reuse digested sludge for agriculture. However, there is a risk of insufficient offtake capacity as contracts with off-takers are not in place. Also, plans regarding alternative or temporary storage solutions including locations for digested and dried sludge appear not to have been finalised.	• **The plan for reusing effluent and sludge** needs to explore options related to temporary storage of treated sludge if there is insufficient capacity within the WWTP site and/or alternative long term storage solutions if there is not sufficient offtake capacity amongst farmers or other users in the area. • Within the plan, **temporary or longer-term storage solutions need to be analysed** and could include the current sludge pond area, subject to permits from the relevant authorities, and the implementation of appropriate impact mitigations and monitoring of impacts on nearby soil, surface, and groundwater sources.
Ongoing landscaping and maintenance	• Use of pesticides	• Avoid the use of pesticides and herbicides within the site.

As a general measure, KS and its contractors should monitor and maintain a registry of all environmental incidents and accidents, their causes and how they were dealt with, to inform continuous improvement efforts.

Summary of residual impacts

The overall key impacts affecting surface and groundwater mainly relate to the following:

- Risk of contamination from construction activities
- Handling and storage of sludge and effluents during operational phase

Risk of contamination affecting surface or groundwater from general construction and operation phase activities **at the WWTP site itself** and related to transport to and from the site. The risk of such impacts materialising can be effectively minimised with proper mitigation, management, and monitoring measures as outlined above, to become of **negligible negative significance**.

The following table summarises the assessed pre-mitigation impacts, and residual impacts considering successful implementation of the above mitigation measures.

Table 8.14: Summary of impacts on ***surface and groundwater at the WWTP site****, pre-mitigation and residual (post-mitigation).*

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Low**	
Pre-construction and construction		
Spatial extent	*Limited to local*	*Limited to local*
Duration	*Medium term risk (short-term impacts)*	*Medium term risk (short-term impacts)*
Magnitude of impact	*Medium - negative*	*Low - negative*
Overall impact significance	***Minor to moderate - Negative***	***Negligible – Negative***
Operation phase		
Spatial extent	*Limited to local*	*Limited to local*
Duration	*Medium term risk (short-term impacts)*	*Medium term risk (short-term impacts)*
Magnitude of impact	*Medium - negative*	*Low - negative*

Overall impact significance	***Minor to moderate - Negative***	***Negligible – Negative***

Operation phase impact from **handling and storage of sludge** from the WWTP process, involving potential leeching and contamination of surrounding water sources from sludge ponds. The proposed Project will abandon the use of the sludge ponds, hence with a positive impact compared to the current practice.

Table 8.15: Summary of impacts on ***surface and groundwater at the WWTP site related to sludge handling and storage****, pre-mitigation and residual (post-mitigation).*

Impact characterisation	**Pre-mitigation**	**Residual impact**
Receptor sensitivity:	**Low**	
Operation phase		
Spatial extent	*Limited*	*Limited*
Duration	*Long-term*	*Long-term*
Magnitude of impact	*Medium – positive*	*Medium - positive*
Overall impact significance	***Minor – positive***	***Minor - positive***

Operation phase impact related to **effluent discharge** to the **Sokyr river**. The proposed Project will improve the quality of effluents and hence improve the Sokyr river water quality downstream, compared to the current situation, and enable the possibility to reuse effluent water for irrigation prior to discharge to the river.

Table 8.16: Summary of impacts on ***surface water of the Sokyr river****, pre-mitigation and residual (post-mitigation).*

Impact characterisation	**Pre-mitigation**	**Residual impact**
Receptor sensitivity:	**Medium**	
Operation phase		
Spatial extent	*Local to regional*	*Local to regional*
Duration	*Long-term*	*Long-term*
Magnitude of impact	*Medium – positive (w.o. reuse of effluents)*	*Medium – positive (w.o. reuse of effluents)*
Overall impact significance	***Moderate - positive***	***Moderate - positive***

Summary of positive impacts and opportunities for environmental improvements

Improved effluent quality as well as sludge treatment resulted from the proposed WWTP enables the reuse of effluents for irrigation in agriculture, and reuse of sludge as fertilizer. It is recommended that KS plans and implements initiatives to explore possibilities to exploit the opportunities and enhance the positive outcome of the project, in dialogue with relevant stakeholders.

8.1.5 Impacts on ambient air quality (*incl.* odour)

Pre-construction and construction phase activities

The typical air quality impacts during construction are related to **dust** generated through excavation activities, removal of vegetation and related soil erosion and transport on gravel roads. The area receives limited precipitation, so dust generation can be expected. Also, **emissions from vehicles and construction equipment** result in air pollution containing, *e.g.,* nitrogen oxides (NO_x), particulate matter (PM), and carbon monoxide (CO). These impacts are medium-term, limited to the construction phase and spatial extent is limited to the WWTP site itself and access road to the site. There are not immediate residential receptors in the vicinity, so the impacts are likely to affect primarily the health and safety of the workers on site (OHS). These impacts can be effectively mitigated through standard mitigation, management, and good practice measures.

Additionally, emptying the existing sludge ponds as part of potential rehabilitation activities of the area is likely to result in **odour generation** at the site, which can be dispersed to nearby residential areas. As the use of the sludge ponds will stop with the proposed and improved WWTP process, this impact is also limited to the time it takes to empty the ponds The required ‘plan for closing and rehabilitating the existing sludge pond area’ (ESMP) should define measures to minimise the odour impacts during this phase, based on consultation with the potentially affected areas.

Overall, the magnitude of construction phase impacts on air quality is assessed to be medium. The receptor sensitivity is assessed to be medium with regards to typical pollutants. The sensitivity is higher for odour, where there are already substantial impacts and limited capacity to accommodate further impact, although this is mostly experienced in residential areas located >500m away from the WWTP site but can also affect the wellbeing of workers on site. The overall sensitivity is therefore medium. The un-mitigated significance of **construction phase impacts on air-quality is considered moderate – negative.**

Operation phase activities

During operation phase, the most important impacts relate to odour from the WWTP and associated sludge handling. Additionally, the on-site combined heat and power (CHP) plant will be a source of emissions which may include nitrogen oxides (NOx), particle matter (PM) and in some cases sulphurous compounds, in addition to CO_2. The use of biogas to generate energy at the WWTP site will substitute the need for energy (electricity) sourced from the electricity grid (production of which is primarily dominated by coal, a fossil fuel), hence the overall impact of the CHP in terms of air quality is considered largely neutral or minor positive at the regional level (as biogas combustion is more benign than coal), and positive in terms of climate impacts (see section above on climate impacts).

As reflected in the relevant baseline chapter, odour from the existing WWTP is already a significant issue and a source of significant impacts on nearby settlements. The current odour impacts relate to mainly:

- Sludge ponds used for treating / dewatering raw sludge and in particular cleaning of the sludge ponds during summer
- May also stem from the WWTP processes itself.

The proposed WWTP Project is expected to significantly improve the odour situation, through the following design components of the Project:

- The **primary tanks and sand traps will be covered and gases treated in ‘gas treatment building’ to reduce odours** (Aquarem FS, 2023 and clarifications provided through e-mail)
- The WWTP includes **anaerobic digestion (AD) of the sludge**. This in itself stabilizes the sludge and significantly reduces or eliminates unpleasant odours associated with untreated sludge. The digestion process helps to minimize the release of odorous gases, resulting in a more favourable environment for workers and nearby communities.
- With adoption of the AD, the **use of the open sludge ponds** for treating and dewatering the raw sludge **will be abandoned**. This removes a key source of odour problems which currently originate from the sludge pond area particularly throughout the summer months.

Prior to combustion, the biogas from the AD facility needs to undergo pre-treatment, which particularly consists of passing through **hydrogen sulphate** filters to remove hydrogen sulphates and siloxanes (organosilicon compounds) (Aquarem FS, 2023, table 7.2). This process removes majority of the odorous gases.

For the reasons provided above, Sweco's expectation is that the odour situation will significantly improve and not cause nuisance in nearby villages. This is supported by the general experience that odour from modern WWTPs equipped with AD does not pose a problem beyond a distance in the range of 500 m from the source.

An air dispersion modelling has been conducted as part of the local EIA (EcoMusey, Dec 2023) estimating approximate expected emissions for both the construction and operational phases. Conducting an air dispersion modelling for the project is not a legal requirement for the proposed WWTP project but has nonetheless been conducted to further inform the impact assessment.

With regards to the operational phase, the following sources of emissions were considered:

- 0001– Biogas combustion station;
- 0002– Chemical laboratory;
- 6001– Sand traps;
- 6002– Primary radial settling tanks;
- 6003– Aeration tanks;
- 6004 – Secondary radial settling tanks;
- 6005 – Block of gratings and receiving chamber;
- 6006 – Gravity seal;
- 6007 – Compacted sediment reservoir;
- 6008– Sludge storage area.

Due to the lack of approved legal regulations of the Republic of Kazakhstan in the field of calculating emissions of pollutants into the atmospheric air from wastewater treatment plant operations, the calculation was made according to methodological recommendations - "Methodological recommendations for calculating the amount of pollutants released into the atmospheric air from unorganized sources of pollution from wastewater aeration stations" Approved by the Atmosphere Research Institute St. Petersburg 2011.

Air emissions and dispersion was calculated for the following substances expected to be associated with the WWTP operations, based on currently available design information (as based on the Aquarem FS):

- Ammonia
- Nitrogen oxide
- Nitrogen dioxide
- Carbon monoxide
- Ethanethiol (Ethyl mercaptan)
- Methane
- Hydrogen sulphide
- Hydrocarbons C6-C10
- Phenol
- Formaldehyde

Of the above pollutants, the following are known to have characteristics which can contribute to odour pollution:

- Ammonia
- Ethanethiol (Ethyl mercaptan)
- Hydrogen sulphite
- Hydrocarbons C6-C10
- Phenol
- Formaldehyde

Maps with air dispersion modelling results for the above odorous pollutants, reflecting the cumulated emissions from all identified and relevant sources, is shown below (except for Ethanethiol, due to very low concentrations). The pollutants concentration is compared against the maximum permitted concentration (MPC) of the pollutants, reflected as fractions of the applicable MPC. The red line on the below air dispersion maps indicates a pollutant concentration equal to the MPC (1.0 MPC). Lower fractions (<1 MPC) indicate concentrations below the MPC.

While the air dispersion modelling results cannot be compared directly to the current situation, due to lack of data to conduct comparable baseline analysis, it indicates that all pollutant concentrations, including for those substances that can contribute to odour, are modelled to be well below the MPC values when reaching the nearest residential areas. The air modelling is assuming worst case weather conditions, including dominant wind direction from the WWTP towards the residential areas, as well as the worst case emission scenario.

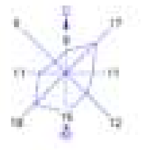
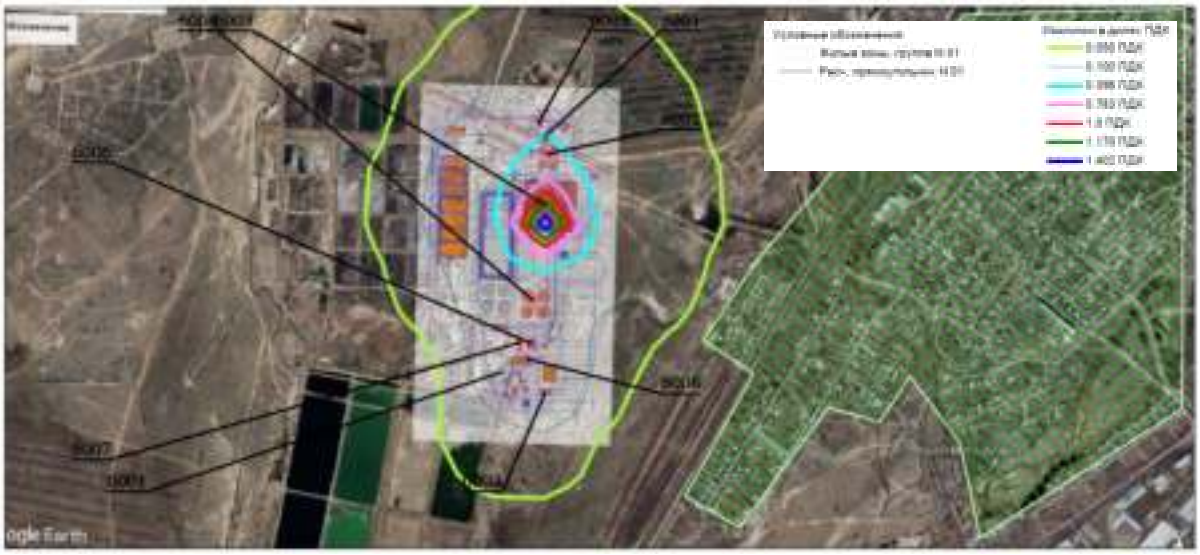


Figure 8.4 Wind characteristics assumed in the air dispersion modelling, with worst case dominant wind towards the residential areas.

Table 8.17 Maps showing air dispersion modelling results for air pollutant substances with odorous characteristics. The modelling reflects cumulated emissions from all sources, however only concentrations above 0.05 (5%) of MPC are shown as lines on the maps. Hence, sources resulting in <5% of MPC are not shown as lines on the maps.

Ammonia

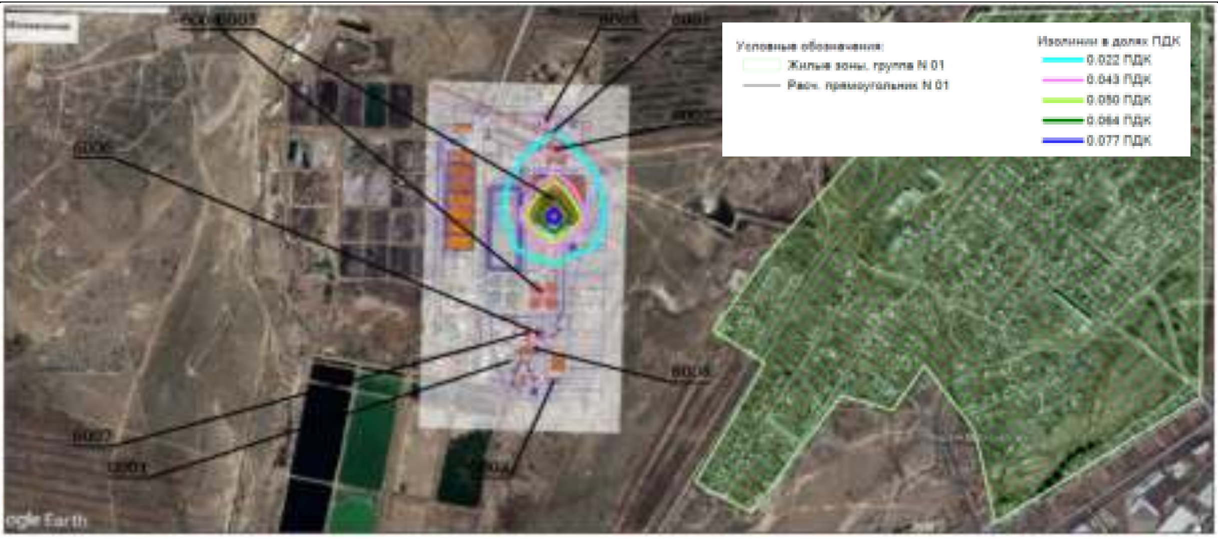


- ➔ Concentration has reached a fraction of 0.05 (5%) of the MPC before reaching the residential areas.

Hydrogen sulphite

- ➔ The H2S concentration has fallen to below the MPC approx. 300 m. before reaching the residential areas. When approx. 2000m from the source, the concentration has reached 10% of the MPC (0.1 MPC).

Hydrocarbons C6-C10



➔ The concentrations are very low and at 2.2% of MPC levels already close to the source within the WWTP area.

Phenol (hydroxybenzene)

➔ Concentrations fall to below the MPC levels just outside the boundary of the project area and to 10% of the MPC at a distance of approx. 1000m from the project area. Hence, the concentration within the residential areas is well below the MPC.

Formaldehyde

➔ Formaldehyde concentration has fallen to 5% of the MPC before reaching the residential areas.

The air dispersion modelling results for the non-odorous substances is shown below.

Table 8.18 Maps showing air dispersion modelling results for air pollutant substances without odorous characteristics.

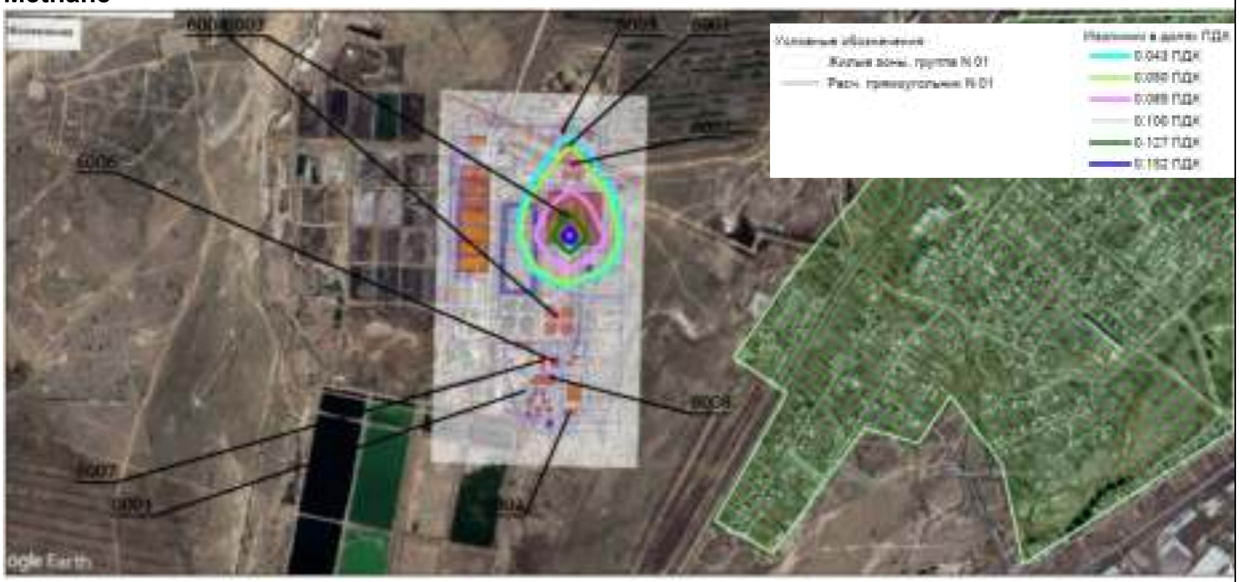
Nitrogen oxide

➔ Modelled nitrogen oxide concentrations are well below the MPC close to the source and below 10% of the MPC when reaching the residential areas.

Nitrogen dioxide

➔ Modelled nitrogen dioxide concentrations are well below the MPC already at source and well below 5% of the MPC when reaching the residential areas.

Methane



➔ Methane originating from wastewater is already well below the MPC limits inside the WWTP area.

Carbon monoxide

➔ Carbon monoxide concentrations are well below 5% of MPC before reaching residential areas.

The applicable MPCs referred to in the above maps are outlined in the following table. In relation to the air dispersion modelling, the relevant MPC reference are the ‘maximum daily MPC (mg/m^3)’ values. The pollutant concentrations in relation to the MPCs, based on the air dispersion modelling maps above, are also summarised in the table, showing that concentrations are expected to be well below the MPC for all pollutants when reaching the nearest residential areas.

Pollutant code	Name of pollutant	Maximum daily MPC mg/m3	MPC maximum single mg/m3	Calculated Concentration when reaching nearest residential areas (% of MPC)
0301	Nitrogen (IV) dioxide (Nitrogen dioxide) (4)	0.2	0.04	<5%
0303	Ammonia (32)	0.2	0.04	<5%
0304	Nitrogen (II) oxide (Nitrous oxide) (6)	0.4	0.06	<10%
0333	Hydrogen sulfide (Dihydrosulphide) (518)	0.008		<80%
0337	Carbon monoxide (Carbon monoxide, Carbon monoxide) (584)	5	3	<5%
0410	Methane (727*)			<4%
0416	Mixture of C6-C10 hydrocarbons (1503*)			<2%
1071	Hydroxybenzene (155)	0.01	0.003	<70-80%
1325	Formaldehyde (Methanal) (609)	0.05	0.01	<5%
1728	Ethanethiol (668)	0.00005		Not measurable

To put the above concentrations into context with odour thresholds as detected by humans, the following can be noted for the two substances modelled in possible concentrations closest to the MPC, namely hydrogen sulphide (H2S) and Hydroxybenzene (phenol). Mindful that the exact threshold for detection of odour varies among individuals, the following odour thresholds have been found in literature:

- **H2S**: 0.0047 ppm is the recognition threshold of human smell, at which at which 50% of humans can detect H2S odour[48]. An MPC of 0.008 mg/m^3 is equivalent to approximately 0.00526 ppm (parts per million), which is in the range of the detection threshold. At 80% of the MPC,

[48] Managing hydrogen sulphide detection offshore (hse.gov.uk)

concentration would be equivalent to 0.0042 ppm which is below the detection threshold for most people.

- **Phenol**: An odour detection threshold of 0.010 ppm has been reported[49] for phenol. The MPC of 0.01 mg/m^3 is equivalent to approximately 0.00236 ppm, which is well below the odour detection threshold and thus won't be noticed in residential areas by most people.

Hence, the air dispersion modelling conducted in the EIA supports the expectation that the odour situation will be much improved and that odour from the proposed WWTP should not be detected in residential areas under normal circumstances.

To verify the positive impacts of the Project towards eliminating odour impacts at currently affected receptors, KS must adopt and implement a structured monitoring and management regime based on approved qualitative methods, with the aim to identify, assess and register odour levels at source, and in the currently affected residential areas. The monitoring should also take account of potential other sources of odour in the broader area, such as from the pig farm which is operating to the west from the WWTP. The monitoring plan should also outline odour thresholds, which if exceeded can trigger additional mitigation measures. A list of potential measures and odour control technologies should be reflected in the monitoring plan. Refer to ESMP for description of required monitoring measures.

To further eliminate the risk of odour impacts, the anaerobic digestor (AD) and biogas facility should be designed applying best practice odour controlling technologies, enclosed system design and filters as deemed feasible and applicable, to avoid the release of odorous gases. Operators of the facility should undergo training in process optimisation to help reduce odour generation.

Overall, the operation of the proposed WWTP is considered to result in positive impacts on air quality, in the form of significantly reduced odour levels compared to the current situation. The impact is long-term with limited to local spatial extent, and of high magnitude. Given the high sensitivity of the receptor with regards to odour, the **overall significance of the air quality impact is considered major – positive**.

The size of a sanitary protection zone (SPZ) for the project is expected to remain the same, i.e., 500 m. The actual size of the SPZ will be determined by the regulator, the State Environmental Expertise (SEE).

Closure and decommissioning activities

The negative impacts that may occur during future decommissioning of the new WWTP are similar to those identified for the construction activities in general. With regards to air quality, these relate to vehicle emissions and dust generation in particular, including from demolishing activities. Any planned closure of facilities and infrastructure should be carried out appropriately to prevent the closed site constituting a risk for humans and animals and with measures in place to reduce impact on air quality.

Mitigation measures

The following mitigation measures should be implemented and have been included in the ESMP to avoid and minimize the identified impacts on ambient air quality.

Table 8.19: Mitigation measures related to ambient air

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
	• Dust generation leading to H&S impacts for workers on site	• Maintain proper road surfaces to minimize dust from vehicle movement.

[49] Phenol Acute Exposure Guideline Levels - Acute Exposure Guideline Levels for Selected Airborne Chemicals - NCBI Bookshelf (nih.gov)

Excavations, haulage, and transport activities		• Use dust collectors or filters on construction equipment to capture airborne particles. • Cover lorries transporting construction and demolition waste. • Cover stockpiles of materials to prevent wind erosion and reduce dust emissions. • Apply water to suppress dust generation
	• Emissions from vehicles resulting in air pollution at the WWTP construction site	• Use low-emission or electric-powered construction equipment when possible. • Conduct regular maintenance and tuning of equipment to optimize performance and minimize emissions. • Retrofit older equipment with emission control devices, such as diesel particulate filters. • Encourage eco-driving practices among operators to reduce fuel consumption.
Closure and emptying of sludge ponds	• Odour problems affecting the WWTP site workers and village / residential areas closest to the site.	• Plan sludge pond cleaning activities during periods of favourable weather conditions, such as low wind speeds and atmospheric stability, to minimize odour dispersion. • Consider using vacuum trucks or equipment with enclosed systems to minimize the escape of odorous gases during sludge removal and transport.

In terms of impact monitoring during WWTP operations, **KS should adopt and implement a structured monitoring regime** based on approved qualitative methods, with the aim to identify, assess and register odour levels at source, and in the currently affected settlements. Refer to ESMP for proposed monitoring measures.

Summary of residual impacts

The overall key impacts affecting air quality related to dust and machine emissions during the construction phase. Odour from sludge pond closure and/or rehabilitation can also result in odour impacts during the time it takes to empty the ponds. During operations phase, the most important impacts relate to odour from the WWTP and associated sludge handling, which will be significantly reduced compared to the current situation.

Table 8.20: Summary of impacts ***on air quality*** *associated with the Project, pre-mitigation, and residual (post-mitigation).*

Impact characterisation	**Pre-mitigation**	**Residual impact**
Receptor sensitivity:	**Medium**	
Pre-construction and construction		
Spatial extent	*Limited to local*	*Limited to local*
Duration	*Medium*	*Medium*
Magnitude of impact	*Medium - negative*	*Low – negative*
Overall impact significance	***Moderate - Negative***	***Minor – Negative***
Operation phase		
Spatial extent	*Limited to local*	*Limited to local*
Duration	*Long - term*	*Long - term*
Magnitude of impact	*High – positive*	*High – positive*
Overall impact significance	***Major – positive***	***Major – positive***

8.1.6 Noise and vibration impacts

Pre-construction and construction activities

The typical noise impacts during construction are **related to operations of construction machines and equipment**. These impacts are medium-term, limited in time during day-time and to the length of the construction phase, and the spatial extent is limited to the WWTP site itself and the access road to the site. There are no immediate residential receptors in the vicinity, so the impacts are likely to affect primarily the health and safety of the workers on site (OHS). These impacts can be effectively mitigated through standard mitigation, management, use of personal protective equipment (PPE) and good operational practice measures.

Unmitigated, the noise impacts during construction are considered of medium negative magnitude. The sensitivity of the receptor is low; hence the impact significance is considered minor.

Operation and maintenance activities

During the operations phase of the WWTP, the main sources of noise include pumps and air blowers for the aeration tanks, which will be housed within buildings. These sources of noise are mainly associated with OH&S impacts for workers employed within these buildings. In outside areas, noise may stem from transport vehicles to and from the site, and various equipment used for maintenance activities but is not considered a concern in surrounding outdoor areas due the distance to inhabited areas (>500 m). Residents in these areas do not experience noise from the current WWTP (see baseline section).
Vibrations are not considered a significant issue.

To ensure optimal working environment, detailed design of the WWTP should include measures to limit noise from pumps, air blowers and other noisy equipment, to protect workers.

Unmitigated, the noise impacts during operations are considered of low to medium negative magnitude. The sensitivity of the receptor is low; hence the impact significance is considered negligible to minor.

Closure and decommissioning activities

The negative impacts that may occur during decommissioning of the new WWTP are similar to those identified for the construction activities in general, *e.g.,* relating to noise from construction and transport machinery and related to demolition activities. Any planned closure of facilities and infrastructure should be carried out appropriately to prevent the closed site constituting a risk for humans and animals, and plan measures to mitigate construction noise and protect workers from noise impacts, in line with good international practice.

Mitigation measures

The following mitigation measures should be implemented and have been included in the ESMP to avoid and minimise the identified impacts related to noise associated with the Project:

Table 8.21: Mitigation measures related to noise

Activity	**Impact or risk**	**Mitigation measures**
Pre-construction and Construction phase		
Detailed design of WWTP facilities (pre-construction)	• Risk of insufficient noise insulation around noisy equipment (pumps, air blowers, *etc*.).	Detailed design of the WWTP to: • Choose equipment and machinery with low noise emission levels. Look for manufacturers' specifications regarding noise output during the selection process. • Place noisy equipment away from worker areas or implement soundproof enclosures around equipment.

		• Install vibration isolation mounts or pads for equipment that can cause structural vibrations and noise propagation. • Install physical barriers, such as walls or fencing, to create a sound barrier between noise sources and worker areas. • Include soundproof enclosures or rooms around noisy equipment to contain noise emissions. • Use materials with sound-absorbing properties for barriers and enclosures to reduce noise reflection and transmission in rooms with noisy equipment. • Utilize noise monitoring systems to track noise levels in noisy areas and ensure compliance with applicable regulations and standards.
Operation of vehicles and machinery, *incl.* haulage activities during construction	• Noise from machinery impacting H&S of construction workers	• Set traffic speed limits and verify drivers' behaviour with regards to driving speed. • Limit construction work to daylight hours. • Raise awareness and educate workers about the potential risks of noise exposure and the importance of using hearing protection. • Provide workers with appropriate personal protective equipment, such as earmuffs or earplugs, to minimize their exposure to high noise levels.
Operation phase		
Operation and maintenance of the WWTP	• Noise from pumps, air blowers and other equipment with impacts on workers	• Implement regular maintenance schedules to keep equipment in optimal condition, minimizing the risk of increased noise levels due to wear or malfunction. • Train operators on proper equipment operation techniques to reduce unnecessary noise emissions. • Raise awareness and educate workers about the potential risks of noise exposure and the importance of using hearing protection. • Provide workers with appropriate personal protective equipment, such as earmuffs or earplugs, to minimize their exposure to high noise levels.

Summary of residual impacts

The noise impacts during construction are **related to operations of construction machines and equipment**. During operations phase the main sources of noise include pumps and aerators for the aeration tanks, which will be housed within buildings but may cause OHS impacts. No significant noise impacts are anticipated outside the WWTP site, due to the distance to nearest receptors.

Table 8.22: Summary of noise impacts, pre-mitigation and residual (post-mitigation)

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Low**	
Pre-construction and construction		
Spatial extent	*Limited*	*Limited*
Duration	*Medium term*	*Medium term*
Magnitude of impact	*Medium - negative*	*Low - negative*

Overall impact significance	Minor - Negative	Negligible – Negative
Operation phase		
Spatial extent	*Limited*	*Limited*
Duration	*Long term*	*Long term*
Magnitude of impact	*Low - negative*	*Low - negative*
Overall impact significance	Negligible to minor - negative	Negligible - negative

8.1.7 Impact on biodiversity - Flora

Pre-construction and construction activities

The construction activities will include excavations, trenching and backfilling, removing vegetation cover and transforming a large part of the 12.75 ha site directly adjacent to the current WWTP site from current greenfield to an industrial use (WWTP) site. The impacts are direct and long term, but limited to the proposed site, which is largely divided into a steppe, wasteland, and depression where thaw water remains for some time during springs. The area is characterised by significant anthropogenic impact on vegetation and the dominant species being weeds such as austrian wormwood and southern wormwood.

No rare or protected species were identified during flora surveys in June 2023. However, as the habitat could be suitable for protected ephemerals and ephemeroids species whose life cycle runs rapidly immediately after snowmelt, the flora receptor sensitivity is conservatively considered **medium** (instead of low) until the presence of these species has been ruled out.

The magnitude of impact is considered medium negative, and given the medium receptor sensitivity, the overall significance of the construction impacts on flora are considered **moderate – negative.**

Operation and maintenance activities

The WWTP is not considered to have negative impacts on flora during the operations phase.

The negative operation impacts related to flora are considered insignificant. However, various measures can be taken to improve the broader WWTP site by planting vegetation and regenerating habitats, as well as rehabilitating parts of the existing WWTP site, including sludge ponds.

Biodiversity impacts related to the Sokyr river are discussed in the below section on Fauna.

Closure and decommissioning activities

The negative impacts that may occur during decommissioning of the new WWTP are similar to those identified for the construction activities in general, e.g., relating to destruction or disturbance of vegetated areas. Any planned closure of facilities and infrastructure should be carried out appropriately to prevent the closed site constituting a risk for humans and animals and follow measures to reduce the impact on existing vegetation related to construction activities, as proposed here below.

Mitigation measures

The following general mitigation measures should be implemented and have been included in the ESMP to avoid and minimise the identified impacts on flora/vegetation associated with the Project. Some of the outlined mitigation measures related to soil and geology are also applicable in this context, including those related to 'Ground and soil disturbance' and 'Vegetation removal and associated risk of soil erosion', and should be adopted with that in mind.

Table 8.23: Mitigation measures related to flora.

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
Additional spring vegetation survey to rule out presence of threatened species within the directly affected WWTP site (pre-construction).	• The characteristics of the land plot for the new proposed WWTP indicate that it could be suitable as a habitat for rare and protected species such as: Tulipa patens, Adonis vernalis L. and Pulsatilla patens (L.) Mill. • These species are ephemerals and ephemeroids whose life cycle runs rapidly immediately after snowmelt. As the site survey was carried out in June, no representatives were identified, and a spring survey is required in 2024.	• Conduct an additional spring vegetation survey in spring 2024 within the WWTP site area directly affected by the new WWTP infrastructure, and the area directly disturbed by overhead line relocation and underground cable trenches, to rule out the presence of potentially threatened ephemerals and ephemeroids whose life cycle runs rapidly immediately after snowmelt. The survey must be conducted by a qualified botanist. • Should any threatened species be identified, a mitigation plan should be developed and implemented, based on the identified species characteristics. This may include relocating plants to suitable locations within the adjacent areas, when possible, under the surveillance of a qualified botanist, establishing offsetting measures, to ensure 'no net loss' of rare species.
Detailed design of WWTP facilities (pre-construction)	• Opportunity to identify areas within the proposed WWTP site where existing vegetation can be maintained.	• Plan construction activities to minimize disturbance to flora habitats. • Phase construction activities to allow for the completion of work in one area before moving on to the next, reducing the overall footprint of disturbance. • Develop a **restoration plan** to rehabilitate disturbed areas post-construction, including a **plan to rehabilitate the sludge pond area** to support biodiversity.
Excavations, trenching and backfilling activities	• Removal and/or damage to vegetation	• Implement measures to minimize soil compaction and disturbance in areas with significant vegetation. • Separate excavated topsoil from other excavated material and store in a designated area for reuse. • Utilize appropriate construction techniques, such as temporary access roads or mats, to distribute the weight of construction vehicles and equipment. • Apply mulch or organic materials to exposed soil surfaces to control erosion and promote vegetation growth. • Implement erosion control measures, such as erosion control blankets or sediment barriers, to prevent sediment runoff that could impact nearby flora. • Select native plant species appropriate for the site conditions and recreate habitats that support local flora biodiversity.
Operation phase		
Ongoing landscaping within the WWTP site	• Opportunity to revegetate the site and create new biodiversity habitats.	• Select native plant species appropriate for the site conditions and recreate habitats that support local flora biodiversity. • Consider using treated effluents and treated sludge to support vegetation within and around the site.

Summary of residual impacts

The flora biodiversity impacts related to construction are first and foremost related to excavations, trenching and backfilling and associated removal of vegetation cover. No significant negative impacts on flora are anticipated during operation, although improvement in effluent quality can be expected to benefit aquatic ecosystems in downstream receptors.

Table 8.24: Summary of flora impacts, pre-mitigation and residual (post-mitigation).

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Medium**	
Pre-construction and construction		
Spatial extent	*Limited*	*Limited*
Duration	*Long term*	*Long term*
Magnitude of impact	*Medium - negative*	*Low to medium - negative*
Overall impact significance	Moderate – Negative *Tentative, subject to outcome of required spring survey.*	Negligible to minor – negative *Tentative, subject to outcome of required spring survey.*
Operation phase		
Spatial extent	*No significant negative impacts anticipated*	
Duration		
Magnitude of impact		
Overall impact significance		

Summary of positive impacts and opportunities for environmental improvements

There are opportunities to regenerate and strengthen habitats for flora and fauna within the proposed WWTP site and to rehabilitate the existing sludge ponds to create more natural biodiversity habitats. This could be seen to offset some of negative vegetation impacts associated with the greenfield WWTP construction.

8.1.8 Impact on biodiversity - Fauna

Pre-construction and construction activities

In terms of terrestrial and avifauna, as reflected in the baseline section, the 12.75 ha heavily disturbed pasture area planned for the new WWTP support little wildlife and has poor biodiversity. Work in this area is therefore not expected to result in significant impacts on fauna at any time of the year.

The biopond area and downstream discharge channel, and to some extent the existing sludge pond area, are a habitat for birds, including some rare or near threatened bird species (see baseline section). The biopond area will not be directly affected by the project, as (based on information from Aquarem) the intention is to leave it as is and utilize the bioponds as has been done to date. Nonetheless, some indirect impacts cannot be ruled out, in the form of noise, more presence of people and other activities, and other related interruption during the construction phase of the new WWTP. This could particularly have some negative impacts during the nesting period from March to July. Hence, general care should be taken during the bird nesting period not to disturb bird life in the biopond and sludge pond area.

In case of rehabilitation of the sludge pond area, it is also advisable that this takes place outside the peak nesting season to the extent possible, and following an inspection for bird nests, to avoid direct impacts on bird habitats and nesting.

Overall, the fauna habitat within the WWTP site directly affected is considered of low sensitivity, although due to the presence of the sensitive or rare species around the bioponds, a more conservative approach is to consider it of **medium sensitivity**. The impacts are considered of medium negative magnitude, and the overall significance of impacts is therefore **moderate – negative**, prior to mitigation.

Operation and maintenance activities

In terms of **impacts on terrestrial and avifauna** around the WWTP site, the operation or maintenance of the Project is not considered to have any significant impacts beyond the impacts caused by the construction of the WWTP, and associated removal of habitats (although of low sensitivity) within the existing site and additional greenfield pasture area assigned for the new WWTP site.

However, the project is considered to result in **positive impacts on the aquatic ecosystems** and benthic fauna in the downstream water receptors, particularly **in the Sokyr river**, compared to the current situation.

As outlined in the baseline section, the hydrobiological study conducted indicates the river has homogenous environmental conditions and is characterised by the low flow of the river, which is appeared stagnant in places. Signs of eutrophication were also identified. Species diversity appeared lowest at the surveyed baseline point (no.1), but increases somewhat further downstream, which is somewhat surprising and the reasons for which are unknown. This could be down to a measurement error at the baseline point upstream from the effluent discharge, or that increased river flow from effluents originating from the bioponds somehow enables higher species diversity downstream. At the same time, a spike in biomass and number of individuals (of a homogenous type) at point 3 below the effluent discharge point can likely be explained by the increased inflow of nutrients from the WWTP.

The new WWTP will generate effluents of higher quality which will reduce the nutrient load to the river, which are already high due to the limited flow. The proposed WWTP is anticipated to improve the quality of the effluents discharged to the Sokyr river via the bioponds. This can be expected to create more balanced and favourable habitat conditions for benthic fauna, which may support higher species diversity. The magnitude of impact on the Sokyr river receptor is considered medium positive, and the **impact significance therefore moderate positive**.

Regular hydrobiology monitoring in the Sokyr river should be adopted to verify the potential positive impacts from the proposed Project.

Closure and decommissioning activities

The negative impacts that may occur during decommissioning of the new WWTP are similar to those identified for the construction activities in general, e.g., relating to the destruction or disturbance of vegetated areas and potential habitat for animals. Any planned closure of facilities and infrastructure should be carried out appropriately to prevent the closed site constituting a risk for humans and animals and follow general measures to reduce the impact on existing habitats, as proposed below.

Mitigation measures

The following general mitigation measures should be implemented and have been included in the ESMP to avoid and minimise the identified impacts on fauna habitats.. Some of the above mitigation measures related to flora, as well as for soil and geology, are also applicable in this context, including those related to ‘Ground and soil disturbance’ and ‘Vegetation removal and associated risk of soil erosion’, and should be adopted with that in mind.

A dedicated biodiversity management (action) plan is not considered necessary for the project. Although several bird species were identified that are listed as vulnerable or near threatened according to IUCN or as vulnerable (V) in the Kazakhstan Red Data Book, all were observed in the bioponds area and/or in the sludge pond area and not within the actual proposed WWTP site. Nonetheless, it is important that construction activities are planned with due consideration of fauna with the objective to avoid habitat disturbance during the bird breeding season, as outlined below and in the ESMP.

Table 8.25: Mitigation measures related to fauna.

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
Detailed design of WWTP facilities (pre-construction)	• Opportunity to identify areas within the proposed WWTP site where existing habitats can be maintained.	• Plan construction activities to minimize disturbance to fauna habitats, particularly during sensitive breeding or migration seasons. • If needed, implement buffer zones and sediment control measures around wetlands and watercourses to prevent sediment runoff and pollution. • Phase construction activities to allow for the completion of work in one area before moving on to the next, reducing the overall footprint of disturbance. • Develop a **restoration plan** to rehabilitate disturbed areas post-construction, including a **plan to rehabilitate the sludge pond area** to support biodiversity. • When rehabilitating the sludge pond area, avoid any direct disturbance during the bird breeding season, and conduct visual inspection for bird nests prior to any works. Postpone earth works where nests have been identified.

Excavations, trenching and backfilling activities	• Removal and/or damage to vegetation and habitats of *e.g.* nesting birds	• Schedule noisy activities during periods when the least impact on fauna is expected, such as avoiding nocturnal species during their active periods.
		• Create or enhance alternative habitats nearby to compensate for any lost or impacted habitats.
		• Establish new vegetation areas, nesting sites, or artificial shelters suitable for the affected fauna species, *e.g.,* within the sludge pond area.
		• Take extra construction precautions to avoid indirect disturbance of the biopond and sludge pond bird habitats during the breeding season, due to the likely presence of vulnerable or near threatened species. This may involve:
		  • Establish a buffer zone between the WWTP construction site and the biopond habitats.
		  • Avoid traffic in the biopond area during the breeding season.
		  • Implement noise control and limit works to active day period.
		  • Limit artificial lighting at night.
		  • Avoid dust pollution.
		  • Consult with bird experts to refine the necessary mitigation measures.
		• Provide education and training to construction workers on the importance of fauna protection measures and ensure that workers understand mitigation requirements and their role in minimizing impacts on fauna. Provide training to the personnel responsible for construction site management in identifying the vulnerable and threatened bird species, to help avoid impacts should the species enter the construction site.

Activity	Impact or risk	Mitigation measures
Operation phase		
Ongoing landscaping within the WWTP site	• Opportunity to revegetate the site and create new biodiversity habitats.	• In line with the habitat restoration plan, continue creating or enhance alternative habitats nearby to compensate for any lost or impacted habitats. Establish new vegetation areas, nesting sites, or artificial shelters suitable for the affected fauna species, *e.g.*, within the sludge pond area.

Summary of residual impacts

The terrestrial and avifauna biodiversity impacts related to construction are first and foremost related to excavations, trenching and backfilling and associated removal of vegetation and potential habitats of birds or small animals within the affected WWTP area. No additional significant negative impacts on fauna or habitats are anticipated during construction. Indirect impacts on the nearby biopond bird habitats can be largely avoided by employing good management practice during the construction phase, with focus on avoiding disturbance for birds in the adjacent areas, especially during the breeding season.

Table 8.26: Summary of Terrestrial and Avifauna impacts around the WWTP site, pre-mitigation and residual (post-mitigation).

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Medium**	
Pre-construction and construction		
Spatial extent	*Limited*	*Limited*
Duration	*Long term*	*Long term*
Magnitude of impact	*Medium - negative*	*Low - negative*
Overall impact significance	Moderate - Negative	Minor – Negative
Operation phase		
Spatial extent	*No significant impacts anticipated*	
Duration		
Magnitude of impact		
Overall impact significance		

The improved effluent quality from the proposed WWTP is considered to result in **positive impacts on the aquatic ecosystems** and benthic fauna in the downstream water receptors, particularly **in the Sokyr river**, compared to the current situation. As no additional enhancement measures are anticipated, the pre-mitigation and residual impacts are the same.

Table 8.27: Summary of aquatic ecosystem impacts in the Sokyr river, pre-mitigation and residual (post-mitigation).

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Medium**	
Operation phase		
Spatial extent	*Regional*	*Regional*
Duration	*Long term*	*Long term*
Magnitude of impact	*Medium - positive*	*Medium – positive*

Overall impact significance	Moderate - positive	Moderate – positive

Regular hydrobiology monitoring in the Sokyr river should be adopted to verify the positive impacts from the proposed Project. This should be conducted annually for the first 3 years of operation of the new WWTP. At the end of 3 years, the results of monitoring should be reviewed to see if there is a clear understanding of the dynamics in the river benthic fauna and suggesting a clear improvement in water quality and biodiversity conditions, based on indicator species. If this is not the case after the first 3 years, the monitoring should be continued, and the appropriate monitoring frequency determined accordingly. Refer to baseline section and/or ESMP for outline of proposed monitoring parameters.

Summary of positive impacts and opportunities for environmental improvements

As for flora, there are opportunities to regenerate and strengthen habitats for fauna within the proposed WWTP site and to rehabilitate the existing sludge ponds to create more natural habitats promoting biodiversity. This could be seen to offset some of the negative vegetation impacts associated with the greenfield WWTP construction adjacent to the current WWTP.

8.1.9 Impacts on access roads and communal infrastructure

The proposed WWTP **construction and operation** will rely on various infrastructure or utilities which may not be located on the Project site, and/or not owned and operated by the Project proponent (KS) and which may be shared with the remaining community. This includes roads, access to water, energy and waste management or disposal infrastructure. This section discusses the potential impacts associated with the Project on the mentioned key infrastructure.

Pre-construction, construction and operation activities

As outlined in the baseline section, an approximately 5 km (4.7 km) **gravel road** connects the WWTP site, passing by the Kir-zavod 3-4 residential area to the north and passing through an industrial area before entering the western part of Karaganda City. Of this distance, a 750 m road is exclusively used for accessing the WWTP. The existing access road will remain the same for the proposed WWTP renewal, and no major works are planned.

During normal WWTP operations, the traffic to the WWTP is likely to be limited and similar to what it is today, which is likely only a small fraction of the total transport volumes on the part of the road passing through the industrial area. However, heavy traffic on the road will increase during construction (medium term) of the proposed WWTP, to supply the site with the necessary building materials. This can increase the wear and tear of the road, which appeared in a moderate condition at the time of the ESIA site visit, showing some signs of erosion after the winter and snow melt.

Provided that the road undergoes regular maintenance to sustain current traffic levels, it is expected that it can sustain temporary increase in traffic associated with the WWTP construction, without significant impact on other users. That said, some road deterioration can occur during the construction phase, due to the project and/or other traffic. Hence, it is important that:

- The condition of the access road used by the WWTP project is assessed and well documented prior to construction-start to determine the baseline condition (pre-construction survey).
- That division of responsibilities for road maintenance and potential improvements prior to and/or following the construction starts, is agreed between KS and the municipality prior to start of construction, to avoid the risk of disputes.

An activity in this regard is included in the list of mitigation measures below, and in the ESMP for the project.

In terms of **solid waste generation and disposal**, KS relies on external service providers with relevant permits to collect and dispose of solid waste (other than sludge) through appropriate channels based on waste types.

The construction phase will include the generation of construction related waste and household waste from workers on site. The largest waste fraction will be demolition waste from removing existing WWTP infrastructure once the new WWTP has been made operations. The estimated quantities have been estimated by Aquarem, as reflected in section 3.5, indicating almost 260,000 tons (115,000 m^3) demolition waste. Large parts of the demolition waste can be expected to be concrete and metal fractions.

As reflected in the baseline section, the municipal landfill is located 15.6 km to the north from the WWTP site. Although not highly developed, there is some recycling infrastructure in the city and a couple of waste companies are engaged in and accept construction waste for sorting and further recycling of some fractions, through specialised recycling providers.

To reduce the load on municipal landfills and to encourage resource efficiency and productivity in line with circular economy principles, KS should conduct an early pre-demolition audit to support selective deconstruction of the existing WWTP structures. This should have the aim to identify potential components that can be directly reused in the new WWTP and to sort remaining fractions on site to enable recycling. KS should engage with specialised construction waste service provides that offer recycling services. For the demolition and construction waste management, it is recommended that KS and its contractors follow, to the extent possible in the local context, the EU Construction and Demolition Waste Protocol and guidelines to guide the process. Requirements in this regard should be included in tendering documents.

To avoid illegal dumping of construction and demolition waste in the city, it is important to monitor waste contractors to ensure appropriate disposal and compliance.

Like the existing WWTP, the proposed WWTP will be connected to the municipal **water supply** mains with metered supply. The WWTP is not considered a significant consumer of water, which is limited to domestic use and cleaning purposes, hence no significant impacts expected.

For **electricity supply**, the WWTP will be connected to the regional electricity grid via a substation, similar to the current WWTP. As noted in the baseline section, the current WWTP is connected to the regional electricity grid via a 35kV overhead line that is connected to the onsite 35/10/0.4kV substation. Karaganda Regional Electricity Company manages the grid. Relocation of some transmission lines is planned to make space for new WWTP components (see chapter 3.3.5).

Aquarem has estimated that the gross electricity consumption of the proposed WWTP will be around 16.9 million kWh/year, which is a slight increase from the current 15.6 million kWh/year (2022). However, the proposed WWTP will include anaerobic digestion (AD) of sludge to produce biogas, which will be turned into heat and electricity with an on-site combined heat and power (CHP) plant. This will reduce the dependency on external power and heat sources to operate the proposed WWTP. It is estimated that between 40 and 50% of the gross electricity demand can be met by electricity generated in the on-site biogas fuelled CHP, hence reducing the grid electricity demand. Full details on the exact demand for off-site vs. on-site electricity are not yet available and should be clarified during detailed design.

For **heat**, the existing WWTP uses electricity for heating with on-site boilers. The same arrangement is expected for the new WWTP, although some of the heating demand can also be met by heat from the on-site CHP fuelled by biogas.

With regards to heat from biogas, the FS (Aquarem, 2023) states that biogas produced during anaerobic digestion in digesters and purified from impurities is burned in the gas generators of the cogeneration system of the boiler house and generators located in the building, and due to this, electric energy and hot water are generated. The regenerated heat from the generator cooling system will be used for the needs of digester heating systems, heating systems for sewage treatment plants, domestic hot water supply systems, and other purposes. There is also a flare facility for temporary or periodic complete combustion of biogas produced by biogas plants (methane tanks) in the absence of the possibility of its useful use as an energy carrier, as well as for burning elimination of excess biogas, which can be formed during maintenance work during operation and in case of accidents in the system. Sweco notes that there are currently no details available on to what extent on-site heat generation will substitute off-site sources. This should be clarified during detailed design of the facility.

Significant impacts on energy infrastructure are not expected.

Closure and decommissioning activities

N/A

Mitigation measures

Although significant impacts are not expected related to the use of the discussed infrastructure, the following general measures should be implemented, and have been included in the ESMP, in line with good practice.

*Table 8.28: Mitigation measures related to potential impacts on **communal infrastructure** and associated resource or waste streams.*

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
Use of access road to WWTP site	• Increased wear and tear due to increased heavy traffic during construction phase of the WWTP	• KS in collaboration with relevant authorities, ensure that the access road is maintained in adequate condition for heavy transport, prior to, during and following the construction phase. This should include as a minimum: - Conduct a pre-construction survey of the access road to be used for transport to and from the WWTP site with the aim to establish the condition of the road prior to construction start. - Document the condition of the road with technical documents and visual materials (photos and videos), as relevant. - Consult and obtain written confirmation and feedback (approval) on the pre-construction road survey from key stakeholders, incl. KS director, city council, local resident representatives (chairman) in the Kir-zavod residential area. - Agree on a road inspection protocol outlining how to record potential road deterioration during the construction phase. - A document agreement made between KS and the city council on the division of responsibilities for road maintenance and potential improvements prior to and/or following the construction starts. The agreement should be signed by KS and the municipality prior to start of construction and include provisions for funding of required road maintenance and other improvements. •
Waste generation and disposal during construction, including construction and	• Risk of inappropriate handling of CDW by waste contractors and/or contractors' sub-contractors.	• KS to adopt and implement auditing of waste contractors to ensure appropriate handling and disposal of waste, and compliance with legal requirements.

Activity	Impact or risk	Mitigation measures
demolition waste (CDW)	• Encourage sorting, reuse, and recycling of existing WWTP assets and demolition waste in line with circular economy principles	• Encourage sorting of waste, reuse, and recycling, in dialogue with relevant service providers. • To reduce the load on municipal landfills and to encourage resource efficiency and productivity in line with circular economy principles, KS should conduct an early pre-demolition audit to support selective deconstruction of the existing WWTP structures, with the aim to identify potential components that can be directly reused in the new WWTP and to sort remaining fractions on site to enable recycling. KS should engage with specialised construction waste service providers that offer recycling services. For the demolition and construction waste management, it is recommended that KS and its contractors follow, to the extent possible in the local context, the EU Construction and Demolition Waste Protocol and guidelines to guide the process. Requirements in this regard should be included in tendering documents.
Operation phase		
Waste generation and disposal during WWTP operation	• Risk of inappropriate handling of waste by waste contractors and/or contractors' sub-contractors.	• Adopt and implement auditing of waste contractors to ensure appropriate handling and disposal of waste, and compliance with legal requirements. • Encourage sorting of waste, reuse, and recycling to the extent possible, in dialogue with relevant service providers.
Resource (energy, water, materials) sourcing and consumption	• Risk of higher than necessary resource consumption, driving excessive demand from the distribution network with higher than necessary environmental and climate impacts.	• Develop and implement a **resource management and conservation plan** for the Project, outlining procedures and actions to continuously identify opportunities and alternatives for resource efficiency in its operations, including related to: - Energy efficiency - Water use efficiency - Material use efficiency - Waste minimisation and strategies for reduction, reuse, and recycling.

Summary of residual impacts

N/A – significant impacts are not expected.

8.1.10 Supply chain risks and impacts (ESG related)

Pre-construction, construction, and operation activities

Key construction inputs for civil works, including aggregates, concrete, timber, and other building materials are likely to be sourced from local providers, although the initial source of some input materials may be through international supply chains. It is important to ensure that aggregates for construction purposes are sourced from quarries which have the required permits.

Specific mechanical and electrical components for the WWTP itself are likely to be sourced internationally, through international tender processes.

In terms of sourcing of key consumables for the WWTP, the key sources of water, energy and waste services have been described in the baseline section. Additionally, the WWTP has been estimated to use

1,794 tons of coagulants (reagents) annually (Aquarem FS, 2023), which are likely to be sourced through national suppliers.

Given the nature of the Project, the risks in the supply chain related to Environmental, Social and Governance (ESG) factors, are not considered high. Nonetheless, risk areas include the sourcing of aggregates from local quarries and sourcing of construction materials, including wood products. Minor to moderate impacts may occur in the absence of risk mitigation measures. Nonetheless, basic due diligence procedures should be adopted to reduce the risk of ESG violations in the supply chain.

Mitigation measures

Although significant ESG supply chain risks are not expected related to construction and operation of the Project, the following general measures should be followed, in line with common good practice.

Table 8.29: Mitigation measures related to potential ESG impacts in the supply chain

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
Procurement of products and materials for the WWTP construction	• Risk of ESG impacts or violations in the supply chain	• Provide training to procurement teams to raise awareness about supply chain ESG impacts and build capacity to conduct ESG due diligence to identify and mitigate supply chain risks. • KS to integrate supply chain requirements into tendering and contractual documents and processes and reserve the right to monitor supply chain risks in contractors and subcontractors' activities through relevant clauses in contracts.
Sourcing of aggregates from local quarries	• Risk that material comes from quarries without the necessary permits	• Conduct appropriate due diligence to ensure that aggregates and other locally sourced construction materials come from legitimate sources and hold the necessary permits, including with regards to environmental, health and safety performance.
Sourcing of wood and wood products	• Risk that wood and wood products have been sourced from illegal or unsustainable forest operations	• Endeavor to source wood and wood products with internationally recognised sustainable forestry certifications, such as the FSC label. Conduct appropriate due diligence to verify this.
Operation phase		
Procurement of products and materials for the WWTP operation	• Risk of ESG impacts or violations in the supply chain	• Provide training to procurement teams to raise awareness about supply chain ESG impacts and build capacity to conduct ESG due diligence to identify and mitigate supply chain risks.

Summary of residual impacts

N/A

8.1.11 Opportunities related to reuse of effluents and digested sludge from the WWTP

The proposed WWTP Project will result in improvement of effluent quality as well as in treatment of sludge from the WWTP process, compared to the current situation.

This creates opportunities to further enhance the positive impacts of the Project, by striving for the optimal use of water and nutrients, in the spirit of a regenerative circular economy, as shortly outlined below.

It is acknowledged that there is a considerable need to improve resource efficiency in Kazakhstan. This need is clearly reflected in Kazakhstan's Green Economy Strategy, the aim of which is to address the current situation of inefficient use of resources, deteriorating natural resources and dependency on fossil fuels amongst others, and to put the country on a sustainable development path.[50]

Opportunities to reuse treated effluents from the WWTP

The bulk of water consumed in Kazakhstan, *approx.* 70%, is used for agriculture. A state Programme for Water Resources Management in Kazakhstan 2014-2040 is one of several programmes in the country that address water resources and water utilization issues. Amongst the priorities provided by the programme is that average tariffs for water supply to agriculture should be increased ten-fold to 58 tenge (USD 0.18 cent) per m^3 of water.[51] This seems to indicate an increasingly strong incentive for pursuing water efficiency and reuse in agriculture in the near future.

In Karaganda, annual rainfall is low, with an average of 340mm per year. Consequently, there appears to be an incentive to re-use treated effluent.

Treated effluents from the existing WWTP are not currently used for agricultural irrigation purposes, although the effluents appear to meet minimum requirements of the EU Water Reuse Regulation[52].

There is no agricultural land in the immediate vicinity of the WWTP. However, there seems to be an opportunity for local re-use of effluent within the green belt forestry area approx. 0-2 km to the west and south-west from the WWTP. It is recommended that KS explore further the potential to reuse effluents for irrigation (and/or other industrial purposes) in the vicinity of the WWTP, in dialogue with relevant authorities, farmers and industry associations. Using the water for irrigation of crops would, however, require regular testing that pathogen concentration does not exceed the appropriate EU limits.

The proposed new WWTP is designed to treat on average 100,000 m^3/day of wastewater, which is also roughly the amount of effluent that will be discharged from the plant. This amounts to 36.5 million m^3/year of effluent water.

A World Bank Report (2003) indicates that water withdrawals per irrigated hectare in Central Asia may be in the order of 12,000 – 14,000 m^3/ha, which is according to the report “excessively high”[53]. Nonetheless, this gives a rough indication of the irrigation potential of the treated wastewater in terms of how much land could theoretically be supplied with irrigation water in the form of treated effluents, assuming that other conditions such as crop type, soil and effluent conditions are also suitable. In this regard, 100,000 m^3 effluents (which is the approx. daily flow) could meet the irrigation needs of 8 ha assuming 12,000 m^3/ha irrigation requirements.

As outlined in chapter 8.1.48.1.4, the effluent from the new WWTP will, based on the design parameters, also comply with the EU minimum requirements for water reuse as specified in the EU’s water re-use guideline[54], with regards to BOD and TSS corresponding to crop category A, which is the highest water quality level. However, re-use of the water for agriculture must be subject to evidenced compliance with the remaining pathogen (E.Coli, Legionella, etc.) requirement of the EU regulation. (Table 8.12) and strict monitoring requirements as outlined in the EU’s water re-use guideline.

Also, the characteristics of treated wastewater, soil composition and crop type must be considered carefully. Despite the common positive effects of re-using treated effluents for agriculture, studies have shown that increase of electrical conductivity (EC) in soil may negatively affect crop productivity or soil salinization,

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50 https://www.oneplanetnetwork.org/sites/default/files/kazakhstan_concept_for_transition_of_the_republic_of_kazakhstan_to_green_economy.pdf

51 https://www.s-ge.com/sites/default/files/article/downloads/industry_report_kazakhstan_water_management_2017.pdf

52 eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R0741&from=EN

53 Irrigation in Central Asia Social, Economic and Environmental Considerations (World Bank, 2003)

54 Regulation (EU) 2020/741 of the European Parliament and of the Council of 25 May 2020 on minimum requirements for water reuse. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32020R0741

depending on the treated effluent and soil compositions, and crop type[55]. Hence, careful monitoring of the relevant factors is required prior to use. FAO's irrigation guidelines provide insights on how to overcome salinity risks associated, guidance on good practice and efficient irrigation methods, *etc*.

Opportunities to reuse treated sludge from the WWTP

At the EU level, the Sewage Sludge Directive 86/278/EEC encourages re-use of sewage sludge in agriculture and regulates its use in such a way as to prevent harmful effects on soil, vegetation, animals and man. The Directive accepts the re-use of sludge on agricultural land if the sludge has undergone treatment involving "biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use".

The proposed anaerobic digestion (AD) also enables compliance with the EU Sewage Sludge Directive 86/278/EEC.

There is currently no regular re-use of sludge from the Karaganda WWTP for agricultural or other land-use purposes. Some Kir-zavod residents have used it for their vegetable patches in small scale.

In general, KS indicated that there was insufficient land for sludge application, but at the same time it was noted that a green belt of trees and other vegetation is being created around the city, but using sludge for these areas was difficult and required special permission. It was noted however, during the ESIA site visit, that last year a local energy company used dried sludge from the WWTP in a one-off project (39,870 m^3) to cover and rehabilitate a disposal area used for (incineration) ash. While sludge quality measurements have likely been conducted in this regard, KS did not have access to these. It is not known why this initiative has not continued.

Sludge quality sampling conducted as part of this ESIA does however indicate that heavy metal values in the historic sludge are low, and well within the limit values of the EU Sludge directive "Limit values for heavy metals concentrations in sludge for use in agriculture". Hence, based on this, **the sludge is suitable for use in agriculture**.

Sweco also notes that, in addition to the Karaganda green belt initiative, there is substantial coal mining activity around the city, which could be explored in terms of need for material to support rehabilitation efforts. Furthermore, as part of the ESIA process, a contact was made to the Karaganda forest and wildlife protection farms which is directed to Karaganda Region Natural Resources and Nature Management Department of Karaganda Region. They expressed interest to use sludge as fertiliser. They have much land which is not forestry land, and where they could apply treated sludge. They were interested in further dialogue regarding the process, e.g., on who would deliver the treated sludge to the sites.

Hence, a dedicated effort to identify areas for reusing treated sludge with mutual benefits seems possible. However, identifying and following up on reuse opportunities requires focused coordination between different stakeholders to be successful.

The proposed WWTP is projected to generate 50 tons/day of treated and dried sludge (50% dry solids), which amounts to roughly 18,250 tons/year.

In Kazakhstan, the reuse of sludge for agricultural purposes is accepted. There is no sludge disposal policy in Kazakhstan. However, waste handling and disposal requirements are given in the Environmental Code. Sludge is categorised as non-hazardous waste and can be used in agriculture or horticulture, providing the maximum permitted concentrations of pollutants and pathogens in the soil are met. Composting sludge is also considered to remove pathogens but rarely applied.

55 https://www.researchgate.net/publication/258614930_Salinity_effect_of_irrigation_with_treated_wastewater_in_basal_soil_respiration_in_SE_of_Spain

Spanish studies have shown that long term application of sewage sludge enhances soil properties but indicate maximum dosage of 40 tons per ha (dry solids), applied biannually. Above this level, soil quality did not improve, and may even worsen[56].

Potential land areas for effluent and sludge reuse in the vicinity of the WWTP

In light of the above opportunities, and as reflected in Table 8.13, KS should develop a **resource management and conservation plan**, that amongst other includes **a plan for reusing effluents and sludge** from the WWTP, including measures to consult relevant farmers and other stakeholders in Karaganda with regards to potential utilisation of these resources.

Identified reuse options need to be further explored and a **plan for reusing effluents and sludge** will need to be developed by KS to continuously explore options to reuse the generated and treated sludge, in dialogue between the operating authority of the WWTP and other relevant stakeholders in the area, municipality, famers, railway operator, Forestry Committee, etc. Any sludge reuse involving land application, must be subject to prior monitoring of contaminants and with account taken of the nutrient requirements of plants, and that the quality of the receiving soil and of the surface and groundwater is not impaired, in line with the EU sludge directive.

8.2 Socio-economic impacts

This section describes the positive and negative impacts that the proposed WWTP Project is assessed to have on the human receptors described in the baseline section of this ESIA report. The assessment is made in relation to activities during the pre-construction and construction phase and the operation and maintenance phase, while there are not expected to be any socio-impacts of activities during closure and decommissioning of the proposed WWTP.

The following table provides an overview of the human receptors and their assessed level of sensitivity in the context of the Project. Sensitivity rating has been based primarily on proximity to the project site, considering also receptors vulnerability to project impacts.

Table 8.30: Human receptors and level of sensitivity in the context of the Project.

Receptor	Assessed sensitivity
Residents in the settlement of Railway Junction 737	High
Residents on Proizvedstyannya street	High
Residents in Kir-zavod 3 and 4	Medium
Workers at the IP MetalWork	Low to Medium
Residents in Karaganda City	Low
Construction workers	Medium to High

8.2.1 Impact on employment

Pre-construction and Construction Phase activities

The construction of the new WWTP will be associated with moderate workforce engagement. The Project is expected to employ around 100 workers during the construction phase of approximately 3 years' duration[57]. The construction workforce will require both unskilled, semi-skilled, and skilled workers.

56 https://ec.europa.eu/environment/integration/research/newsalert/pdf/298na3_en.pdf. Referred to as an example - results not directly transferrable to other countries and regions.

57 As Aquarem's Feasibility Study (2023) does not provide details of the construction workforce, an estimate has been made by Sweco's wastewater specialist.

The baseline demonstrates that in 2022 approx. 37,853 persons in Karaganda Region were engaged in the construction sector, which constituted 6.7% of the total workforce. This is slightly lower than the percentage of the workforce at national level (7.3%) engaged in the construction sector.

Due to the Project's location within the borders of Karaganda City and the availability of construction workers in the area, it is expected that the construction workforce will be hired from Karaganda City, enabling local-level job generation, or within Karaganda Region.

The construction activities will lead to employment opportunity for a moderate number of unskilled and skilled workers during the construction period. The impact on the employment is **direct** and **medium-term** (estimated 36 month of construction). The spatial extent of the impact is **regional** within Karaganda Region. The impact magnitude is determined as medium and positive. Given the medium sensitivity of the receptor, the **overall impact is considered of moderate – positive** when unmitigated.

Operation and maintenance activities

The KS number of staff is relatively high for a utility with a total of 1,623 employees, of which 339 employees work in the departments involved in wastewater related services, while the vast majority of staff work in departments related to water supply.

Table 8.31: Overview of main KS departments/units and staff engaged in wastewater services

KS Department/Units*	Total staff	Men	Women	% of Women
Wastewater Department (wastewater network, incl. repair work)	234	154	80	34%
Wastewater treatment plant (WWTP)	105	43	62	59%
TOTAL	**339**	**197**	**142**	**42%**

Source: Karaganda Su
** The operations and maintenance of wastewater pumping stations are the responsibility of the Department of Water Supply and Treatment Services*

The Feasibility Study (FS) prepared by Sweco (2021) considers KS as overstaffed and foresees a substantial staff reduction of O&M staff working at the Karaganda WWTP. The FS recommends that efforts are made to transfer the surplus staff to other positions within the company. The Sweco technical team has based on experience from similar WWTP operations, estimated that KS will reduce its existing WWTP staff from 105 to 50 people, leaving a redundance of approximately 55 people.

According to the collective agreement, the notice period in connection with dismissals is two months and the KS trade union committee is to be informed in writing about the dismissal and the reasons for this. It is understood that when reduction of staff is considered necessary in a particular working area, the employees concerned would be offered other jobs within the company, in accordance with the Labour Law.

The impact on employment during operation is **direct** and **long-term**. The spatial extent of the impact is **regional** within Karaganda Region. The impact magnitude is determined as high and negative. Given the medium sensitivity of the receptor, the **overall impact is considered of moderate – negative** when un-mitigated.

Mitigation measures

The following general mitigation and enhancement measures should be implemented to minimise the identified negative impacts related to employment and enhance the positive ones.

Table 8.32: Mitigation measures related to employment

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
Construction of the WWTP	• Risk of influx of workers	• KS to contract local contractor to ensure local employment. • Contractor will develop a local recruitment policy, including advertising jobs locally, aiming at employing local workers from Karaganda City and neighbouring villages, where appropriate.
Operation phase		
Operation and maintenance of the WWTP	• Risk of retrenchment	• KS shall promptly, but no later than 60 days before any decision is taken in respect of any planned redundancy, inform EBRD if such redundancy affects at least 10% of its total employees over a 30-day period and prepare a Retrenchment Plan in line with PR2 requirements. In the case of any planned redundancy affecting at least 25% of its total employees over a 30-day period of time, KS will provide the Retrenchment Plan to EBRD prior to undertaking any of the planned redundancies. KS to cooperate with the City Akimat to identify employment opportunities for redundant employees outside of KS.

Summary of residual impacts

The employment impacts related to construction are overall positive as the Project will create jobs. During operations a negative impact is foreseen due to reduction of WWTP staff in KS.

Table 8.33: Summary of impacts on employment, pre-mitigation and residual (post-mitigation).

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Low – medium**	
Pre-construction and construction		
Spatial extent	*Regional*	*Regional*
Duration	*Medium term*	*Medium term*
Magnitude of impact	*Medium*	*Medium*
Overall impact significance	Minor – Positive	Moderate – Positive
Operation phase		
Spatial extent	*Regional*	*Regional*
Duration	*Long term*	*Long term*
Magnitude of impact	*Medium*	*Low*
Overall impact significance	Major – Negative	Moderate – Negative

8.2.2 Impact on labour and working conditions

Potential risks related to labour and working condition arise in case KS and contractors fail to comply with specific requirements of national and international labour standards, leading to:

- Violation of labour conditions, *e.g.,* working hours and overtime, remuneration and delayed payment, provision of rest and holidays, workers' unions, and personal data protection.
- Discriminatory practices and lack of equal opportunity.
- Lack of or restricted access to a workers' grievance mechanism.

Pre-construction and Construction Phase activities

During construction, KS is to ensure that provisions for Contractor labour compliance are followed, including but not limited to the following:

- Compliance with national social security, health and safety and labour requirements.
- Adherence to fundamental standards and principles of the International Labour Organization regarding minimum age and child labour, forced labour, freedom of association and non-discrimination.
- Fair and timely remuneration.
- Provision of a workers' grievance mechanism.
- Contractors' personnel management and control.

KS is to require the Project contractors and subcontractors to comply with the labour requirements of EBRD PR2 as a special clause in the service and supply contracts. KS will monitor contractors and subcontractors for compliance with requirements through regular labour inspections conducted by KS staff, establishing compliance on the above.

KS shall extend access to their internal grievance mechanism to contractors and subcontractors' workers and ensure that contractors are aware of the need to allow for confidential submission of grievances from their personnel.

It is anticipated that the Project will not require any construction workers' accommodation camp, as workers are expected to be able to commute to and from the WWTP construction site. In 2022, Karaganda City had 90 registered accommodation facilities (hotels of various categories of comfort, motels, summer house zones, rest houses and other facilities), with 2,778 registered beds. A relatively limited number of tourists and other visitors stay overnight in Karaganda Region, leaving an excess accommodation capacity that can be used in case this may be needed during construction. Due to the availability of a construction workforce in Karaganda Region, migrant workers are not foreseen to be hired for Project construction or operation. In case international staff will be used for positions requiring specific expertise, these are expected to be accommodated in Karaganda City.

KS will be responsible for managing contractors and subcontractors during the construction phase, ensuring that labour is managed in a manner compliant with EBRD's Performance Requirement (PR) 2 requirements. It is assessed that KS's approach to and experience in regulating contractor labour conditions is insufficient to ensure proper contractor management on labour and working conditions. The environmental and social requirements and actions set out in the ESMP will apply to all contractors and sub-contractors working on the Project. At the corporate level, KS will strengthen its contractor management system to make sure that contractors working on project sites meet these labour requirements.

The impact on labour conditions is **direct** and **medium-term** (estimated 36 month of construction). The spatial extent of the impact is **regional** within Karaganda Region. The impact magnitude is determined as medium and negative. Given the medium sensitivity of the receptor, the **overall impact is considered of moderate – negative** when un-mitigated.

Operation and maintenance activities

Labour and working conditions are regulated by a number of documents including the collective agreement, employee contracts, and internal labour regulations.

In terms of labour management, KS has many appropriate human resource procedures and has documented and communicated working conditions and terms of employment to their employees. The company does not have a written HR policy, but working conditions are documented in the collective agreement signed between the KS management and the KS trade union committee. Identified gaps in the Environmental and Social Management System (ESMS) are addressed in the company Environmental and Social Action Plan (ESAP) and will be closed prior to operation.

The impact on labour conditions is **direct** and **long-term**. The spatial extent of the impact is **regional** within Karaganda Region. The impact magnitude is determined as high and negative. Given the medium sensitivity of the receptor, the **overall impact is considered of moderate – negative** when unmitigated.

Mitigation measures

The following general mitigation measures should be implemented to avoid and minimise the identified impacts on labour and working conditions associated with the Project.

Table 8.34: Mitigation measures related to labour and working conditions

Activity	Impact or risk	Mitigation measures
Construction phase		
Construction work, operation, and maintenance	• Working conditions and terms of employment	• KS to integrate labour requirements in tender documents and in contracts with all contractors involved in the construction. • KS to develop and implement auditing and performance monitoring procedures to check contractors' compliance with labour requirements. • Contractors are required to adopt and implement a Labour Management Plan including human resources policy and procedures, which will set out the approach to labour management consistent with the EBRD requirements and the laws of Kazakhstan. The policy and procedures will cover and ensure compliance with the relevant requirements for the following: i. non-discrimination, equal opportunity, and equal pay. ii. prevention of child labour and forced labour. iii. freedom of association and right of collective bargaining. iv. contractor management. v. terms of employment including recruitment, hours of work, overtime arrangement and overtime remuneration, the right to refuse overtime requests. vi. commitment to apply zero tolerance for gender-based violence, workplace harassment, sexual exploitation, and abuse. vii. formal grievance mechanism. • The human resources policy and procedures including the grievance mechanism will be provided to all workers. These documents will contain information that is clear and understandable regarding workers' rights under national labour and employment law(s) and any applicable collective agreements.
	• Workers' grievance mechanism	• The Contractor will provide construction workers with an effective grievance mechanism (GM) and make the GM available for the workforce of sub-contractors and suppliers. • The GM shall include provision for GBVH grievances ensuring confidentiality. • This mechanism shall involve appropriate level of management and address concerns promptly, using an understandable and transparent process that provides timely feedback to those concerned without retribution. The mechanism should allow for anonymous complaints to be raised and addressed. The mechanism should not impede access to other judicial or administrative remedies that might be available under the law or through existing arbitration procedures, or substitute for grievance mechanisms provided through collective agreements.
	• Workers' accommodation	• In case workers accommodation will be provided during the construction phase, ensure that facilities are compliant with

Activity	Impact or risk	Mitigation measures
		EBRD/IFC Guidance "Workers' Accommodation: Processes and Standards".

Summary of residual impacts

The impacts on labour and working conditions during the construction phase are related to the risk of Contractors and sub-contractors not adhering to national and international labour requirements. Improvements to KS human resources practices are addressed in the company Environmental and Social Action Plan (ESAP) and will be closed prior to the operation phase of the Project**.**

Table 8.35: Summary of impacts on labour and working conditions, pre-mitigation and residual (post-mitigation).

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Low – medium**	
Pre-construction and construction		
Spatial extent	*Regional*	*Regional*
Duration	*Medium term*	*Medium term*
Magnitude of impact	*Medium*	*Medium*
Overall impact significance	Moderate – Negative	Minor – Negative
Operation phase		
Spatial extent	*Regional*	*Regional*
Duration	*Long term*	*Medium term*
Magnitude of impact	*Medium*	*Low*
Overall impact significance	Moderate – Negative	Minor – Negative

8.2.3 Impact on workers' health and safety

Pre-construction and Construction Phase activities

Almost all of the activities during the construction phase of the Project can entail risks related to Occupational Health and Safety (OHS). The types of OHS risks during the construction phase are typical for most large construction and infrastructure projects and include the following activities and associated risks, amongst others:

Table 8.36: Mitigation measures related workers' health and safety

Activity	Risk and Impacts
Construction phase	
Excavation and trenching	• Cave-ins, engulfment, falls, exposure to hazardous substances in soil. • Resulting in worker injuries or fatalities, damage to underground utilities, environmental contamination.
Demolition works	• Structural collapse, falling objects, exposure to hazardous materials (asbestos, lead, etc.), exposure to noise and vibration. • Resulting in worker injuries, release of hazardous substances into the environment.
Working at heights	• Falls from heights, unstable scaffolding, inadequate fall protection measures, falling objects. • Resulting in serious injuries or fatalities, damage to property, disruption of work, potential environmental impact.
Heavy lifting and handling of materials	• Risk of musculoskeletal injuries, strains, falls, struck-by hazards, improper use of lifting equipment.

Activity	Risk and Impacts
	• Resulting in worker injuries, property damage, project delays, increased costs.
Working with hazardous materials.	• Exposure to chemicals, asbestos, lead, silica, solvents, fumes, and dust, inhalation, skin contact, or ingestion hazards. • Resulting in occupational illnesses, long-term health effects, contamination of soil, water, or air.
Electrical work	• Electric shock, burns, arc flash, contact with energized equipment or overhead powerlines. • Resulting in worker injuries or fatalities, electrical fires, damage to equipment, disruption of electrical services.
Welding and cutting	• Risk of burns, eye injuries, inhalation of toxic fumes and gases, fire hazards. • Resulting in worker injuries, fire incidents, damage to structures or equipment, air pollution.
Exposure to Noise and vibration	• Risk of noise-induced hearing loss, communication difficulties, vibration-related disorders. • Resulting in occupational hearing loss, reduced productivity, disturbance to nearby communities.
Work in confined spaces	• Risks of lack of oxygen, toxic gases, engulfment, physical hazards, poor visibility. • Resulting in worker injuries or fatalities, rescue operations, project delays, potential environmental risks.
Transport activities	• Risk of vehicle collisions, struck-by incidents, worker exposure to moving traffic. • Resulting in worker injuries or fatalities, traffic congestion, potential disruptions to local traffic flow.

The project will include relocation of sections of 35kV and 6kV overhead power lines, as described in further detail in section 3.3.5. A separate plan for the relocation of the overhead lines will be prepared at the detailed design stage and submitted for approval to the city power network management company. The overhead lines will be relocated by a special contractor following the approved plan. It is important that this plan includes specific OHS provisions related to electrical works and safety associated with the OHS relocation process. Also, provisions should be made in this plan related to the access road to the WWTP site and where the lines are passing, in terms of H&S measures, and if any temporary access needs to be prepared during the relocation work. Alignment should be made with relevant sections of the construction traffic management plan.

The sensitivity of workers to H&S risks is high. Given the size and complexity of the construction project, the magnitude of potential impact is considered medium. Hence, the overall significance is **considered major – negative.**

Operation and maintenance activities

The OHS risks related to the operation and maintenance of the WWTP are largely the same as during construction. However, some specific risks are relevant for WWTPs. The IFC EHS guidelines for Water and Sanitation outline the **following risks and impacts** associated with the operational phase of water and sanitation projects:

- **Accidents and injuries**; related to open water and risk of drowning, trenches, slippery walkways, working at heights, energized circuits, and heavy equipment, entry into confined spaces, including manholes, sewers, pipelines, storage tanks, wet wells, digesters, and pump stations. Methane generated from anaerobic biodegradation of sewage can lead to fires and explosions.
- **Chemical exposure and hazardous atmosphere**; including use of potentially hazardous chemicals, ammonia, pollutants accumulating in wastewater and sludge, pumps and piping with mineral scales, lagoons with residual sludge, enclosed facilities, exposure to hydrogen sulphide, methane, carbon monoxide, *etc*.
- **Exposure to pathogens and vectors**; including pathogens contained in sewage. Bioaerosols which are suspensions of particles in the air consisting partially or wholly of microorganisms, such as bacteria,

viruses, moulds, and fungi. Vectors for sewage pathogens include insects (*e.g.* flies), rodents (*e.g.* rats) and birds (*e.g.* gulls).
- **Noise**; from pumps, air blowers, traffic, *etc*.

As for construction, the sensitivity of workers to H&S risks is high. Without proper management of H&S risks, the magnitude or potential H&S impacts at a WWTP site is also medium to high, depending on the type of work and exposure to risks. Hence, the overall significance of impacts if unmitigated is **considered major – negative.**

It should be noted, however, that the existing WWTP is in a poor condition and poses significant safety risks for workers. Hence, in comparison with the existing WWTP, the proposed new WWTP will result in substantial improvements in OHS as it regards infrastructure safety.

Mitigation measures

The risks of health and safety incidents and accidents occurring must be minimised through effective OHS management systems implemented by KS and its contractors. The following high-level measures should be implemented to avoid and minimise the identified risks. Further details are provided in the ESMP.

Table 8.37Mitigation measures related to Occupational Health and Safety

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
Construction work, operation, and maintenance	• Occupational Health and Safety	• KS shall develop and adapt an Occupational Health and Safety Policy and procedures for the construction Project, within their overall OHS management system. • KS to integrate OHS requirements in tender documents and in contracts with all contractors involved in the construction. OHS requirements to favour companies with OHS management systems in line with international standards (ISO 45001 or similar). • KS to develop and implement auditing and performance monitoring procedures to check contractors' compliance with OHS requirements. • OHS Policy and procedures will be developed and adopted by the Contractor and sub-contractors. KS will check the adoption and monitor implementation of the Policy provisions. • Prior to commencement of construction works the Contractor shall develop specific health and safety procedures, including procedures for transportation of workers to and from the construction site. • Contractor to provide capacity building to its workers on OHS matters.
		• Contractor to ensure provision of sanitary facilities in compliance with sanitary norms.
Organisational capacity and staffing		• KS to assign at least one full time employee to the coordination and monitoring of OHS management during the construction phase, including supervision of contractor OHS management. • Each contractor to assign at least one manager to oversee OHS management of their respective work responsibilities.
Medical emergency response plan		• Provide medical emergency response plan. • Ensure presence of a well-equipped on-site first aid facility and train staff to act as first aid responders.
Monitoring and reporting		• Construction contractor to report to KS on all incidents and accidents and continuous improvement measures on at least a monthly basis. Serious incidents to be reported immediately.
Relocation of overhead power lines	• Specific H&S risks related to electrical safety	• OHS provisions related to electrical works and safety associated with the OHS relocation process to be included in the plan for the relocation of the overhead power lines, to apply for the relevant contractors as contractual obligations.

Activity	Impact or risk	Mitigation measures
		• Provisions should be made in this plan related to the access road to the WWTP site where the lines are passing, in terms of H&S measures, and if any temporary or permanent access needs to be prepared during the relocation work to allow for safe movement of vehicles and heavy equipment to the WWTP site. Alignment should be made with relevant sections of the construction traffic management plan.
Operation phase		
OHS management	• Occupational Health and Safety	• KS to adopt and implement an OHS management system based on ISO 45001 or similar for its WWTP operations.

Summary of residual impacts

Table 8.38: Summary of impacts on workers' health and safety, pre-mitigation and residual (post-mitigation)

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**High**	
Pre-construction and construction		
Spatial extent	*Limited*	*Limited*
Duration	*Medium term*	*Medium term*
Magnitude of impact	*Medium – negative*	*Low – negative*
Overall impact significance	Major – negative	Moderate – negative
Operation phase		
Spatial extent	*Limited*	*Limited*
Duration	*Medium term*	*Medium term*
Magnitude of impact	*Medium – negative*	*Low – negative*
Overall impact significance	Major – negative	Moderate – negative

8.2.4 Impact on migrant influx

While Karaganda City experienced a negative net migration in 2016-2019, the net migration since 2020 has been slightly positive. The Karaganda Region, however, is experiencing a negative net migration, although it has declined over the past years. The Department for Coordination of Employment and Social Programmes in Karaganda Region registered in the period from January 2022 to August 2023 applications from 5 persons for refugee status in Karaganda Region.

Given the Project's limited use of construction workers, the Project is not expected to prompt additional migrant influx into Karaganda City or Region. No mitigation will be required.

Based on the assessment, the impact on migrant influx is **not significant.**

8.2.5 Impact on community health and safety

The proposed WWTP is located in an industrial area with the nearest residential area located >500m from the new WWTP site.

The main potential receptors considered for the assessment of community health and safety impacts are:

- Residents in Railway Junction 737 located approximately 530 m east of the WWTP with 34-40 families.

- Residents on Proizvedstyannya street located 505 m north-west of the WWTP consisting of two houses but only 1 resident.
- Residents in Kir-zavod 3 and 4 located 800 m north-west of the WWTP with 83 households and 324 inhabitants.
- Workers at the IP MetalWork 1 km east of the new WWTP.

There are no schools, health clinics, or other social facilities located close to the WWTP. The closest school and medical centre are located north-east of the WWTP in Bolshaya Mikhaylovka and Fedorovka micro-districts, respectively. The school is approximately 1.8 km from the WWTP, while the closest medical centre is approximately 3.8 km. from the WWTP.

Pre-construction and Construction Phase activities

The following potential risks to community health and safety in connection with pre-construction and construction activities are considered in the assessment:

- Non-communicable diseases due to air quality, including odour and dust, and noise from Project construction activities.
- Communicable diseases spread though contact between Project construction personnel and local communities.
- Risk of gender-based violence and harassment (addressed in section 8.2.6).
- Potential for disputes and conflicts.
- Risk of injuries due to traffic and transport to the site during construction.

<u>Air quality</u>

Analysis and assessment of Project impacts related to air quality is presented in section 8.1.5.

Air quality impacts during construction are related to **dust** generated through excavation activities, removal of vegetation and related soil erosion and transport on gravel roads, while **emissions from vehicles and construction equipment** result in air pollution. The analysis of air quality concludes that dust and emissions are expected mostly in residential areas located >500m away from the WWTP site. Impacts related to air quality are likely to affect primarily the OHS of construction workers on site, which is assessed in a separate section of this report.

Emptying the existing sludge ponds as part of potential rehabilitation activities of the area is likely to result in **odour generation** at the site, which can be dispersed to nearby residential areas. Focus group discussions with neighbouring communities confirmed that the existing WWTP cause significant odour annoyances to the residents. As the use of the sludge ponds will stop with the proposed and improved WWTP process, this impact is also limited to the time it takes to empty the ponds.

The un-mitigated significance of **air quality impacts during construction** is considered **moderate - negative.**

<u>Noise</u>

Analysis and assessment of Project impacts related to noise in section 8.1.6.

Noise impacts during construction are **related to operations of construction machines and equipment**. These impacts are medium-term, limited in time during day-time and to the length of the construction phase, and spatial extent is limited to the WWTP site itself and the access road to the site. There are no immediate residential receptors in the vicinity, so the impacts are likely to affect primarily the OHS of construction workers on site, which is assessed in a separate section of this report.

The un-mitigated significance of **noise impacts during construction** are considered of **minor – negative**.

Communicable diseases, and risk of conflict

The assessment is based on high-level baseline data on the epidemiological situation in Karaganda City. No detailed data on the health profiles of the neighbouring residential areas are available. Overall, the health-related impacts associated with the Project implementation are two-fold with negative impacts occurring during the construction phase and positive impacts during operation.

The risk of communicable diseases, including sexually transmitted diseases (STDs), such as HIV/AIDS are primarily related to contact between the Project workforce and residents in the Project area.

The construction workforce is foreseen to mainly be recruited from within Karaganda Region, and no influx of construction workers is expected. Given the distance of the WWTP site to the nearest residential areas the interaction between the Project construction workforce and the local communities will be low. For these reasons, impacts on community health and safety caused by influx, such as spread of communicable diseases, including STDs and COVID, and risk of conflict is assessed to be low.

The un-mitigated significance of **impacts on communicable diseases, and risk of conflict** during construction is considered **minor – negative.**

Traffic and transport

Transport of equipment, construction materials and workforce will be needed during the construction period. The existing and proposed WWTP site is accessed via an approximately 5 km gravel road passing by the Kir-zavod 3-4 residential area to the north and an industrial area, before entering the western part of Karaganda City. Of this distance, a 750 m road is exclusively used for accessing the WWTP. The existing access road will remain the same for the construction of the proposed new WWTP, and no major road works are planned. During normal WWTP operations, the traffic to the WWTP is likely to be limited and similar to what it is today, which is likely only a small fraction of the total transport volumes on the part of the road passing through the industrial area. However, heavy traffic on the road will increase during construction (medium term) of the proposed WWTP, to supply the site with the necessary building materials.

Data obtained from the Department of Housing and Communal Services, Passenger Transport and Roads of Karaganda City, show that in the first six months of 2023, a total of 39 traffic accidents were registered, in which 10 people were killed and 40 were injured to varying degrees of severity. This is a 22% decrease in the total number of traffic accidents compared to the year prior. According to the Territorial Police Departments of Karaganda City, 5 traffic accidents were registered in the Mikhailovsky district (where the new WTTP is located) in the first six months of 2023, in which 2 people were killed and 6 people were injured.

The un-mitigated significance of **risk of injuries due to traffic and transport** during construction is considered **moderate – negative.**

The impact on community health and safety during construction is **direct** and **medium-term**. The spatial extent of the impact is **local**. The overall impact magnitude is determined as medium and negative. Given the medium – low sensitivity of the receptors, the **overall impact is considered of moderate – negative** when un-mitigated.

Operation and maintenance activities

The potential risks to community health and safety assessed for operation activities considered in the assessment:

- Air quality including odour from the WWTP and the effluent discharge.
- Safe use of effluent and sludge for agricultural and/or other land rehabilitation purposes.
- Water and sanitation related diseases.

- Traffic and transport to the site during operation.

The Project will provide significant benefits for the residents in Karaganda, through improved wastewater services. The Project is anticipated to generate a range of positive environmental and health and safety impacts during its operation phase, by treating wastewater to the required standards, and by removing old and potentially dangerous structures. This is expected to lead to reduced pollution levels and accident risks, improved sludge management, and should also help improve the biological condition of the environmental recipients, particularly the Sokyr river to where effluents are discharged, which improves community health and safety more broadly. The other environmental, health and safety impacts are anticipated to be the same as those for the construction phase of the WWTP.

Air quality including odour

During the operation phase, the most important impacts relate to odour from the WWTP and associated sludge handling. The proposed WWTP Project is expected to significantly improve the odour situation, by using anaerobic digestion of the sludge, abandoning the use of open sludge ponds, and improving the quality of effluents.

Use of effluent and sludge

There is currently no reuse of effluent and sludge from the Karaganda WWTP for agricultural purposes. While there is no agricultural land in the immediate vicinity of the WWTP, there appear to be opportunities for local re-use of effluent within the green belt forestry area. The proposed WWTP project will result in significant improvement of effluent quality as well as in treatment of sludge from the WWTP process, compared to the current situation. This creates opportunities to further enhance the positive impacts of the project.

Water and sanitation related diseases

Statistics on water and sanitation related diseases in Karaganda City were obtained from the Department of Sanitary and Epidemiological Control of Karaganda Region. The Department provided information on infectious and parasitic diseases in Karaganda over the past 7 years. The incidence rates per 100,000 persons for all diseases including those related to water and sanitation have fluctuated over the last seven years, with most having decreased substantially compared to 2019 (pre-Covid 19), except for rotaviral enteritis. However, these incidences cannot necessarily all be attributed to poor water quality, and/or poor sanitary situations.

Some reduction in water and sanitation related diseases is expected from the improved wastewater treatment due to the Project, resulting in reduced mortality and morbidity; this may lead to reduced health costs for the individual family and the society as a whole. The expected positive impacts cannot, however, be quantified.

The un-mitigated significance of **impacts on water and sanitation related diseases** during operation is considered **moderate – positive.**

Traffic and transport

The operation will involve some ongoing heavy transport activities to and from the site. During normal WWTP operations, the traffic to the WWTP is expected to be a small fraction of the heavy transport to the industrial area.

The un-mitigated significance of **risk of injuries due to traffic and transport** during operation is considered **minor – negative.**

The overall impact on community health and safety during operation is considered to be positive. The impact is **direct** and **long-term**. The spatial extent of the impact is **local**. The overall impact magnitude is determined as medium and positive. Given the medium – low sensitivity of the receptors, the **overall impact is considered of moderate – positive**.

The overall impact on community health and safety during operation is considered to be positive. The impact is **direct** and **long-term**. The spatial extent of the impact is **local**. The overall impact magnitude is determined as medium and positive. Given the medium – low sensitivity of the receptors, the **overall impact is considered of moderate – positive**.

Mitigation measures

The following general mitigation measures should be implemented to avoid and minimise the identified impacts on community health and safety associated with the Project.

Table 8.39: Mitigation measures related to community health and safety

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
Air quality and noise	• Non-communicable diseases	• Described in section 8.1.5 and 8.1.6
Interaction between construction workers and communities	• Communicable diseases	• As part of the safety induction training and regular safety trainings, inform about the risk of STDs and methods for prevention. • Introduce a Code of Conduct to be followed by contractors and subcontractors. • Inform the local communities on functioning of the grievance mechanism. • Dissemination of Project related information among local communities as indicated in the Stakeholder Engagement Plan
Transport of construction materials	• Risk of accidents	• Conduct pre-construction assessment of the local roads to be used during construction. • Oblige Contractor to have damage claims and complaints procedure in place for local communities. • Manage the Project transportation activities in a manner ensuring use of roads at low traffic hours to the extent possible. • Ensure observance of traffic safety rules, including speed limits. • Regular inspections of vehicle fleet to avoid breakdowns during trips and prevent consequential traffic congestion or increased risk of accidents.
Operation phase		
Traffic and transportation	• Risk of accidents	• KS to include the new WWTP traffic and transportation into its management plan.

Summary of residual impacts

The community health and safety impacts during construction are related to the risk of injuries related to increased traffic and impacts related to construction nuisance of air quality and noise. This will, however, mainly constitute an OHS risk to construction workers, due to the distance to the site of other human receptors. Residual impacts are considered minor.

For operation, the impacts are considered positive due to improvements in the water and sanitation health conditions.

Table 8.40: Summary of impacts on community health and safety, pre-mitigation and residual (post-mitigation).

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Low – medium**	
Pre-construction and construction		
Spatial extent	*Local*	*Local*
Duration	*Medium term*	*Medium term*
Magnitude of impact	*Medium*	*Low*
Overall impact significance	Moderate – Negative	Minor – Negative
Operation phase		
Spatial extent	*Local*	*Local*
Duration	*Long term*	*Long term*
Magnitude of impact	*Medium*	*Medium*
Overall impact significance	Moderate – Positive	Moderate – Positive

8.2.6 Risks of gender-based violence and harassment

There do not appear to be any specific policies or legislation in relation to gender-based violence and harassment in Kazakhstan, legislation on sexual harassment in employment is not in place and there are no criminal penalties or civil remedies for sexual harassment in employment.

While there are no official statistics on the prevalence of GBVH, a survey undertaken by UN Women documented that 13% of women reported experiencing violence and harassment in the workplace. Based on this survey, the Ministry of Labour and Social Protection (MLSP) has in December 2022, published an article on their website about gender-based violence in the workplace, proposing amendments to several legal acts, including the Labour Code as well as the integration of ILO Convention No. 190 on the Elimination of Violence and Harassment in the World of Work.

As demonstrated by Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) the prevalence of domestic violence including intimate partner violence is high in Central Asia countries, including Kazakhstan. This is in part because of regressive gender norms, with many men and women finding that domestic violence is acceptable under certain circumstances. Such norms can enhance the risk of GBVH both in relation to the workforce and the interaction with communities.

Pre-construction and Construction Phase activities

Generally, the risk of gender-based violence and harassment is exacerbated with influx of construction workers. As the Project will not lead to any significant influx, there is nothing to suggest that the Project will impact on gender-based violence and harassment resulting from construction workers' interaction with communities.

The risk of GBVH between workers at the construction site is also considered to be low due to the limited number of construction workers and given that most of these workers are expected to come from Karaganda City and surrounding villages. As a precautionary measure, the Contractor should put in place a workers' Code of Conduct and provide inductions and trainings such as i) introduction and training for Contractor's and sub-contractors' staff to include awareness on GBVH definitions, prevention, encouragement to report/submit concerns and grievances related to GBVH etc., and ii) introduction to local communities on the same, ensuring that communities are familiar with the expectations as to how construction workers should behave, the rights of community members and their access to a grievance mechanism.

The risk of gender-based violence and harassment during construction is **direct** and **medium-term**. The spatial extent of the impact is **local**. The overall impact magnitude is determined as medium and negative. Given the medium sensitivity of the receptors, the **overall impact is considered to be moderate – negative** when un-mitigated.

Operation and maintenance activities

The risk of GBVH during operation and maintenance relates both the risk of inter-worker misconduct as well as misconduct by workers during stakeholder interaction or vice-versa. KS does not have a separate policy or procedures related to gender-based harassment and/or violence. Identified gaps in the Environmental and Social Management System (ESMS) are addressed in the company Environmental and Social Action Plan (ESAP) and will be closed prior to the operation phase of the Project.

The risk of gender-based violence and harassment during operation is **direct** and **short-term**. The spatial extent of the impact is **local**. The overall impact magnitude is determined as medium and negative. Given the medium sensitivity of the receptors, the **overall impact is considered to be moderate – negative** when un-mitigated.

Mitigation measures

The following general mitigation measures are proposed to avoid and minimise the identified impacts related to gender-based violence and harassment during the construction phase of the Project.

Table 8.41: Mitigation measures related to gender-based violence and harassment.

Activity	**Impact or risk**	**Mitigation measures**
Pre-construction and Construction phase		
General construction	• Risk of GBVH	• Contractor puts in place a workers Code of Conduct including zero tolerance for GBVH, and provide inductions and trainings for Contractor's and sub-contractors' staff to include awareness on GBVH definitions, prevention, encouragement to report/submit concerns and grievances related to GBVH etc.

Summary of residual impacts

The GBVH risks during construction concerns inter-worker and worker-community misconduct, which is considered preventable following good labour practices implemented through the mitigation measures. Identified gaps in the Environmental and Social Management System (ESMS) are addressed in the company Environmental and Social Action Plan (ESAP).

Table 8.42: Summary of impacts on gender-based violence and harassment, pre-mitigation and residual (post-mitigation).

Impact characterisation	**Pre-mitigation**	**Residual impact**
Receptor sensitivity:	**Medium**	
Pre-construction and construction		
Spatial extent	*Limited*	*Limited*
Duration	*Medium*	*Medium*
Magnitude of impact	*Medium*	*Low*

Impact characterisation	Pre-mitigation	Residual impact
Overall impact significance	Moderate – Negative	Minor – Negative
Operation phase		
Spatial extent	*No significant impacts anticipated.*	
Duration		
Magnitude of impact		
Overall impact significance		

8.2.7 Impact on land acquisition and land use

Pre-construction and Construction Phase activities

The new WWTP is planned to be constructed on a 12.75 ha land plot which is state-owned land. The City Akimat issued Resolution No. 30/29 on 5 April 2023 to grant the Department of Housing and Communal Services, Passenger Transport and Highways of Karaganda City the right of permanent use of a land plot of 9.155 ha for the construction of a WWTP in Karaganda City. According to the city Land Management Department, another resolution will be issued for the plot of additional 3.8 ha. The City Akimat confirms that the land is not under any lease agreement or informally used, this was further confirmed through stakeholder engagement undertaken during the ESIA preparation.

The impacts on land and land use pre-construction are **direct** and **long-term**. The spatial extent of the impact is **limited**. The overall impact magnitude is determined as low and negative. Given the medium – low sensitivity of the receptor, the **overall impact is considered to be minor – negative** when un-mitigated.

Operation and maintenance activities

No land acquisition or easement will be needed during the operation phase of the Project.

Mitigation measures

The following general mitigation measures should be implemented to minimise the identified impacts on land acquisition and land use associated with the Project.

Table 8.43: Mitigation related to land acquisition and land use.

Activity	Impact or risk	Mitigation measures
Pre-construction and Construction phase		
Allocation of land	• Land acquisition process	• KS to ensure that the land acquisition be implemented in accordance with the resolution dated April 5, 2023, and that a resolution for the plot #09-142-176-058 is obtained prior to construction.

Summary of residual impacts

The land acquisition and land use impacts related to the Project is considered minor, and with the implementation of the proposed mitigation, negligible.

Table 8.44: Summary of impacts on land acquisition and land use, pre-mitigation and residual (post-mitigation).

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Low**	
Pre-construction and construction		
Spatial extent	*Limited*	*Limited*
Duration	*Long term*	*Long term*
Magnitude of impact	*Low*	*Low*
Overall impact significance	Minor – Negative	Negligible
Operation phase		
Spatial extent	*No significant impacts anticipated.*	
Duration		
Magnitude of impact		
Overall impact significance		

8.2.8 Impact on cultural heritage

The site designated for the proposed WWTP does not contain any registered cultural heritage or archaeological objects.

The Department of Housing and Communal Services, Passenger Transport and Highways of Karaganda city confirmed in June 2023 in a letter the absence of historical and cultural heritage of significance at the proposed location of a new WWTP (200 m east of the existing WWTP). In July 2023, the Department of Culture, Archives, and Documentation of Karaganda Region provided a list of all registered cultural heritage sites in Karaganda City, including their locations. This list indicates that the cultural heritage closest to the proposed new WWTP site is the mass grave of 17 Soviet soldiers who died in hospitals of Karaganda in 1941-1945, located 5.2 km from the new WWTP site. Other registered cultural heritage sites are in the city centre and in the northern part of Karaganda City, i.e., far away from the proposed new WWTP.

Pre-construction and Construction Phase activities

Based on the information received from the Department of Culture, Archives, and Documentation of Karaganda Region, there is nothing suggesting that the pre-construction and construction activities will cause any impacts on cultural heritage.

Contract documents should, however, require contractors to develop and implement chance find procedures in case of new cultural heritage discoveries during construction work. Standard conditions of contract provide basic procedures when such articles are found.

The impacts on cultural heritage during construction is **direct** and **medium-term**. The spatial extent of the impact is **limited**. The overall impact magnitude is determined as medium and negative. The **overall impact is considered minor – negative** when un-mitigated.

Operation and maintenance activities

The risk of impacting cultural heritage during operation and maintenance is considered low.

The impacts on cultural heritage during construction is **direct** and **short-term**. The spatial extent of the impact is **limited**. The overall impact magnitude is determined as medium and negative. The **overall impact is considered minor – negative** when un-mitigated.

Mitigation measures

The following general mitigation measures should be implanted to avoid and minimise the identified impacts on cultural heritage associated with the Project.

Table 8.45: Mitigation measures related to cultural heritage.

Activity	Impact or risk	Mitigation measures
Construction and operation phases		
Soil excavation	• Chance Find	• The Contractor will develop and adopt a Chance Find Procedure for the construction work. Covering, at a minimum: the legal framework for cultural heritage; the process to follow in the event of chance finds; roles and responsibilities for implementing the procedure and an induction for all workers, including project staff, contractors, and government agencies.
Operation phase		
Soil excavation	• Chance Find	• KS will develop and adopt a Chance Find Procedure for the operation and maintenance work.

Summary of residual impacts

The impacts on cultural heritage related to the Project is considered minor, and with the implementation of the proposed mitigation, negligible.

Table 8.46: Summary of impacts cultural heritage, pre-mitigation and residual (post-mitigation).

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Low**	
Pre-construction and construction		
Spatial extent	*Limited*	*Limited*
Duration	*Medium*	*Medium*
Magnitude of impact	*Medium*	*Low*
Overall impact significance	Minor – Negative	Negligible
Operation phase		
Spatial extent	*Limited*	*Limited*
Duration	*Short term*	*Short term*
Magnitude of impact	*Medium*	*Low*
Overall impact significance	Minor – Negative	Negligible

8.2.9 Impact on vulnerable groups

3.8% of the population in Karaganda Region lived in 2022 below the official subsistence level, which defines the minimum level of income for basic needs. No data is available for Karaganda City. Persons living below the poverty line are entitled to targeted social assistance, as are other vulnerable groups. In Karaganda city, 1,119 families and 4,911 persons received such assistance in 2022.

According to information received from FGDs with residents in the Railway Junction 737 there are no poor households in the settlement, while four community members have disabilities. Most residents in Kirzavod 3-4 settlement are retired but not considered poor or vulnerable.

In Proizvodstvennaye Street there is only one permanent resident. Interviews with this resident revealed that some of the abandoned houses in the street are occasionally used overnight by homeless persons. The resident is considered vulnerable as he does not relate to the social structures of the neighbouring residential areas, has unspecified health issues, and are the closest resident to the WWTP.

Pre-construction and Construction Phase activities

The interaction between the Project construction workforce and the neighbouring communities is expected to be limited, and no impacts related to vulnerable groups are foreseen during the construction phase.

Operation and maintenance activities

The Project may lead to an increase in tariffs. 1% of the population in Karaganda City received social support in 2022, constituting 1,119 families receiving housing aid. KS's collection ratio of water and wastewater bills was close to 100% in the last years, as noted in Sweco's Feasibility Study (2021). The report also notes that the collection ratio from 2020 was not affected by the COVID-19 situation due to special assistance to help socially vulnerable groups to pay their utility bills. The high collection ratio indicates that most households pay their water and wastewater bills without problems.

Sweco's Feasibility Study Report (2021) includes an affordability analysis using EBRD's affordability methodology, which sets 5% of the total household expenditure as the affordability threshold for water supply and wastewater services. This affordability analysis is based on a total investment of EUR 37 million in improved wastewater treatment and shows that potential future tariff increases to cover this investment as well as operations cost are affordable to households in all deciles. It is uncertain whether this affordability analysis is valid for the current project proposed in the local Feasibility Study (2023), which has significantly higher investment costs.

The impacts on vulnerable groups during operation is **direct** and **long-term**. The spatial extent of the impact is **regional**. The overall impact magnitude is determined as medium and negative. The **overall impact is considered moderate – negative** when un-mitigated.

Mitigation measures

The following general mitigation measures should be implemented to avoid and minimise the identified impacts on vulnerable groups associated with the Project.

Table 8.47: Mitigation measures related to vulnerable groups

Activity	Impact or risk	Mitigation measures
Operation phase		
Tariff increase	• Risk of non-affordable services	• KS to closely monitor the affordability for low-income households after potential tariff increases due to the Project.

Summary of residual impacts

The Project is not assessed to cause any impacts on vulnerable groups related to construction, while the increase in tariff during operation may have minor residual impacts on vulnerable groups.

Table 8.48: Summary of impacts on vulnerable groups, pre-mitigation, and residual (post-mitigation).

Impact characterisation	Pre-mitigation	Residual impact
Receptor sensitivity:	**Medium**	
Pre-construction and construction		
Spatial extent	*No significant impacts anticipated*	
Duration		
Magnitude of impact		
Overall impact significance		
Operation phase		
Spatial extent	*Local*	*Local*
Duration	*Long term*	*Long term*
Magnitude of impact	*Medium*	*Low*
Overall impact significance	Moderate – Negative	Minor – Negative

8.3 Cumulative Impacts

The ESIA study has considered the potential cumulative impacts in relation to other existing, planned and/or proposed projects within the PAI. With regards to existing activities, the following cumulative impacts may be of relevance:

- **Noise** and **traffic safety** due to increase in heavy traffic during the construction phase of the WWTP which will be in addition to existing traffic load in the city. The main access to the proposed Project site is outside the city centre and through an existing industrial area, hence significant cumulative impacts affecting traffic levels in the city are not anticipated. Some increase in traffic may be felt during the construction phase in areas adjacent to the access road, e.g., in the Kirzavod 3-4 residential area, although traffic will not pass directly through these residential areas. No specific mitigation measures are considered necessary for cumulative impacts, other than the project specific measures required in the ESMP and discussed in chapters 8.1.6 and 8.1.9
- **Water quality in the Sokyr river**; the Sokyr river is already affected by various anthropogenic activities other than the Karaganda WWTP, both upstream and downstream from the effluent discharge point from the existing WWTP. This includes potential pollutants in the Bukpa river which runs through Karaganda City and discharges into the discharge channel connecting the WWTP biopονds and the Sokyr river. Existing impacts would be reflected in the background water quality and benthic fauna characteristics reflected in the respective baseline data, although determining to what extent pollutants may be carried via the Bukpa river vs. the WWTP effluent is difficult as there is currently no monitoring in the Bukpa river above the discharge point to the Sokyr river. Although the Bukpa river carries water only a few months a year, it may carry pollutants from its catchment area (which includes part of the city) during snow melt in spring for example. To further determine this impact as part of ongoing monitoring of the Sokyr river, it is suggested that KS engage in dialogue with the local environmental authorities to conduct environmental monitoring in the Bukpa river above the discharge point to the Sokyr river.
- **Odour** from the WWTP activities; The existing WWTP is likely the most significant source of odour impacts in the area (based on, among others, focus group discussions). However, it is possible that other activities, e.g., the nearby pig farm located to the west from the WWTP, may be sources of odour

during periods. The extent of odour contribution from such other potential sources is difficult to assess due to the absence of systemic monitoring/registration of odour in the area. Hence, the ESMP includes measures for KS to implement systemic odour monitoring going forwards, which also takes into account possible other sources of odour in the area. This will help determine to what extent odour may originate from other sources. Should that be the case, KS should engage in dialogue with the relevant actors, and local authorities to help ensure that responsible actors address the problem.

Based on the information available during the ESIA process, no planned or proposed activities have been identified that could result in further cumulative impacts in the context of the proposed WWTP Project.

9 OVERALL ESIA CONCLUSION

The ESIA has assessed the potential environmental and social (E&S) impacts of the proposed Project to construct a new wastewater treatment plant (WWTP) for the city of Karaganda in Kazakhstan. The WWTP is designed for treating on average 100,000 m^3/day influent WW to service a population of 500,000. The proposed WWTP will replace an existing WWTP that is located within and immediately adjacent to the proposed new WWTP site. The location of the site is considered appropriate as it allows for continued use of key inflow and outflow piping infrastructure, and it is remotely located >500m away from nearest residential areas, hence does not require a change in the existing sanitary protection zone (SPZ).

The overall impacts of the proposed WWTP project are assessed to be positive.

The existing WWTP effluents do not fully meet EU and national effluent requirements and raw sludge is dried and treated in sludge ponds without prior stabilization. Particularly the sludge handling from the existing WWTP results in substantial odour problems, which are felt in residential areas located 236haract. 600m to the east from the WWTP.

Hence, the most significant impact of the Project will be improvements in effluent quality to EU and national standards, and the sludge treatment will be much improved with the introduction of anaerobic digestion (AD) to the WW treatment process. Both aspects are expected to significantly reduce or eliminate current odour problems. The improved WWTP sludge handling will also substantially reduce the Green House Gas (GHG) emissions associated with wastewater treatment, compared to the current situation.

The outcome of the proposed Project will create an opportunity to reuse both the effluents and sludge for agricultural purposes, within green forest belts and/or for other land rehabilitation purposes in the vicinity of the WWTP. However, a detailed plan for how to promote effluent reuse and to ensure offtake of the treated sludge has not yet been presented, nor has a plan for closure of the existing sludge ponds. Hence, a plan for this needs to be prepared by the proponent (KS) in parallel with the detailed design of the WWTP, including a plan for alternative long-term storage of treated sludge in case there is not sufficient offtake capacity or interest in the area.

The effluents from the existing WWTP are discharged via existing bioponds and subsequent discharge channel to the Sokyr river, and this arrangement is planned to continue for the proposed WWTP.

Potential negative environmental impacts of the project are mostly typical for construction activities and WWTP of similar size and complexity. These include worker health and safety risks and risks of contamination to nearby environment through daily construction and operation activities. These impacts are of minor to moderate significance if not adequately mitigated and managed but can be effectively mitigated through the implementation of proposed measures, and through the implementation of robust Environmental and Social (E&S) management system design in line with international good practice management system standards. This will bring the negative impacts of the Project to be minor or negligible. Within this, Environmental, Health and Safety (EHS) management needs to be fully adopted, led, and supervised by the project proponent, and integrated in all works conducted by contractors involved in the project.

In terms of socio-economic impacts, the proposed Project will have few negative impacts. Due to the WWTP site's location in the outskirts of Karaganda City in an area with several industries and no communities in the immediate proximity, the Project impacts on community health and safety due to construction impacts on air quality and noise is of moderate significance and will with adequate mitigation and management be reduced to minor significance. Increased traffic and transport are moderate during construction if not adequately managed but can be effectively mitigated through the implementation of proposed measures.

While some employment opportunities will be created during construction, there will be a reduction of WWTP staff in the operation phase.

Other social aspects such as impacts on land use and cultural heritage are considered to be negligible after the implementation of proposed mitigation measures.

The Project will through improvement of the wastewater treatment have a positive effect on the prevalence of water and sanitation related diseases in the Project area. This will together with the significant reduction in odour substantially improve the health and wellbeing of the population in the Project area. The risk of increased tariffs negatively impacting on vulnerable groups in Karaganda City needs to be monitored during operations to ensure that such impacts are adequately mitigated and managed.

The following table summarises the findings of the ESIA for the identified potential impacts. An environmental and social management plan (ESMP) is proposed in a separate document. The ESMP needs to be fully executed to ensure successful mitigation of potential negative impacts.

Table 9.1: Summary of findings for identified potential impacts

Receptor/Baseline aspect and main impacts / risks	**Construction Impact significance**		**Operation Impact significance**	
	Pre-mitigation	**Post-mitigation**	**Pre-mitigation**	**Post-mitigation**
Impacts on physical and natural environment				
Landscape and topography				
• Change in topography • Change of site appearance from greenfield to industrial • Removal of topsoil and vegetation	Minor – Negative	Negligible – Negative	Negligible – Negative	Negligible – Negative
Soil and geology				
• Ground and soil disturbance • Soil erosion and stormwater management • Risk of spillages of contaminants • Sludge handling	Minor – Negative	Negligible – Negative	Moderate – Negative	Negligible – Negative
Climate and climate change aspects				
Climate – GHG impacts • Material embodied GHGs • Energy consumption associated GHGs • WWT process	Moderate to major – Negative	Moderate – Negative	Moderate to major – Positive	Moderate to major – Positive
Climate Resilience • Flood risk	Overall low sensitivity to climate change, Not requiring uplift compared to regular storm water management and site drainage.			
Surface and groundwater resources				
At and around the WWTP site • General site activities resulting risk of contamination	Minor to moderate – Negative	Negligible – Negative	Minor to moderate – Negative	Negligible – Negative

Receptor/Baseline aspect and main impacts / risks	Construction Impact significance		Operation Impact significance	
	Pre-mitigation	Post-mitigation	Pre-mitigation	Post-mitigation
• Erosion and stormwater management				
Handling and storage of sludge (WWTP site) • Risk of contamination from sludge handling	-	-	Minor – Positive	Minor – Positive
Surface water of Sokyr river • Level of water pollution from effluents	-	-	Moderate – Positive	Moderate – Positive
Ambient air quality				
• Dust generation • Emissions from vehicles resulting • Odour problems	Moderate – Negative	Minor – Negative	Major – Positive	Major – Positive
Noise and vibration				
• Noise from machinery • Noise from pumps, air blowers and other equipment • Impacts on human receptors	Minor – Negative	Negligible – Negative	Negligible to minor – Negative	Negligible – Negative
Flora				
• Removal and/or damage to vegetation • Opportunity to revegetate the site and existing sludge pond area	Moderate – Negative	Negligible to minor – Negative	No significant negative impacts anticipated	
Fauna				
Terrestrial and Avifauna • Removal and/or damage to vegetation and habitats • Opportunity to revegetate the site and create new biodiversity habitats	Moderate – Negative	Minor – Negative	No significant negative impacts anticipated	
Aquatic ecosystem Sokyr River • Benthic fauna diversity in the Sokyr river and impacts from effluents	Not affected		Moderate – Positive	Moderate – Positive
Communal infrastructure (access roads, solid waste, water and electricity supply)				
Communal infrastructure • Increased wear and tear due to increased heavy traffic • Risk of inappropriate handling of waste	Significant impacts are not expected.			

Receptor/Baseline aspect and main impacts / risks	Construction Impact significance		Operation Impact significance	
	Pre-mitigation	Post-mitigation	Pre-mitigation	Post-mitigation
• Strain on water and energy infrastructure				
Supply chain (ESG risks)				
Supply chain • General risk of ESG impacts or violations in the supply chain • Risk that material comes from quarries without the necessary permits	High supply chain risks are not expected. However, minor to moderate impacts may occur in the absence of basic risk management / due diligence procedures.			
Opportunity to reuse effluents and digested sludge				
• Opportunity to reuse effluents in the area • Opportunity to reuse sludge in the area	There are opportunities to reuse sludge in the broader area of the proposed WWTP, and potentially also effluents, enabled by the improved quality and effluents and sludge handling with anaerobic digestion.			
Socio-economic impacts				
Employment				
• Risk of influx of workers • Risk of retrenchment	Minor – Positive	Moderate – Positive	Major – Negative	Moderate – Negative
Labour and working conditions				
• Working conditions and terms of employment • Workers' grievance mechanism • Workers' accommodation	Moderate – negative	Minor – Negative	Moderate – negative	Minor – Negative
Worker's health and safety (OHS)				
• Risk of accidents typical to construction activities • H&S risk specific to water and sanitation projects	Major – Negative	Moderate – negative	Major – Negative	Moderate – negative
Migrant influx				
• Project is not expected to prompt additional influx of migrants into Karaganda City or Region	Significant impacts are not expected.			
Community health and safety				
• Communicable diseases • Non-communicable diseases • Risk of accidents	Moderate – negative	Minor – Negative	Moderate – Positive	Moderate – Positive
Gender based violence and harassment				
• Risk of GBVH	Moderate – Negative	Minor – Negative	Significant impacts are not expected.	

Receptor/Baseline aspect and main impacts / risks	Construction Impact significance		Operation Impact significance	
	Pre-mitigation	**Post-mitigation**	**Pre-mitigation**	**Post-mitigation**
Land acquisition and land use				
• Land acquisition process	Minor – Negative	Negligible – Negative	Significant impacts are not expected.	
Cultural heritage				
• Chance Find	Minor – Negative	Negligible – Negative	Minor – Negative	Negligible – Negative
Vulnerable groups				
• Risk of non-affordable services	Significant impacts are not expected.		Moderate – Negative	Minor – Negative
Cumulative impacts				
• Cumulative impacts with other planned or proposed projects.	No planned or proposed activities have been identified that could result in cumulative impacts in the context of the proposed WWTP project.			

10 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

An Environmental and Social Management Plan (ESMP), which also includes a monitoring plan, has been prepared. The ESMP includes a proposed framework for an Environmental Social Management System (ESMS), a project impact mitigation plan based on the recommendations in the ESIA, and a framework proposal for specific E&S management plans that need to be prepared either by KS or by the construction contractor(s).

Please refer to the separate ESMP.

ANNEX 1: RECORDS OF PUBLIC MEETINGS & CONSULTATIONS

The following stakeholder meetings were held during the scoping and the ESIA processes:

1. 2 February 2023: Kick off-meeting with Karaganda Su with discussions about the ESIA process and work schedule, including an overview of information requirements and potential stakeholders.
2. 1 March 2023: Meeting with the following stakeholders: Department of Natural Resources and Environmental Management, Department of Emergency Situations of Karaganda, and Karaganda Su (a previously planned stakeholder meeting with more stakeholders – Department of Sanitary and Epidemiological Control of Karaganda Region, Department of Emergency Situations of Karaganda City, Balkhash-Alakol Basin Inspectorate, Department of Natural Resources and Regulation of Nature Management of Karaganda Region and representatives of Karaganda Su – had to be cancelled due to stakeholders not being available).
3. 29-31 March 2023: Brief interviews with a few residents living relatively close to the existing WWTP (summary of discussions included in section 7.1 of this ESIA report).
4. September 2023: Two FGDs for Railway junction 737 and Kir-zavod 3-4 settlement with both men and women (summary of discussions included in section 7.3.3 of this ESIA report)
5. September 2023: One FGD for NGOs and activists (summary of discussions included in section 7.3.3 of this ESIA report).

MINUTES OF THE MEETING

Stakeholder consultation to prioritise environmental and social impact assessment
01 March 2023 16:00 (ZOOM conference)

PARTICIPANTS:

Public authorities:

- Nadezhda Viktorovna – Expert of the Department of Natural Resources and Environmental Management
- Merey Ospanov – Expert of Department of Emergency Situations of Karaganda district MES RK

Representatives of Karaganda Su:

- Shadyar Zhunusova – Head of the Capital Construction and Design Department-
- Gulsara Konysbekova – Chief Ecologist

EcoSocio Analysts:

- Meeting facilitator Vladimir Merkuryev – Environmental Specialist
- Meeting secretary Nargiza Ospanova – E&S Specialist

Presentation by Vladimir Merkuryev.

Vladimir: Are there any questions on project and wastewater treatment in Karaganda? Karaganda Su, have you had any developments with Aquarem on the location of the sewage treatment plant?

Shadyar: Yes, there have been some developments. Currently Aquarem proposed two options for location of the WWTP: the first option is construction on existing sludge ponds and the second option is to locate it on biological ponds. Karaganda Su gave a partial refusal to place the WWTP on sludge ponds as there will not be enough sludge beds during construction for use. It agreed to place the WWTP on the bio-ponds, but to use only 1/6 part. But Aquarem thinks that bioponds will not work as the Water and Basin Inspectorate will not approve this location due to the water protection zone. The Bukpa river runs through it. Currently the project is in limbo, as the location of the new WWTP has not been decided.

Nadezhda: If you have questions about the water protection zone, you need to talk to the basin inspectorate. If there are questions about the sanitary protection zone, you need to talk to SES.

Vladimir: Both departments are now being consulted by Aquarem.

Nadezhda: One of the problems is unpleasant smell towards the city. Could you please advise whether there will be a green belt around the whole perimeter of the WWTP?

Vladimir: The green belt around Karaganda is fragmented.

Karaganda Su: This WWTP is located neither in a forest fund lands[58], nor in a nature protection zone. There are green areas around it.

Nadezhda: I am interested that there is no smell.

Karaganda Su: We have tree planting around the WWTP according to our environmental action plan.

Vladimir: Complaints are coming from the Bolshaya Mikhailovka micro-district due to the wind direction.

Karaganda Su: The smell is not always there, only when the wind changes direction, then the smell appears.

Vladimir: We looked at the prevailing winds and about 16% of the wind blows towards Bolshaya Mikhailovka micro-district. The smell is not permanent, it occurs when the sludge beds are cleaned. The methane tanks themselves will eliminate the need for the filtration fields themselves, the residue will be dry and can be stored or taken away. Thus, there will be no smell.

Karaganda Su: Aquarem says if we place WWTP on the bioponds, then we don’t go through the water protection zone.

Vladimir: The water protection zone is not big, only 20 meters. Aquarem is aware of all this, we will check with them. So, we don’t go into the water protection strip or the zone. There is one more unknown, to what extent the sludge beds, or rather the soil under them, will withstand constructions above them.

Karaganda Su: The soil under the sludge beds is concreted, no seepage will occur. There are concrete bases under the silt chambers.

Vladimir: Everything is clear. Are there any more questions?

There are no more questions. Goodbye.

[58] Lands of the state forest fund includes land covered with forests of natural origin and artificial forests created at the expense of the state budget, as well as lands not covered with forests provided for permanent land use by state organizations engaged in forestry.

ANNEX 2: CLIMATE CHANGE SCENARIOS – ANALYSIS OF UNCERTAINTIES

The scenarios outlined in the climate change assessment discussed in chapter 6.1.5 are the result of a series of climate models, which carry an uncertainty. It is important to understand this uncertainty as it has the potential to lead to over- or underestimates of the most relevant climate variables, *e.g*. precipitation and temperature. Furthermore, the results presented from the models are given averages, meaning that half of the models predict higher changes whereas the other half predict lower impacts.

In the context of this report, only little will be done to address these uncertainties. However, it is of utmost importance to delineate from where the uncertainties originate and define the implications for the water infrastructure of Karaganda. In this regard, the main causes of uncertainties in the above-outlined climate change development are:

- Low model resolution (e.g. 5x5 degrees from SNC projections, the equivalent to 244haract. 500x500 km).
- Lack of observed reliable data.
- Uncertainties in the climate forcing scenarios (SRES and RCP).
- Inaccuracy in simulating large scale patterns, i.e. ENSO (El Niño-Southern Oscillation).
- Difficulty in simulating small-scale processes, such as convection.

Although the amount of data collected at Karaganda is significant (+80 years of measurements, however with small gaps) compared to other locations where limited observed data tends to be the case, it has not been possible to perform a deeper analysis of the data to validate it. Hence, potential errors have not been investigated, and this might cause under/overestimates of precipitation and temperature.

Likewise, quantitative estimates of projected changes in precipitation are difficult to obtain, due to lack of observed data, significant inter-model differences in representing monsoon processes, and lack of clarity over changes in ENSO (El Niño-Southern Oscillation) patterns (DHI, 2012).

A way to tackle some of these issues would be to perform a probability analysis on the data, which might lead to more robust results. However, more data would need to be collected. For example, the interaction between snow cover and temperature response is a complex process, and this requires more specific data, *i.e*. evapotranspiration, solar radiation, *etc*.

It should be noted that, for the purposes of this Project, the important issue is to properly identify the direction of change in the climate projections. Tackling the uncertainty attained to these projections is an issue to be dealt with in other projects. The biggest challenge in suggesting adaption measures in Karaganda might be the high uncertainty related to extremes (which lacks a national assessment regarding climate projections), *i.e*. extreme rainfall events and heatwaves. Hence, the assessment of climate change impacts is carried out considering these uncertainties.

ANNEX 3 – SCOPING OF POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

The following sections reflect the outcome of a scoping assessment for the Project, for the pre-construction/construction and operational phases, respectively. The matrices illustrate interfaces between key Project activities and outputs and environmental and social receptors. Where a potential interface is identified, an assessment of the respective impacts will be included in the ESIA (scoped in). Areas where no feasible or negligible interface is anticipated, are scoped out. For those interfaces (potential impacts) scoped in, the ESIA will elaborate further on the type and magnitude of impact and assess the level of impact significance, in context of the sensitivity of affected receptors.

Main Potential Environmental and Social Impacts
Pre-construction and Construction Phase Matrix

			Routine activities and outputs																Unplanned events	
			Demolition works, if any	Demolition waste generation	Site preparation and excavation	Transportation of construction material, construction machinery and equipment	Transportation of workers	Relocation of power lines	Operation of concrete batch mixer and aggregate crushing	Installation of pipes	Installation of biogas plant and CHP	Construction of WWTP and operation of construction machinery and equipment	Wastewater management in construction	Construction and demolition waste generation	Electrical installations	Site drainage installation	Decommissioning of sludge ponds	Landscaping	Risks related to climate change	Risk of natural disasters (earthquake, etc.)
Environmental receptor	Physical	Topography and landscape																		
		Geology and soil																		
		Climate																		
		Surface waters																		
		Groundwater resources																		
		Ambient air quality																		
		Ambient Noise and vibration																		
	Biological	Protected areas*																		
		Terrestrial Flora and fauna																		
		Aquatic Flora and Fauna																		
	Public resource infrastructure and services	Energy supply																		
		Solid waste management																		
		Water Supply																		
Social receptor	Other services	Social infrastructure: schools, health clinics, utilities																		
	Workforce	Local employment and commercial opportunities																		
		Refugee influx due to war in Ukraine																		
		Workers' employment conditions																		
		Workers' accommodation																		
	Health & safety	Workers' health & safety																		
		Community health & safety																		
		Risks of gender-based violence & harassment																		

		Traffic and traffic safety																		
	Economic and physical displacement	Land use & acquisition																		
		Houses & other structures																		
		Commercial activities																		
		Household economic activities & livelihood																		
	Cultural heritage	Cultural heritage																		
	Disproportionate group impacts	Vulnerable groups																		
	Indigenous people	Indigenous people																		
Cross-Cutting E & S Aspects	Transboundary impacts																			
	Cumulative impacts																			
	Supply chain																			

*No protected areas identified in the vicinity of the project. To be further elaborated in the ESIA.

Potential interface (potential impacts) – scoped IN
No interface (no or negligible potential impacts) – scoped OUT

Operation Phase Matrix

			Routine activities and outputs															Unplanned events			
			Transportation of material + equip. + waste	Transportation of workers	Vehicle fleet management	WWTP laboratory operation	WWTP operation and effluent	WWTP maintenance	Biogas plant operation	Biogas plant maintenance	CHP operation	CHP maintenance	Site drainage and storm water management	Landscaping	Security operations	Waste generation	Sludge and digestate generation	Spill and leak of oil and chemicals	Fire, explosion risks	Risks related to climate change	Risk of natural disasters (earthquake, etc.)
Environmental receptor	Physical	Topography and landscape																			
		Geology and soil					■						■	■		■	■	■	■	■	■
		Climate					■		■		■						■			■	
		Surface waters					■	■					■	■		■	■	■	■	■	■
		Groundwater resources					■	■					■	■		■	■	■	■	■	■
		Ambient air quality incl. odour	■	■			■	■	■	■	■					■	■		■		
		Ambient Noise and vibration	■	■			■		■		■										
	Biological	Protected areas*																			
		Terrestrial Flora and fauna											■	■			■	■			
		Aquatic Flora and fauna					■						■				■	■			
	Public infrastructure and services	Energy supply					■		■		■										
		Solid waste management					■		■								■				
		Water Supply					■				■			■							
Social receptor	Other services	Social infrastructure: schools, health clinics, utilities	■				■		■		■		■					■	■	■	■
	Workforce	Local employment and commercial opportunities	■	■	■	■	■	■	■	■	■	■	■	■	■		■				
		Refugee influx due to war in Ukraine																			
		Workers' employment conditions	■	■	■	■	■	■	■	■	■	■	■	■	■		■				
		Workers' accommodation																			
	Health & safety	Workers' health & safety	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■
		Community health & safety	■	■			■		■		■		■		■		■	■	■	■	■
		Risks of gender-based violence & harassment	■	■	■	■	■	■	■	■	■	■	■	■	■						
		Traffic and traffic safety	■	■													■			■	
	Economic and physical displacement	Land use & acquisition																			
		Houses & other structures																			
		Commercial activities															■				
		Household economic activities & livelihood					■										■				
	Cultural heritage	Cultural heritage					■										■				
	Disproportionate group impacts	Vulnerable groups	■												■		■				
	Indigenous people	Indigenous people																			
Cross-cut	Transboundary impacts																				

		Routine activities and outputs															Unplanned events			
	Cumulative impacts																			
	Supply chain																			

*No protected areas identified in the vicinity of the project. To be further elaborated in the ESIA.

Potential interface (potential impacts) – scoped IN
No interface (no or negligible potential impacts) – scoped OUT

ANNEX 4 – SOKYR RIVER HYDROBIOLOGICAL STUDY

REPORT ON ANALYSIS OF MACROZOOBENTHOS SAMPLES FROM THE SOKYR RIVER AT THE KARAGANDA WASTEWATER DISCHARGE

No published data on the macrozoobenthos of the Sokyr River were found.

Research Methodology
The collection of macrozoobenthos from the Sokyr River was conducted on June 29th from 11:00 to 16:00 along the central axis of the runoff. Efforts were made to avoid backwaters, rifts, and areas shaded by vegetation. Samples were collected from eight stations, each spaced 500 meters apart (Figure 2), using a GR-91 boom dredger with a bucket area of 0.004 m^2 and a volume of 0.0003 m3. Five replicates (totalling a volume of 0.0015 m^3) were taken at each station, with a 1 to 1.5-meter upstream offset between the scoops. The depth was determined using a dredging rod marked at 10 cm intervals.

Difficulties in collection were encountered only at station 2, where the combined discharges from the sewage treatment plant and the river resulted in a more rocky soil. Here, five full scoops were obtained after ten attempts. Incomplete scoops, caused by stones getting stuck in the dredger's bucket, were discarded. With the exception of station 2, the riverbed composition remained relatively consistent. Transparency, measured using a Secchi disk, was approximately 0.6 meters at all stations. Bottom vegetation was present everywhere, including in the control section between stations 1 and 2, but was especially dense between stations 6 and 8, impeding boat movement through thick water plants. Water temperatures at the stations ranged from +11.5 to +12.5°C.

Samples were rinsed through a 250 μm mesh screen, released into river water, and then transferred to a 1-liter plastic jar with a tight-fitting lid, which was duly labelled. The fixation of water samples with formalin was not performed, as the samples were delivered to the laboratory within one hour of collection and placed in a refrigerator.

The Sokyr River above and below stations 1-4 and 7-8.

Photos 1 & 2: Station 1. Located 20m downstream from the ford and characterized by a noticeable lack of current and the presence of algae on the riverbed. Here, the width of the river is 9m, the depth is 1m, with a water transparency of 0.6m.

Photos 3 & 4: Station 2 with the WWTP discharge shown in the first picture and the river in the second photo. The clarity of the water has increased. Width 9m. Depth 0.5m

Photos 5 & 6: Station 3. Heavily overgrown with algae and with a rocky bottom. River width 14m, depth 0.7m. Transparency to the bottom. The water current is visible.

Photos 7 & 8: Station 4 Algae on the silt bottom. River width 10m, depth and visibility 0.5m

Photos 9 & 10: Station 7 Rocky seaweed bottom. Width 9m, depth 0.7m, transparency 0.5m

Photos 11 & 12: Station 8 Overgrown seaweed bottom. Width 10m, depth and visibility 0.5m

The laboratory processing of samples involved methods of counting and weighing. Identification and counting of hydrobionts were performed using MBS and Micros brand microscopes. Taxonomic classification was determined in accordance with available manuals.[59] The taxonomic status of chironomids was determined to the level of subfamily, tribe, or genus. The rest of the animals were assigned to the order or even higher level. Subsequently, the number of individuals within each taxonomic group was counted. The weight was determined by weighing small animals on a torsion scale with a precision of 0.001 g, and larger organisms on an electronic scale with precision of 0.01 g.[60] For the smallest individuals, where

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[59] Narchuk E.P., Tumanov D.V. (Editors of the volume). Guide to freshwater invertebrates of Russia. -T.4. Dipteran insects. St. Petersburg. – 2000. 998 p. (in Russian).
Larvae and pupae of mosquitoes of the subfamilies Podonominae and Tanypodinae of the fauna of the USSR. Leningrad: 1977. 254 p. (in Russian).
Larvae and pupae of mosquitoes of the subfamily Chironominae of the USSR fauna. Leningrad: 1983. 296 p. (in Russian).
Larvae and pupae of mosquitoes of the subfamily Orthocladiinae of the USSR fauna. Leningrad: 1970. 344 p. (in Russian).
Chekanovskaya O.V. Aquatic Small Bristle Worms of the USSR Fauna. - 1962. - 411 p. (in Russian).
[60] Chislenko L.L. Nomograms for determining the weight of aquatic organisms by body size and shape (marine mesobenthos and plankton). Leningrad, 1968. 106 p. (in Russian).

weighing was impossible, nomograms were used to estimate the animal's weight based on body size and shape.

Table 1 Taxonomic composition and frequency of occurrence (%) of macrozoobenthos organisms.

Group	Family	Frequency of occurrence
Worms	Nematoda gen.sp.	25
	Oligochaeta gen.sp.	87.5
	Hirudinea gen.sp.	12.5
Crustacean	Ostracoda gen.sp.	25
Insects	Ceratopogonidae gen.sp.	12.5
	Cricotopus sp.	87.5
	Orthocladiinae gen.sp.	62.5
	Chironomus sp.	100
	Polypedilum sp.	75
	Chironomini gen.sp.	100
	Tanytarsini gen.sp.	87.5
	Tanypodinae gen.sp.	12.5

The data for analysis was prepared using the Biota program[61] and Microsoft Excel spreadsheets. Statistical data processing was carried out using the Primer v.6 package.[62]

The Shannon-Weaver information indices (H′) for biomass and Pielou's were used to assess the structure of the community. The first index indicates the level of biodiversity within the river community, while the second index measures the evenness of species distribution among individuals in the community.[63] To assess the ecological status of the river, graphs of the rank distribution of species (ABC curves) and W-statistics were used.[64]

Results

In June 2023, the macrozoobenthos of the Sokyr River comprised insects (8 taxa), crustaceans, worms, nematodes, oligochaetes, and leeches (refer to Table 1).

Only larvae of chironomid mosquitoes of the genus Chironomus and the tribe Chironominae were consistently found in the benthos. A high frequency of occurrence was noted for oligochaetes, chironomid mosquitoes of the genera Cricotopus and Polypedilum, tribe Tanytarsini, and subfamily Orthocladiinae.

The largest number of species was observed at Station 7, the lowest amounts at Station 1. Accordingly, the highest value of the Shannon-Weaver index was noted at Station 5, and the lowest at Station 1 (Table 2).*Table: 2 Structural indicators of macrozoobenthos at 8 stations of the Sokyr River.*

Indicator	1	2	3	4	5	6	7	8

61 Certificate of State Registration of Rights to the Copyright Object Called "Biota" (Computer Program) No. 1715 dated July 11, 2017

62 Clarke K.R., Warwick R.M. Changes in marine communities: an approach to statistical analysis and interpretation, 2nd edition, PRIMERV6: Plymouth, 2001 and Clarke K.R., Gorley R.N. PRIMER v6: User Manual/Tutorial. PRIMER-E, Plymouth, 2006.192 pp

63 Odum Y. Ecology. – T.2. Moscow, 1986. – 376 p. and Konstantinov A.S. General Hydrobiology. Moscow, 1986. 472 p. (in Russian).

64 Clarke K. R. Comparisons of dominance curves // J. Exp. Mar. Biol. Ecol. 1990. Vol. 138. P. 143 – 157.; Warwick R. M., Clarke K. R. Relearning the ABC: taxonomic changes and abun-dance/biomass relationships in disturbed benthic communities // Mar. Biol. 1994. Vol.118, № 4. P. 739 – 744

Number of species	2	6	9	7	8	6	10	7
Number of species, ex/m²	300	2600	19250	6500	10050	950	18100	21600
Biomass, g/m²	550	3100	48930	8500	4600	460	13275	10875
Shannon-Weaver index, H′	1	2.19	2.21	2.03	2.70	2.25	2.48	2.24
Pielu index, e	1	0.85	0.70	0.72	0.90	0.87	0.75	0.80

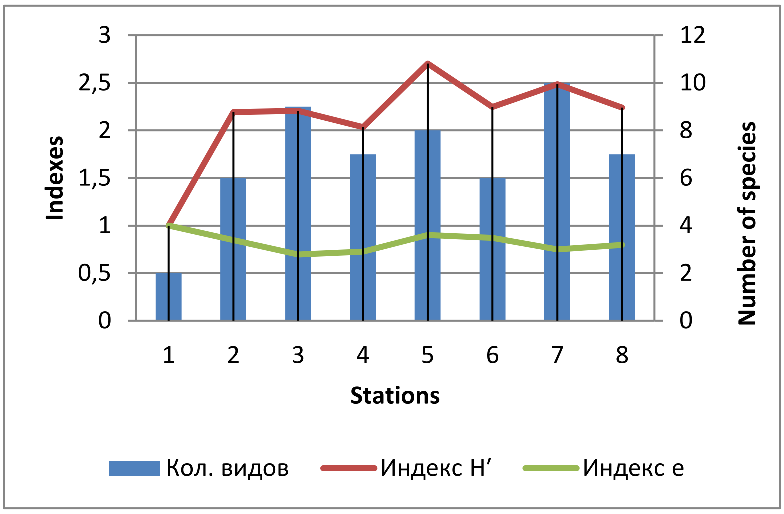

Figure: 10.1 Dynamics of macrozoobenthos indicators Sokyr river.

Table: 3 Macrozoobenthos numbers (ind./m²) in the Sokyr River.

Point	Vermes	Crustacea	Insecta	Всего
1	0	0	300	300
2	750.00	0	1850	2600
3	2150.00	0	17100	19250
4	2150.00	0	7900.00	10050
5	1750.00	750.00	4000	6500
6	100.00	200.00	650	950
7	6300.00	0	11800	18100
8	850.00	0.00	20750	21600

Table: 4 Macrozoobenthos biomass (mg/m²) Sokyr River.

Point	Vermes	Crustacea	Insecta	Всего
1			550	550
2	1050.00		2050	3100
3	3005.00		45925	48930
4	1700.00		2900	4600
5	4000.00	400.00	4100	8500
6	50.00	100.00	310	460
7	5610.00		7665	13275
8	500.00		10375	10875

Downstream from Station 1 to Station 3, diversity increases and then fluctuates slightly (Figure 1). The number of benthic animals varied from 300 (Station.1) to 21,600 (Station 8) individuals/m² (Table 2), biomass – from 460 (Station 6) to 48,930 (Station 3) mg/m² (Table 2). The absolute dominants of the quantitative development of macrozoobenthos were insect larvae, the proportion of which in the number ranged from 62 to 100%, and in biomass – from 48 to 100%. Chironomid larvae of the family

Chironominae dominated among the insects. The biomass of oligochaetes was high at Station 5 - almost half of the total indicator.

Figure 2: Overview sampling points

In the studied section, there are two points characterized by minimal quantitative benthos development (Stations 1-2 and 6), and two points where the benthos development is at its maximum (Stations 3 and 8) (Figure 3).

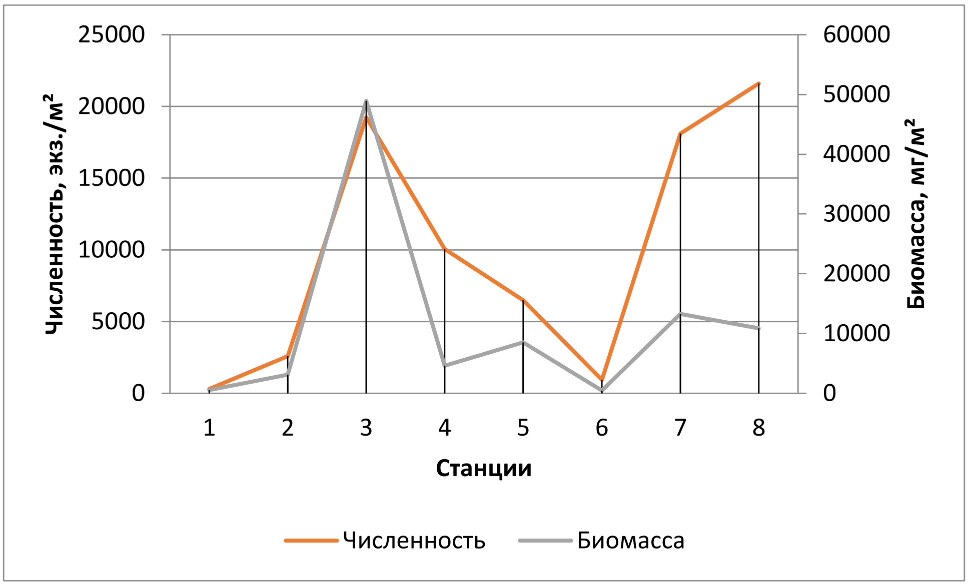

Figure 3. Dynamics of abundance and biomass of macrozoobenthos of the Sokyr river

Analysis of the W-statistic distribution showed a significant decrease from Station 1 and further downstream (Figure 4). Only at Station 5 does this indicator increase.

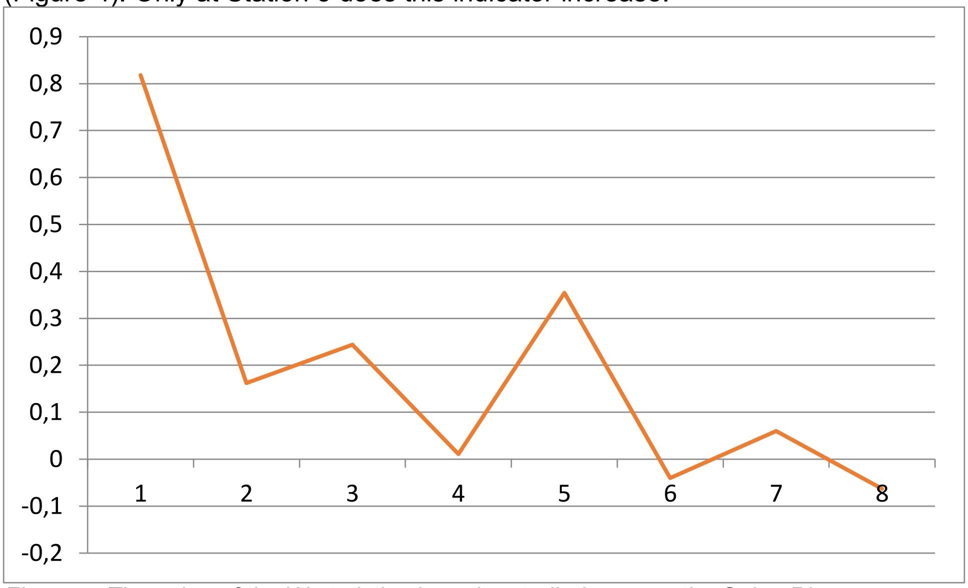

Figure 4. The value of the W-statistic along the studied area on the Sokyr River.

Discussion

The investigated section of the Sokyr River is characterized by fairly homogeneous environmental conditions.

The composition of the benthic fauna is typical for water bodies with weak currents, i.e., practically stagnant water bodies, where organisms such as oligochaete worms and non-biting midges (chironomids) are found.

One of the main limiting factors influencing the development of benthic fauna in these slow-flowing watercourses is the oxygen regime. The presence of a large amount of organic matter can lead to a lack of oxygen. Consequently, species that can tolerate low oxygen content tend to thrive in such waters. Oligochaetes and chironomid mosquitoes of the genus Chironomus are examples of such groups.

The observed dynamics of quantitative indicators of macrozoobenthos demonstrates a sharp increase in the number and biomass at Station 3 – below the discharge of treated wastewater. It is possible that this occurs as a result of nutrient input with wastewater. Here, large larvae of chironomid mosquitoes of the genus Chironomus were found in mass numbers. Quantitative indicators then decrease until Station 6, after which there is a significant increase in numbers with a much smaller increase in biomass.
The variability indicators used do not show a pronounced response to wastewater inflow.
The dynamics of the W-statistics shows the deterioration of the ecological state in the entire surveyed area relative to Station 1.

The reasons for the poorness of samples at Stations 1 and 6 remain unclear.

Recommendations
To monitor the condition of benthic communities downstream of the treated wastewater discharge, it is recommended that sampling be conducted according to the following scheme:

Station 1 - background. It is necessary to adjust the location of the point.
Station 3 - the greatest influence of sewage water
Station 8 – in the recovery zone.

A prerequisite for a correct comparison of monitoring stations with the background is the identity of bottom sediments and the degree of overgrowth with higher aquatic vegetation.

Analysis of the taxonomic composition of the macrozoobenthos of the studied area at this stage of research does not allow us to identify indicators of pollution. To assess the ecological state, it is proposed to use the method of ABC curves and W-statistics.

ANNEX 5 – SUMMARY OF KEY FINDINGS OF THE LOCAL EIA

The following summarises the key findings of the local EIA report prepared by IE Kalmykov D.E. (2023) (summary by Sweco / EcoSocio Analysis).

The basis for development of the local EIA is the Environmental Code of the Republic of Kazakhstan dated 2 January 2021 № 400-VI ZRC and the Conclusion on defining the scope of environmental impact assessment and (or) screening of the impact of planned activities № KZ91VWF00112010 dated 13.10.2023, issued by the Environmental Regulation Committee of the Ministry of Ecology and Natural Resources of the Republic of Kazakhstan.
The local EIA has 226 pages and 5 appendixes that contain responses on the requests of information on the area sensitivity, calculation of noise, emissions and air dispersion modelling, and waste volumes. The project information and calculations in the EIA are based on Aquarem feasibility study (2023) information. The calculations are all approximate and using maximum numbers to reflect a worst-case situation.

The report predicts considerable improvement in the environmental and sanitary-epidemiological situation in the city, compared to the current situation. The construction of new treatment facilities will make it possible to treat discharged and standardised pollutants in wastewater to the level of MPC, established in the sanitary rules "Hygienic standards of safety indicators of household drinking and cultural and domestic water use" Order of the Minister of Health of the Republic of Kazakhstan from 24 November 2022 № KR DSM-138.
After the project implementation, at maximum capacity of treatment facilities (130,000 m3/day or 47,450,000 cubic metres/year), the gross discharge of treated wastewater will amount to 26,436,530 tonnes/year, which is 3,069,282 tonnes/year more than the current norms adopted according to the actual monitoring data. The highest numbers are for sulphate 11, 217 tonnes/year and chlorides 12,541 tonnes/year.
The main air pollutants during construction are predicted to be methane (47 t) and Hydrocarbons C6-C10 (12t).

Emission dispersion modelling showed no exceedances of the maximum permitted concentrations of 20 air pollutants at the residential areas for construction and operation.
According to the calculated data, the noise levels on the territory of the survey site in octave frequency bands and in terms of equivalent and maximum sound levels do not exceed the permissible levels.
Around 2000 tonnes/year of waste with 1894kg of construction waste is expected to be generated during construction. The main waste during the operation is expected to be solid waste (14.5 tonnes/year) and dried sludge (32066 tonnes/year). Out of hazardous waste, oil (0.3 t) and oiled rags (0.09 t) are named.
In the risk assessment section, the EIA describes that proper measures must be taken to prevent accidents in wastewater treatment plants. Daily maintenance and technical inspection of the system will help to detect and eliminate possible breakdowns and failures. Proper operation of the plant and compliance with all technical requirements also reduces the risk of accidents. It is important to train personnel who work at the treatment plant so that they are familiar with safety procedures and proper handling of the equipment.

The local EIA recommends measures for protection of ground and surface waters, protection of soil and vegetation cover, protection, and prevention of damage to wildlife.
These recommendations may become mandatory as part of the environmental permission issued for the project and be included in the associated environmental action plan.

The main measures for the protection of ground and surface waters are in compliance with the technological regulations of WWTP and water legislation of the Republic of Kazakhstan and include: repair of WWTP equipment, works should be carried out strictly within the boundaries of the land allotment area, refuelling of transport vehicles, installation of fuel and lubricants storages, storage and disposal of other harmful substances, chemical and other harmful substances, liquid and solid wastes are collected at specially

designated sites with a concrete base and a water catchment pit, after completion of works: planning and landscaping of the territory.
Measures to protect the soil and vegetation cover in terms of avoiding possible land contamination during organised waste collection include: movement of machinery during construction and installation works and operation along existing field works and places of minimum vegetation accumulation, prevention of fuel and lubricants spills, parking and refuelling of fuel and lubricants equipment on a special site with a hard surface, restoration of disturbed soil cover and bringing the territory back to its natural state for initial or other use, stopping the growth of areas during works implementing preventive measures, following safety rules to avoid burning of shrubs and grasses, prohibition of breaking of shrub flora, production monitoring of soils.

Measures to protect and prevent damage to wildlife comprise: exclude unauthorised passage of machinery on virgin lands, ensure passage on specially designated field roads with strict adherence to the work schedule. In order to avoid littering of the territory with wastes, it is required to store wastes in strictly designated and regulated places, storage of all food wastes in specially adapted closed containers. Compliance with the relevant rules and regulations for the storage and disposal of other hazardous substances. It is recommended to train the personnel in the rules aimed at preservation of biodiversity in the project area. Conduct mandatory training of employees on compliance with special environmental requirements and legislation on specially protected natural areas. To illuminate the facilities, light sources should be used that are covered with green-coloured glass, which acts as a repellent to animals at night; the lighting devices used should be equipped with special protective hoods to prevent mass death of insects. In the course of operation, it is prohibited to:

- prey on, chasing and feeding animals, gathering vegetation, cutting down trees;
- driving on the work area outside the road network;
- keeping domestic dogs on a free walk;

It is recommended to further develop the Rules of internal regulations (internal order) for the enterprise to regulate the activities of the personnel on the reduction of the number of the employees in the territory of the enterprise.

Overall, the local EIA states that following the comprehensive assessment of the environmental and health impacts of the proposed works, the impact of the proposed works on the environment and public health is of low significance, which allows to conclude that the WWTP construction works are feasible.

ANNEX 6 – GEOLOGY AND SOIL REPORTS

1. Azimut Geologiya LLP, Karaganda 2022
2. Inzhenerno geologicheskiey izyskaniya po fondovym materialam, KazTsentr ZhKKh PLC 2019
3. Razrabotka TEO KOS Karaganda technicheskiy otchet Inzhenerno geologicheskiey izyskaniya po fondovym materialam 12-2022.007235-IG, Akva-Rem 2023

ТОО «АЗИМУТ ГЕОЛОГИЯ»

ПАСПОРТ

наблюдательной скважины № 1

Заказчик:	ТОО «Караганды Су»
Местоположение:	Станция аэрации
Город, район:	г. Караганда район имени Казыбек Би
Область:	Карагандинская
Координаты географические: (сняты GPS)	49° 45′ 40,9″с.ш. 73° 01′ 50,8″в.д.

Генеральный директор
ТОО «Азимут Геология» Инкин Д.А.

Начальник инженерно-
экологического отдела Костикова Н.А.

г. Караганда

2022 г.

Таблица 5

Результаты анализа пробы воды на специфические компоненты

Наименование водопункта	**Дата отбора пробы**	**Анализируемые компоненты**	**Ед. изм.**	**Результаты, мг/дм^3**
Скв.№ 1	22.06.2022г.	АПАВ	мг/дм^3	<0,025
		Нефтепродукты	мг/дм^3	0,351
		БПК$_{20}$	мг/дм^3	1,3
		Взвешенные вещества	мг/дм^3	948,4
		Марганец (Mn)	мг/дм^3	0,145
		Железо (Fe)	мг/дм^3	2,17
		ХПК	мг/дм^3	43,4
		Фосфаты (PO_4^{3-})	мг/дм^3	<0,02

Результаты лабораторных исследований отражены в таблицах 4 и 5, а также в приложениях 1 и 2. По химическому составу вода хлоридная натриево-калиевая с минерализацией, составляющей 1,9 г/дм^3. Общая жесткость составляет 2,2 мг-экв/дм^3 (вода мягкая), водородный показатель (pH) в пределах нормы (8,09). В воде наблюдаются повышенные содержания по железу: 2,17 мг/дм^3 и кремнию: 19,61 мг/дм^3.

Согласно Единой системы классификации качества воды в водных объектах (№151 от 9 ноября 2016 г) очищенные сточные воды со станции аэрации соответствуют 5 классу водопользования, которые «пригодны для использования в целях гидроэнергетики, добычи полезных ископаемых, гидротранспорта. Для других целей воды этого класса водопользования не рекомендованы».

Паспорт составила Махсутбекова Р.Б.

ТОО «АЗИМУТ ГЕОЛОГИЯ»

ПАСПОРТ

наблюдательной скважины № 2

Заказчик:	ТОО «Караганды Су»
Местоположение:	Станция аэрации
Город, район:	г. Караганда район имени Казыбек Би
Область:	Карагандинская
Координаты географические: (сняты GPS)	49° 44′ 44,5″с.ш. 73° 01′ 31,2″в.д.

Генеральный директор ТОО «Азимут Геология» — Инкин Д.А.

"Азимут Геология"

Начальник инженерно-экологического отдела — Костикова Н.А.

г. Караганда

2022 г.

Таблица 5

Результаты анализа пробы воды на специфические компоненты

Наименование водопункта	**Дата отбора пробы**	**Анализируемые компоненты**	**Ед. изм.**	**Результаты, мг/дм^3**
Скв. № 2	24.06.2022 г.	АПАВ	мг/дм^3	0,136
		Нефтепродукты	мг/дм^3	0,273
		БПК$_{20}$	мг/дм^3	14,3
		Взвешенные вещества	мг/дм^3	300,0
		Марганец (Mn)	мг/дм^3	2,536
		Железо (Fe)	мг/дм^3	11,60
		ХПК	мг/дм^3	189,7
		Фосфаты (PO_4^{3-})	мг/дм^3	0,43

Результаты лабораторных исследований отражены в таблицах 4 и 5, а также в приложениях 1 и 2. По химическому составу вода хлоридно-сульфатная натриево-калиевая с минерализацией, составляющей 7,5 г/дм^3. Общая жесткость составляет 53,00 мг-экв/дм^3 (вода очень жесткая), водородный показатель (рН) в пределах нормы (6,93 – реакция среды нейтральная). В воде наблюдаются повышенные содержания нитратов- 390,6; железа-11,60 и окисляемости перманганатной-12,8 мг/дм^3.

Согласно Единой системы классификации качества воды в водных объектах (№151 от 9 ноября 2016 г) очищенные сточные воды со станции аэрации соответствуют 5 классу водопользования, которые «пригодны для использования в целях гидроэнергетики, добычи полезных ископаемых, гидротранспорта. Для других целей воды этого класса водопользования не рекомендованы».

Паспорт составила Махсутбекова Р.Б.

ТОО «АЗИМУТ ГЕОЛОГИЯ»

ПАСПОРТ

наблюдательной скважины № 3

Заказчик:	ТОО «Караганды Су»
Местоположение:	Станция аэрации
Город, район:	г. Караганда район имени Казыбек Би
Область:	Карагандинская
Координаты географические: (сняты GPS)	49° 44′ 14,1″с.ш. 73° 01′ 41,4″в.д.

Генеральный директор
ТОО «Азимут Геология» Инкин Д.А.

Начальник инженерно-
экологического отдела Костикова Н.А.

г. Караганда

2022 г.

Таблица 5

Результаты анализа пробы воды на специфические компоненты

Наименование водопункта	Дата отбора пробы	Анализируемые компоненты	Ед. изм.	Результаты, мг/дм^3
Скв. № 3	28.06.2022 г.	АПАВ	мг/дм^3	0,080
		Нефтепродукты	мг/дм^3	0,032
		БПК$_{20}$	мг/дм^3	23,5
		Взвешенные вещества	мг/дм^3	24,4
		Марганец (Mn)	мг/дм^3	2,998
		Железо (Fe)	мг/дм^3	0,55
		ХПК	мг/дм^3	53,0
		Фосфаты (PO_4^{3-})	мг/дм^3	<0,02

Результаты лабораторных исследований отражены в таблицах 4 и 5, а также в приложениях 1 и 2. По анионному составу вода смешанная трехкомпонентная, по катионному - натриево-калиевая с минерализацией, составляющей 1,8 г/дм^3. Общая жесткость составляет 10,8 мг-экв/дм^3 (вода очень жесткая), водородный показатель (рН) в пределах нормы (7,96). В воде наблюдается повышенное содержание железа: 0,55 мг/дм^3.

Согласно Единой системы классификации качества воды в водных объектах (№151 от 9 ноября 2016 г) очищенные сточные воды со станции аэрации соответствуют 5 классу водопользования, которые «пригодны для использования в целях гидроэнергетики, добычи полезных ископаемых, гидротранспорта. Для других целей воды этого класса водопользования не рекомендованы».

Паспорт составила Махсутбекова Р.Б.

ТОО «АЗИМУТ ГЕОЛОГИЯ»

ПАСПОРТ

наблюдательной скважины № 4

Заказчик:	ТОО «Караганды Су»
Местоположение:	Станция аэрации
Город, район:	г. Караганда район имени Казыбек Би
Область:	Карагандинская
Координаты географические: (сняты GPS)	49° 44′ 41,3″с.ш. 73° 02′ 02,7″в.д.

Генеральный директор ТОО «Азимут Геология» — Инкин Д.А.

"Азимут Геология"

Начальник инженерно-экологического отдела — Костикова Н.А.

г. Караганда

2022 г.

Таблица 5

Результаты анализа пробы воды на специфические компоненты

Наименование водопункта	Дата отбора пробы	Анализируемые компоненты	Ед. изм.	Результаты, мг/дм^3
Скв. № 4	29.06.2022 г.	АПАВ	мг/дм^3	0,158
		Нефтепродукты	мг/дм^3	0,063
		БПК$_{20}$	мг/дм^3	3,5
		Взвешенные вещества	мг/дм^3	17,1
		Марганец (Mn)	мг/дм^3	4,582
		Железо (Fe)	мг/дм^3	0,64
		ХПК	мг/дм^3	53,0
		Фосфаты (PO_4^{3-})	мг/дм^3	0,04

Результаты лабораторных исследований отражены в таблицах 4 и 5, а также в приложениях 1 и 2. По химическому составу вода хлоридно-сульфатная кальциево-натриево-калиевая с минерализацией, составляющей 2,1 г/дм^3. Общая жесткость составляет 17,0 мг-экв/дм^3 (вода очень жесткая), водородный показатель (pH) в пределах нормы (7,74). В воде наблюдаются превышенные содержания (мг/дм^3) по: аммонию – 40,0; железу - 0,64 и общей жесткости – 17,00 мг-экв/дм^3.

Согласно Единой системы классификации качества воды в водных объектах (№151 от 9 ноября 2016 г) очищенные сточные воды со станции аэрации соответствуют 5 классу водопользования, которые «пригодны для использования в целях гидроэнергетики, добычи полезных ископаемых, гидротранспорта. Для других целей воды этого класса водопользования не рекомендованы».

Паспорт составила Махсутбекова Р.Б.

АО «КазЦентр ЖКХ»

ТЭО «Реконструкция канализационных очистных сооружений г. Караганды»

К Н И Г А 3.1

Инженерно-геологические изыскания (по фондовым материалам)

Объект:	________ **ИГИ**
Стадия:	**ТЭО**
Заказчик:	АО «КазЦентр ЖКХ»

г. Нур-Султан 2019г.

АО «КазЦентр ЖКХ»

ТЭО «Реконструкция канализационных очистных сооружений г. Караганды»

К Н И Г А 3.1

Инженерно-геологические изыскания
(по фондовым материалам)

Объект:	**ИГИ**
Стадия:	**ТЭО**

АО «КазЦентр ЖКХ»

Председатель правления	Джиенбаев Н.Р.
Главный инженер проекта	Балгужинов А.А.

Г. Нур-Султан 2019 г.

Справка

Право на выполнение работ предоставлено АО «КазЦентр ЖКХ». Отчёт об инженерно-геологических изысканиях на объекте: «Реконструкция канализационных очистных сооружений г. Караганды» выполнен на основании материалов АО «Казахский Водоканалпроект» - Обоснование инвестиций систем водоснабжения и водоотведения г. Караганда. Проектная документация разработана в соответствии с государственными нормативами, правилами и стандартами, требованиями экологических, санитарно-гигиенических, противопожарных и других норм, действующих на территории Республики Казахстан, обеспечивая безопасную для жизни и здоровья людей эксплуатацию при соблюдении всех проектных решений.

Главный инженер проекта
АО «КазЦентр ЖКХ» Балгужинов А. А.

Оглавление

Введение

Заключение об инженерно-геологических и гидрогеологических условиях территории г.Караганды оставлено для «Обоснования инвестиций в развитие системы водоснабжения и водоотведения городов РК».

Сбор, изучение и систематизация материалов инженерно-геологической и гидрогеологической изученности территорий городов РК произведены в архиве института «Казводоканалпроект» с привлечением материалов сторонних изыскательских организаций.

Заключение написано главным специалистом инженерных изысканий АО «Казахский Водоканалпроект» Першиной Т.Г.

1. Физико-географические условия района

В геоморфологическом отношении территория г. Караганды характеризуется как равнинная, со слаборасчленённым рельефом, характеризующимся наличием однообразных округлых холмов, увалов с перепадом высот от 5,0 до 200м.

Район характеризуется резко континентальным климатом. Лето характеризуется высокой температурой, малым количеством осадков и значительной сухостью воздуха. Продолжительность периода со среднесуточными температурами ниже 0^0 С составляет 170суток. Среднемесячная температура воздуха в январе – -15,1^0 С.

Среднемесячная температура воздуха в июле – 20,3^0С.

Среднегодовое количество осадков за многолетний период составляет 273мм. Большая часть осадков выпадает в тёплый период и почти полностью расходуется на испарение.

Снежный покров на территории устанавливается в среднем в первой декаде ноября и сходит во второй декаде апреля. Продолжительность периода с устойчивым снежным покровом составляет 148-151день.

В соответствии со СНиП РК2.04.01-2010 «Строительная климатология» и СНиП 2.01.07-85* «Нагрузки и воздействия» для

г. Караганды характерны следующие нормативные климатические параметры:

- Климатический район – IB;
- Температура наиболее холодной пятидневки - -36^0 С;
- Преобладающее направление ветра за декабрь-февраль: юго-западное; средняя скорость – 7,7м/сек;
- Преобладающее направление ветра за июнь-август: северо-восточное; средняя скорость – 5,0м/сек;

- Ветровой район – IV;
- Нормативная ветровая нагрузка – 0,48кПа (48,0кгс/см2);
- Снеговой район - III
- Нормативная снеговая нагрузка – 1,8кПа (180,0кгс/см2);
- Гололёдный район – III ;
- Нормативная глубина промерзания грунта – 190см;
- Максимальная глубина проникновения изотермы 0^0 - 250см.
- Сейсмичность – район не сейсмичен.

2. Геолого-гидрогеологические условия

В геологическом строении района принимают участие эффузивно-осадочные породы девонского возраста, представленные алевролитами, песчаниками, известняками, сланцами, аргиллитами, порфиритами, альбитофирами и их туфами. В верхних частях отдельных сопок эффузивные породы обнажаются.

Кровля коренных пород, как правило, подвержена физико-механическому выветриванию с образованием элювия различной степени выветрелости – от глыб и щебня до рухляка и глины. Мощность коры выветривания колеблется от долей метра до 2-5м и более.

Широкое распространение в районе имеют неогеновые и четвертичные отложения. Неогеновые отложения представлены красновато-коричневыми глинами павлодарской свиты и зеленовато-серыми глинами аральской свиты.

Мощность неогеновых глин колеблется от 3-5 до 20 и более метров.

Четвертичные отложения представлены разнообразным комплексом грунтов – супесями, суглинками, песками, реже- глинами. Залегают они на размытой поверхности палеозойских пород или на глинах неогена. Мощность их колеблется от 1-2 до 10 и более метров.

Наибольшее распространение имеют четвертичные аллювиальные отложения р. Шерубай-Нуры.

Аллювиальные отложения с поверхности представлены покровными суглинками и супесями, которые залегают повсеместно и имеют мощность от 1,0-1,5 до 3,0м, редко 5-6м. Под ними залегают пески и щебенисто-гравийные грунты. Подстилающими являются неогеновые пестроцветные глины. Максимальная мощность глин 60-80м. Эти глины залегают на размытой поверхности палеозойских пород.

Ранее выполненными лабораторными работами было установлено, что глины аральской свиты набухающие; четвертичные суглинки обладают слабыми просадочными свойствами.

Степень коррозийности грунтов по отношению к стали различная.

В гидрогеологическом отношении исследуемая территория характеризуется наличием водоносных горизонтов, приуроченных к четвертичным и девонским образованиям.

Грунтовые воды четвертичных отложений приурочены к аллювиальным отложениям долины р.Шерубай-Нура. Глубина залегания грунтовых вод колеблется от 0,6-2,0м – в приречной части долины до 5-10м – в её бортовых частях.

Воды аллювиального потока от пресных до солоноватых, большей частью неагрессивные. Лишь на отдельных участках, где в разрезе преобладают глинистые прослои, грунтовые воды имеют сульфатную или хлоридную агрессивность.

Аллювиальные воды получают питание за счёт инфильтрации талых и дождевых вод, за счёт сброса шахтных вод, поливов и залиманивания. Максимальный подъём уровня наблюдается весной, в апреле-мае, реже- в июне-августе. Самое низкое положение уровня отмечается в сентябре-октябре, реже – в феврале-марте.

Амплитуда колебания уровня грунтовых вод колеблется от 0,4 до 2,0м и зависит от расстояния до долины р. Шерубай-Нура. Коэффициенты фильтрации водовмещающих грунтов колеблются от 1-5м/сут – для песков, до 20-50м/сут – для гравийно-галечников.

Горизонт безнапорный, подстилается водоупорными глинами неогена.

Трещинно-жильные воды девонских отложений на отдельных участках обладают напорами от 0,5 до 1,0м от поверхности земли.

Грунтовые воды обладают различной степенью минерализации – от слабо – до сильно солоноватых.

3. Инженерно-геологические условия

Трасса водовода от Караганда-Темиртауского водовода в **Новом Майкудуке в п. Пришахтинский и Сортировочный.**

Поверхность земли относительно ровная, абсолютные отметки изменяются от 520,0-526,0 до 537-538,0м. и 520,0-515,0м.

Геологический разрез представлен четвертичными делювиально-пролювиальными отложениями: преимущественно глины, суглинки, прослои супеси и песка. Мощность прослоев не превышает 1-2м, редко достигает 3,0м. Подстилаются эти отложения глинами неогена красновато-коричневого, иногда зеленовато-серого цвета. Ближе к п. Пришахтинский на гл. 0,5-1,2м встречена кора выветривания девона, представленная аргиллитовыми сланцами, песчаниками. Мощность отложений коры выветривания от 1,0 до 3-4м.

Грунтовые воды вскрыты на глубине от 0,8-1,1 до 4,0-5,0м. По степени минерализации грунтовые воды от солоноватых до солёных, с величиной сухого остатка от 3,0 до 18,0г/л, иногда достигает и 32,0г/л.

По типу минерализации воды хлоридно-натриевые, обладают различной степенью углекислой и сульфатной агрессивности к бетону на сульфатостойких сортах цемента.

Четвертичные глины и суглинки при бытовом давлении не просадочны. На отдельных участках суглинки имеют величину просадки при 3-х метровой толще до 5,0см, то есть имеют 1-ый тип просадки.

Красновато-коричневые глины неогена – непросадочны и не набухающие: зеленовато-серые – набухающие.

Коррозийная активность грунтов колеблется от средней для песков, до высокой и весьма высокой – для глин.

Трасса водовода в районе Майкудука, абсолютные отметки поверхности земли – 525-590м.

В геологическом строении трассы принимают участие элювиальные глины (слой 7) мощностью от 3,0 до 7,5м, подстилаемые глинистыми сланцами (слой 11), в верхней зоне разрушенными до состояния щебня с суглинистым и глинистым заполнителем.

На отдельных участках вскрыты порфириты трещиноватые (слой 12), разрушенные до щебня.(слой 10).

Четвертичные отложения представленные суглинками(слой 5) и песками (слой 4), приурочены к понижениям кровли элювиальных образований. Мощность четвертичных отложений – 2,2-5,0м.

На участках автомобильных и ж/дорог встречены насыпные грунты мощностью от 0,3 до 3,0м.

Грунтовые воды вскрыты в четвертичных отложениях на глубине 0,7-1,2м. Сухой остаток – 1,2г/л; сульфатно-хлоридно-натриевого типа, обладают средней сульфатной агрессивностью к бетону нормальной плотности на несульфатостойком цементе.

В элювиальных отложениях, на глубине 1,3-4,5м, встречаются подземные воды, имеющие спорадическое распространение. Эти воды солёные, с сухим остатком 11,63г/л, сульфатно-кальциевые, также обладающие средней сульфатной агрессивностью.

Трасса водовода в Пришахтинске имеет абсолютные отметки поверхности земли от 521 до 531м.

В основании разреза залегают элювиальные суглинки (слой 6) глины (слой 7) и сланцы (слой 11), в верхней зоне разрушенные до щебня с глинистым заполнителем. Вскрытая мощность элювиальных образований изменяется от 2,5 до5,0м.

С поверхности почти по всей трассе до глубины от 0,8 до 2,5м залегают четвертичные супеси (слой 3) и суглинки (слой 4). Наибольшая мощность их 5,0м.

На отдельных участках встречаются насыпные грунты мощностью 0,3-0,5м.

Грунтовые воды встречены в четвертичных и элювиальных образованиях на глубине 1,3-2,5м. Воды солоноватые, с сухим остатком 1,4г/л; сульфатно-гидрокарбонатно-натриевого типа; обладают средней сульфатной агрессивностью.

Трасса водовода по ул.Солнечной сложена элювиальными суглинками и глинами, покрытыми с поверхности насыпным грунтом.

Вскрытая мощность элювиальных грунтов – 3,3-4,8м; насыпного слоя – 1,3-1,7м.

Грунтовые воды вскрыты на глубине 2,5-3,2м; воды пресные, с сухим остатком 0,8г/л; гидрокарбонатно-сульфатно-кальциевого типа.

Трасса водовода по ул.ул. Космонавтов, Высоковольтной, Керамической, Столярной и Карабаской. В основании разреза залегают четвертичные супеси, пески и суглинки повсеместно перекрытые с поверхности насыпным слоем мощностью от 0,4 до 4,3м.

Грунтовые воды вскрыты повсеместно на глубине от 1,8 до 4,2м.

Воды солёные с сухим остатком 29,6г/л; хлоридно-сульфатно-натриевые; обладают слабой магнезиальной агрессивностью к бетону нормальной плотности и сильной сульфатной агрессивностью.

Площадка насосной станции II зоны с поверхности представлена четвертичными супесями и суглинками мощностью от 0,4 до 1,9м. Насыпной слой встречен участками и имеет мощность до 3,0м. В северо-восточной части площадки с поверхности вскрыты порфириты трещиноватые, в верхней зоне выветрелые до щебня с суглинистым заполнителем. Мощность выветрелой зоны 0,8-2,2м.

Площадка резервуаров промывной воды расположена на сопке с абсолютными отметками 546-549м. Площадка сложена трещиноватыми, незначительно выветрелыми порфиритами, выходящими на поверхность.

Юго-западная часть города. Трасса водовода от западной насосной станции до площадки резервуаров 7 зоны. Абсолютные отметки поверхности земли изменяются от 577-580м на площадке резервуаров, до 539-540,0м по всей трассе. Геологическое строение представлено пестроцветными суглинками и глинами юры. Мощность покровных четвертичных суглинков составляет всего 0,5-0,9м.

Грунтовые воды вскрыты на глубине от 1,3-1,6 до 2,7м.

Воды слабосолоноватые, с минерализацией 2,4г/л, хлоридно-натриевого типа, имеют слабую углекислую и среднюю сульфатную агрессивность к бетону повышенной плотности на обычных сортах цемента.

Коэффициент фильтрации глинистых грунтов – 0,149м/сут.

Северо-восточная- южная- юго-восточная часть города. Поверхность земли ровная, абсолютные отметки изменяются от 533,0 до 587,0м, преимущественно – 563,0м. В геологическом строении этой части города присутствуют глины неогена, с поверхности прикрытые чехлом четвертичных суглинков с прослоями песков. Мощность покровных четвертичных отложений – 1,2-2,6м, лишь иногда достигает 4,0-5,0м.

Четвертичные отложения представлены суглинками с прослоями и линзами среднезернистого песка. Мощность этих отложений 0,5-1,0 до 4,0-5,0м.

Неогеновые отложения представлены глинами зеленова-серого и красно-бурого цвета.

В юго-восточной части территории города под четвертичными отложениями встречены порфириты девона.

Грунтовые воды залегают на глубине от 0,7-0,8 до 2,0-2,5м. Водовмещающими являются четвертичные суглинки, пески и неогеновые глины.

Водопроницаемость их различна. Пески характеризуются коэффициентами фильтрации от 10,0 до 20,0м/сут, а суглинки – 0,001-0,5м/сут.

Коэффициент фильтрации глин неогена изменяется от 0,0001 до 0,1м/сут. Подземные воды неогеновых глин приурочены к тонким прослойкам песков.

По химическому составу подземные воды от слабо до сильно солоноватых, с минерализацией от 1,5 до 6,3г/л, по типу – хлоридно- или сульфатно-натриевые, обладают средней или сильной степенью сульфатной агрессивности к бетону повышенной плотности на обычных сортах цемента. По данным химических анализов водных вытяжек, суглинки и глины обладают средней или сильной сульфатной агрессивностью к бетону на портландцементе и средней хлоридной агрессивностью. Песчаники выветрившиеся дресвяные неагрессивны.

Площадка ВОС расположена в пределах Майкудукского поднятия. Абсолютные отметки поверхности земли изменяются от 527,0до 531,0м. В геологическом строении площадки участвуют коренные породы девона – алевролиты и песчаники. Породы крепкие, слаботрещиноватые. В кровле породы подвержены вывтриванию с образованием дресвяно-щебенистой зоны с суглинистым заполнителем. На отдельных участках в верхней части коры выветривания наблюдается глинистая зона элювия светлосерого или голубовато-серо-зелёного цвета. Мощность нижней дресвяно-щебенистой зоны колеблется от 0,8-1,3 до 5,4м. Глинистая зона не выдержана по мощности, иногда она достигает 6,4м. Четвертичные отложения залегают с поверхности до глубины 0,4-3,5м и представлены суглинками коричневого цвета с включением до 20% дресвы и щебня. В юго-западной части площадки в суглинках прослеживается линза мелкозернистого песка, мощностью до 1,1м.

Грунтовые воды вскрыты всеми выработками на глубине от 1,2 до 3,1м. Уклон грунтового потока на запад. Амплитуда колебания грунтовых вод составляет 0,5м и зависит от сезона года. На участках, где водовмещающими являются глинистые грунты, грунтовые воды хлоридно-натриевого типа, солёные, с минерализацией до 30-50г/л, обладают слабой или сильной степенью магнезиальной агрессивности, а также сульфатной агрессивностью к бетону на шлакопортландцементе, местами слабой или сильной на сульфатостойких сортах цемента.

В долине р. Кокпекты, где водовмещающими являются аллювиальные пески, грунтовые воды от слабосолоноватых до пресных, с минерализацией 1,5г/л, гидрокарбонатно-сульфатно-кальциевые, неагрессивные.

Посёлок Актау, площадка резервуаров на о. Жанааул - геологический разрез с 0,0 до 6,0м представлен щебнем, дресвой известняка с суглинистым заполнителем. Воды нет.

Канализационный коллектор по бульвару Мира –в геологическом строении принимают участие супеси, суглинки и глины. С глубины 3,5-5,5м суглинки с включением гравия до 35-40%.

Грунтовые воды по бульвару Мира залегают на глубинах более 7,0м.

4. Физико-механические характеристики грунтов

Нормативные характеристики суглинков юры:

- Влажность на пределе текучести – 0,29;
- Влажность на пределе раскатывания – 0,15;
- Число пластичности – 0,14;
- Удельный вес – 2,72г/см3;
- Объёмный вес – 1,78г/см3;
- Объёмный вес скелета – 1,64г/см3;
- Пористость – 39,8%;
- Коэффициент пористости – 0,673;
- Естественная влажность – 0,2-0,6;
- Консистенция – твёрдая;

Нормативные характеристики глин:

- Глины отличаются от суглинков большей пластичностью и влажностью;
- Влажность на пределе текучести – 0,43;
- Влажность на пределе раскатывания – 0,2;
- Число пластичности – 0,23;
- Удельный вес – 2,73г/см3;
- Объёмный вес – 1,89г/см3;

- Объёмный вес скелета – 1,61г/см3;
- Пористость – 41,2%;
- Коэффициент пористости – 0,707;
- Естественная влажность – 0,16-0,21;
- Степень насыщения – 0,56-0,75;
- Консистенция – твёрдая;

Как видно из вышеприведённых данных, физические свойства глин и суглинков мало отличаются, поэтому прочностные и деформационные свойства их приводятся совместно:

- Сцепление при естественной влажности – 0,8кг/см2; угол внутреннего трения – $32\text{-}37^0$;
- При водонасыщении сцепление – 0,17-0,27кг/см2; угол внутреннего трения $18\text{-}23^0$;
- Степень набухания – от слабой до средней;
- Величина свободного набухания – 0,8кг/см2;
- Коэффициент относительного набухания при нагрузке 0,5кг/см2 – 0,004;
- Величина начального просадочного давления – 1,4кг/см2;
- Модуль деформации в интервале нагрузок 0,5-3,0кг/см2 грунта естественной влажности – 30кг/см2;
- Водонасыщенного – 20кг/см2;
- Строительные группы: суглинок – суглинок тяжёлый;

Глина – глина тяжёлая;

Глины неогена имеют следующие характеристики:

Залегающие выше уровня грунтовых вод:

- Сцепление – 0,7кг/см2;
- Угол внутреннего трения – 21^0;
- Модуль деформации – 40,кг/см2;

Расчётная величина давления набухания – 5,0кг/см2.

Глины неогена водонасыщенные:

- Сцепление – 0,4кг/см2;
- Угол внутреннего трения – $6\text{-}10^0$;
- Модуль деформации – 30кг/см2;

Четвертичные суглинки, залегающие выше уровня грунтовых вод:

- Сцепление – 0,55кг/см2;
- Угол внутреннего трения – 24^0;
- Модуль деформации – 40,0кг/см2;.

Четвертичные среднезернистые пески:

- Угол откоса сухого песка – 40^0;
- Водонасыщенного – $28\text{-}30^0$;

- Условное давление независимо т влажности – 4,0кг/см2.

Глинистые грунты юры склонны к набуханию – расчётная величина давления набухания – 0,8кг/см2.

При увеличении нагрузок глинистые грунты проявляют просадочные свойства – величина начального просадочного давления – 1,4кг/см2.

На участках развития набухающих глинистых грунтов юры и неогена необходимо предусмотреть устройство песчаной подушки мощностью 0,8-1,0м.

Коррозийная активность грунтов колеблется от средней до высокой.

Приток воды в траншеи и котлованы при строительстве определяется следующими значениями коэффициентов фильтрации:

- Суглинок – 0,1-0,5м/сут;
- Супесь – 1,0-2,0м/сут;
- Песок – 2-5м/сут;
- Глина – 0,001м/сут.

Таблица геотехнических характеристик грунтов

Определяемые характеристики	грунты										
	Слой 2	Слой 3	Слой 4	Слой 5	Слой 6	Слой 7	Слой 8	Слой 9	Слой 10	Слой 11	Слой12
Название грунта	Насыпной грунт	Супесь серовато-коричневая, мелкрпесчанистая,с гравием и щебнем	Песок коричневый	Суглинок серовато-коричневый	Суглинок элювиальный	Глина элювиальная	Щебень Порфипитов с суглинистым заполнителем	Щебень и дресва порфиритов	Порфириты и сланцы в коренном залегании	Сланцы светло-знлёного цвета, выветрелые	Порфирит серый
Строительная группа	Строительный мусор слежавшийся	Супесок с примесью гравия	Песок с примесью гравия	Суглинок тяжёлый	Суглинок тяжёлый	Глина жирная с включением щебня	Дресва в коренном залегании	Порфирит выветрелый	Порфирит выветоелый	Сланцы выветрелые	Порфирит не затронутый выветриванием
Плотность, г/см3	-	2,67	2,66	2,71-2,72	2,69-2,7	2,75					
Объёмная масса г/см3	-	1,63	1,87	1,8-2,0	1,71	1,87		1,9-2,0			
Объёмная масса скелета	-	1,45	1,6	1,6-1,9	1,47	1,6					

г/см3											
Влажность,%	-	12-14									
-на пределе текучести	-	-	16	26	28						
- на пределе раскатывания	-	-	13	15-18	16						
Число пластичности	-	-	3	8-11	12						
Пористость,%	-	46	37		46	42					
Коэффициент пористости	-	0,75	0,64	0,6-0,8	0,83	0,73					
Естественная влажность,%	-	-	10-15	3-18	11-21	16-23					
Коэффициент фильтрации,м/сут	-	0,8-1,2	1,0-1,2	0,2-0,5	0,0001-0,01						
Угол внутреннего трения:											
-естественной влажности	-	27	30-32	36	32	23-26	46	45			
Сцепление, МПа	-	0,008		0,05	0,08	0,057-0,062	0,008	0,007			
-при водонасыщении	-	21	24-26	20	18	11					
Сцепление, МПа	-	0,003		0,015	0,017	0,05					
просадочность	-	Не просадочны		Не просадочны	Не просадочны	Не просадочны					
Коррозийность	-	Низкая и средняя	Низкая и средняя	повышенная	От средней до весьма высо	Весьма высокая	От повышенной до весьма высо				

					крй		кой				
Удельное расчётное давление, МПа	-										
- твёрдые	-	0,22		0,2							
- пластичные	-	0,18		0,16							
Удельная расчётная нагрузка, МПа							0,3	0,3			
Допускаемая нагрузка, МПа											
- на влажные	-	-	0,4						0,5	0,4	0,6
- маловлажные	-	-	0,3								
- водонасыщенные	-	-	0,2								
Модуль деформации, МПа											
- естественной влажности					9	22					
- при водонасыщении					3	9					
набухание						При взаимодействии с водой набухают					
Давление набухания, МПа						0,1-0,25					

5. Оценка воздействия на окружающую среду.

Источниками воздействия на окружающую природную среду, в частности на грунты, подземные и поверхностные воды могут являться сточные воды предприятий, нерациональное накопление и захоронение твёрдых отходов, технологические нарушения (проливы нефтепродуктов).

При строительстве ёмкостных сооружений необходимо выполнять гидроизоляцию подземных частей для уменьшения просачивания поверхностных вод с последующим уменьшением возможности загрязнения подземных вод.

При возможном вскрытии грунтовых вод с последующей организацией строительного водопонижения, необходимо производить организованный сбор воды с отводом её в арычную сеть или специальные пониженные участки местности в соответствии с ТУ «Водоканала».

Разработанные грунты необходимо повторно использовать на нужды строительства

Данные по натурным замерам показателей загрязнения воздушной среды отсутствуют. Воздействие на воздушный бассейн будет оказано только в период выполнения строительных работ.

Основными источниками загрязнения атмосферы в период реконструкции и строительства будут:

- Земляные работы;
- Газовые выбросы от спецтехники;
- Передвижная электростанция;
- Электросварочные работы.

Источниками будут выбрасываться в атмосферу следующие вещества:

Оксиды железа, марганца, диоксид азота, сажа, сернистый ангидрид, фтористый водород, формальдегид, пыль, и др.

Состояние растительного покрова связано с хозяйственной деятельностью человека;

Особых воздействий на животный мир и его ареал обитания не произойдёт.

В период строительства необходимо соблюдать следующие мероприятия с целью предотвращения отрицательного воздействия на окружающую среду:

- Организовать специальную стоянку для строительной техники;
    - Загрязнённые участки поверхности земли от случайно пролитых ГСМ немедленно убирать и утилизировать;
    - Временный склад ГСМ обваловать;
    - Во время производства работ поливать подъездные автодороги;
    - Бытовой мусор и оставшуюся упаковочную тару утилизировать с соблюдением установленных норм и вывозить на свалку;

Выводы

В геоморфологическом отношении территория г. Караганды характеризуется как равнинная, со слаборасчленённым рельефом, характеризующимся наличием однообразных округлых холмов, увалов с перепадом высот от 5,0 до 200м.

В геологическом строении района принимают участие эффузивно-осадочные породы девонского возраста. Широкое распространение в районе имеют неогеновые и четвертичные отложения. Четвертичные отложения представлены разнообразным комплексом грунтов – супесями, суглинками, песками, реже- глинами. Мощность их колеблется от 1-2 до 10 и более метров.

Подстилающими являются неогеновые пестроцветные глины. Ранее выполненными лабораторными работами было установлено, что неогеновые глины набухающие; четвертичные суглинки обладают слабыми просадочными свойствами.

Глубина залегания грунтовых вод колеблется от 0,6-2,0м до 5-10м. Амплитуда колебания уровня грунтовых вод колеблется от 0,4 до 2,0м и зависит от расстояния до долины р. Шерубай-Нура. Коэффициенты фильтрации водовмещающих грунтов колеблются от 1-5м/сут – для песков, до 20-50м/сут – для гравийно-галечников.

Приток воды в траншеи и котлованы при строительстве определяется следующими значениями коэффициентов фильтрации:

- Суглинок – 0,1-0,5м/сут;
- Супесь – 1,0-2,0м/сут;
- Песок – 2-5м/сут;
- Глина – 0,001м/сут.

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С-2271 (ул. Охранная)

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Республика Казахстан
Товарищество с ограниченной ответственностью
«АКВА-РЕМ»

Разработка технико-экономического обоснования Объекта «Строительство канализационных очистных сооружений станции Аэрации в г. Караганда»

Технический отчет инженерно-геологического изыскания

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12-2022.007235-ИГ

ТОО «Аква-Рем»
Директор **Мейзбекова Б.М**

Главный инженер проекта **Ахметова Л.С.**

г. Караганда 2023г.

Содержание

Введение

Заключение об инженерно-геологических и гидрогеологических условиях территории г. Караганда составлено для Разработки технико-экономического обоснования Объекта «Строительство канализационных очистных сооружений станции Аэрации в г. Караганда».

Сбор, изучение и систематизация материалов инженерно-геологической и гидрогеологической изученности территорий городов РК произведены из материалов сторонних изыскательских организаций.

1. ПРИРОДНЫЕ УСЛОВИЯ РАЙОНА РАСПОЛОЖЕНИЯ ОБЪЕКТА

1.1 Природно-климатические условия

В геоморфологическом отношении территория г.Караганды характеризуется как равнинная, со слаборасчлененным рельефом. Характеризующимся наличием однообразных округлых холмов. Увалов с перепадом высот от 5,0 до 200м.

Участок работ расположен на слабоволнистой равнинной поверхности Казахского мелкосопочника в районе водоохраной зоны бассейна реки М. Букпа, земельных участков под обслуживание лесного фонда и водоохраной зоны жилого массива.

Климат района резко континентальный, что обусловлено удалённостью территории от больших водных пространств, а также свободным доступом тёплого субтропического воздуха пустынь Средней Азии и холодного, бедного влагой, арктического воздуха. Зима холодная и продолжительная с устойчивым снежным покровом, с часто наблюдающимися сильными ветрами и метелями. Лето короткое и жаркое. Район относится к зоне недостаточного и неустойчивого увлажнения.

Характеристика составлена по «Научно-прикладному справочнику по климату СССР. Серия 3, вып.18.1989г.» и СП РК 2.04-01-2017* «Строительная климатология» СН РК 2.04-21-2004* «Энергопотребление и тепловая защита гражданских зданий».

Температура воздуха

Годовой ход температур характеризуется устойчивыми сильными морозами в зимний период, интенсивным нарастанием тепла в короткий весенний сезон и жарой в течение короткого лета.

Среднемесячная и годовая температура воздуха

Таблица №1

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Год
-14,5	-14,1	-8,2	4,1	12,7	18,3	20,4	18	11,9	3	6,99	-12,8	2,7

Как видно из таблицы № 1 средняя месячная температура самого холодного месяца года - января составляет -14,5 градусов, а самого тёплого – июля +20,4 градусов тепла.

В отдельные очень суровые зимы температура может понижаться до 39 градусов мороза (абсолютный минимум), но вероятность такой температуры не более 5%.

В жаркие дни температура может повышаться до 39 градусов тепла, (абсолютная максимальная температура) однако такие температуры наблюдаются не чаще 1 раза в 20 лет. Средняя максимальная температура воздуха наиболее тёплого месяца июля-+26,8 градусов.

Расчётная температура воздуха самой холодной пятидневки по г. Караганде -35 градусов с обеспеченностью 0,98 и температура воздуха наиболее холодных суток с обеспеченностью 0,98-39 градусов, температура воздуха наиболее холодных суток с обеспеченностью 0,92-37 градусов. Средняя продолжительность отопительного периода 214-227 суток (см. таблицу 3.3 СН РК 2.04-21-2004*).

Среднее количество атмосферных осадков, выпадающих за год по г. Караганде, равно 315 мм.

По сезонам года осадки распределяются неравномерно, наибольшее количество их выпадает в тёплое время года (апрель-октябрь) - 223 мм, за холодный (апрель-октябрь)-92 мм.

В холодное время года режим ветра складывается в основном под влиянием западного отрога сибирского антициклона, ось которого проходит по линии оз. Зайсан-Актюбинск. Эта сплошная полоса высокого давления является ветроразделительной линией. В связи с этим в рассматриваемом районе в холодное время, начиная с октября, преобладают юго-западные ветры. В январе довольно часто наблюдаются также южные и юго-восточные ветры.

В тёплое время года, когда сибирский антициклон ослабевает, режим ветра изменяется. В середине лета преобладают северные и северо-восточные ветры. Максимальная скорость ветра по румбам за январь равна 5,3м/с. Минимальная из средних скоростей ветра по румбам за июль равна 3,8 м/с. Количество дней с ветром в году составляет 280-300.

Карта районирования:

номер района по средней скорости ветра в зимний период - 5;

- номер района по давлению ветра – IV.

Нормативная глубина промерзания согласно СНиП РК 2.04-21-2004 и СНиП РК 5.01-01-2002 «Основания зданий и сооружений» для г. Караганды для глинистых грунтов -176 см, для песчаных и крупнообломочных грунтов - 252см.

Средняя глубина проникновения нуля в почву – 193 см.

Наименьшая относительная влажность бывает в летние месяцы (53%), наибольшая – зимой (78%).

Среднегодовая величина относительной влажности составляет 62%. Наиболее высокий дефицит влажности наблюдается в тёплое время года с мая по сентябрь.

Туманы бывают преимущественно в холодное полугодие. Среднее число их в зимние месяцы 2-8. При туманах обычно наблюдается изморозь и гололёд.

Характерной особенностью зимних месяцев являются метели. Метели наблюдаются довольно часто и бывают продолжительными, иногда при сильных ветрах и низкой температуре воздуха. Число дней с метелями составляет в среднем 30-40. В зимы с наибольшим проявлением метелевой деятельности число дней с метелью увеличивается в 1,5-2 раза, и в некоторые годы в отдельные зимние месяцы число их достигает 20-25.

Пыльные бури

В тёплый период года в сухую погоду, а иногда и зимой, при отсутствии снежного покрова при сильном ветре наблюдаются пыльные бури.

Среднее число дней с пыльной бурей

Таблица №2

IV	V	VI	VII	VIII	IX	X	XI	Год
1,2	3,6	3,9	2,8	1,8	0,8	1,1	0,04	16,7

В отдельные годы число дней с пыльной бурей увеличивается в 2-3 раза. Вместе с тем бывают год, когда пыльные бури почти не наблюдаются.

Суховеи

Интенсивность суховеев зависит от определённого сочетания дефицита влажности и скорости ветра.

Среднее число дней с суховеем

Таблица №3

IV	V	**VI**	VII	VIII	IX	X
1,4	9,0	14,6	16,9	13,9	8,4	13

Грозы и град

Среднее число дней с грозами достигает - 25. Грозовая активность наиболее активно проявляется в летние месяцы с максимумом в июле (7-9 дней).Град выпадает сравнительно редко 1-3 дня за лето. В отдельные годы может быть 5-8 дней с градом.

По климатическому районированию для строительства территория расположена в районе I В.

По снеговым нагрузкам территория относится к III району.

По средней скорости ветра в зимний период относится к V району.

По давлению ветра территория относится к IV району.

1.2 Месторасположение участка

Участок работ расположен примерно в 5 км к юго-западу от центра города, расстояние до ближайшего жилья составляет около 600 м, рядом с железной дорогой. Зона санитарной охраны составляет 500 метров.

Площадка для строительства, проектируемого КОС намечена рядом существующими очистными сооружениями КОС.

На территории застройки имеются застройки подлежащий демонтажу.

Площадка строительства очистных сооружений сточных вод расположена с подветренной стороны, по отношению к жилой застройке города, основное направление ветра юго-западное.

1.3 Геология и геоморфология

Целью инженерно-геологических изысканий являлось изучение геологического строения и геолого-литологического разреза площадки строительства КОС, ее геоморфологических и гидрогеологических особенностей, а также изучения физико-механических свойств и химического состава вскрытых грунтов и грунтовых вод для установления степени агрессивного воздействия окружающей природной среды на конструкцию фундаменты проектируемых сооружений и материалы в трассах и определения комплекса прочностных характеристик грунтов, необходимого для принятия проектных решений.

Состав и объемы аналитических работ и содержание инженерно-геологического отчета регламентированы СП РК 1.02-105-2014 «Инженерные изыскания для строительства. Основные положения»

В геологическом строении района принимают участие эффузивно-осадочные породы девонского возраста, представленные алевролитами, песчаниками, известняками, сланцами, аргиллитами, порфиритами, альбитофирами и их туфами. В верхних частях отдельных сопок эффузивные породы обнажаются.

Кровля коренных пород, как правило, подвержена физико-механическому выветриванию с образованием элювия различной степени выветрелости - от глыб и щебня до рухляка и глины. Мощность коры выветривания колеблется от долей метра до 2-5м и более.

Широкое распространение в районе имеют неогеновые и четвертичные отложения. Неогеновые отложения представлены красновато-коричневыми глинами павлодарской свиты и зеленовато-серыми глинами аральской свиты.

Мощность неогеновых глин колеблется от 3-5 до 20 и более метров.

Четвертичные отложения представлены разнообразным комплексом грунтов - супесями, суглинками, песками, реже- глинами. Залегают они на размытой поверхности палеозойских пород или на глинах неогена. Мощность их колеблется от1-2 до 10 и более метров.

В геологическом строении участка до изученной глубины принимают участие:

почвенно-растительный слой – 0,2-0,3 м

насыпные грунты-мощность от 1,0 до 3,2м, характеризуется на данном участке как слежавшиеся. Состоящие из суглинка, супеси, щебня, кирпича, дресвы, строительного мусора и характеризуется значениями предела текучести от 18 до 26%, предел раскатывания от 13 до 20%, числа пластичности от 5 до 7%;

аллювиальные отложения средне - верхнечетвертичного возраста;

Вскрытая мощность 0,2-2,2 м. Ниже залегают пески средней крупности.

Суглинки характеризуются следующими показателями физических свойств

№	Наименование	Ед.изм	количество	Предельные значения	
				минимальные	максимальные
1	2	3	4	5	6
1	Природная влажность	%	3	12,4	16,8
2	Влажность на пределе текучести	%	5	21	34
3	Влажность на пределе раскатывания	%	5	12	18
4	Число пластичности	%	5	7	18
5	Консистенция			0,04	0,38
6	Плотность грунта	г/см3	5	2,12	2,14
7	Плотность частиц грунта	г/см3	5	2,72	2,72
8	Коэффициент пористости	Доли.ед	5	0,44	0,48
9	Степень влажности	Доли.ед	5	0,76	0,94

Нормативные и расчетные значения характеристик прочностных свойств суглинков при замачивании, следующие:

<u>Нормативные</u>

Удельное сцепление -37кПа

Угол внутреннего трения-24градусов

Модуль деформации-9,0Мпа

Плотность грунта-2,05г/см3

За расчетные значения характеристик п деформациям рекомендуется принять их нормативные значения с коэффициентом надежности по грунту равным 1:

<u>Расчетные по деформациям</u>

Удельное сцепление -22кПа

Угол внутреннего трения-22градусов

Плотность грунта-2,04г/см3

За расчетные значения характеристик по несущей способности рекомендуется принять их нормативные значения с коэффициентом надежности по грунту равным 1,5 для удельного сцепления и 1,15 для угла внутреннего трения и 1,01 для плотности:

Расчетные по по несущей способности

Удельное сцепление -13кПа

Угол внутреннего трения-20градусов

Плотность грунта-2,03г/см3

Пески средней крупности характеризуется содержанием определяющей фракции (частиц крупнее 0,25мм) 61,5%.

Угол естественного откоса для песков средней крупности составил в сухом состоянии-38градусов, под водой-32 градус.

Вскрытая мощность 1,8-3,3 м. Ниже залегают глины.

Нормативные значения характеристик для песков средней крупности рекомендуем по материалам изученности с учетом действующих на территории РК нормативных документов:

Удельное сцепление -2кПа

Угол внутреннего трения-35градусов

Модуль деформации-20,0Мпа

Плотность грунта-1,75г/см3

За расчетные значения характеристик п деформациям рекомендуется принять их нормативные значения с коэффициентом надежности по грунту равным 1:

Удельное сцепление -2кПа

Угол внутреннего трения-35градусов

Плотность грунта-1,75г/см3

За расчетные значения характеристик по несущей способности рекомендуется принять их нормативные значения с коэффициентом надежности по грунту равным 1,5 для удельного сцепления и 1,1 для угла внутреннего трения:

Удельное сцепление -1,33кПа

Угол внутреннего трения-32градусов

Плотность грунта-1,75г/см3

Неогеновые отложения-глины. Мощность их колеблется от 1,1 до 13,5 метров. Характеризуются следующими показателями физических свойств

№	Наименование	Ед.изм	количество	Предельные значения		Средние (норм)знач
				Миним.	Максим.	
1	2	3	4	5	6	7
1	Природная влажность	%	4	23,3	26,7	25,1

2	Влажность на пределе текучести	%	4	54	60	58
3	Влажность на пределе раскатывания	%	4	25	28	26
4	Число пластичности	%	4	29	34	32
5	Консистенция			<0		
6	Плотность грунта	г/см3	4	2,00	2,04	2,02
7	Плотность частиц грунта	г/см3	4	2,74	2,74	2,74
8	Коэффициент пористости	Доли.ед	4	0,66	0,74	0,70
9	Степень влажности	Доли.ед	4	0,97	1,00	0,99
10	Модуль деформации	Мпа	4	7,2	14,9	10,2

Нормативные и расчетные значения характеристик прочностных свойств глин при замачивании, следующие:

Удельное сцепление -55кПа

Угол внутреннего трения-17градусов

Модуль деформации-10,0Мпа

Плотность грунта-2,02г/см3

За расчетные значения характеристик п деформациям рекомендуется принять их нормативные значения с коэффициентом надежности по грунту равным 1:

Удельное сцепление -39кПа

Угол внутреннего трения-14градусов

Плотность грунта-2,02г/см3

За расчетные значения характеристик по несущей способности рекомендуется принять их нормативные значения с коэффициентом надежности по грунту равным 1,5 для удельного сцепления и 1,1 для угла внутреннего трения и 1,01 для плотности:

Удельное сцепление -30кПа

Угол внутреннего трения-11градусов

Плотность грунта-2,00г/см3

Гидрогеологические условия.

Грунтовые воды на площадке вскрыты на глубине 1,4-1,8 м. Установившийся уровень грунтовых вод на 06.10.19 г. составляет 1,4-1,8 м. На исследуемой площадке вскрыты грунтовые воды, приуроченные к четвертичным отложениям. Водовмещающими породами служат суглинки и пески средней крупности.

Питание грунтовых вод осуществляется за счет инфильтрации атмосферных осадков, утечек техногенных вод а в весеннее время - талых и паводковых вод.

Режим грунтовых вод подвержен сезонным колебаниям, минимальный уровень отмечается в марте, максимальный в начале мая. В паводковый период следует ожидать поднятие уровня грунтовых вод на 0,3-0,4м.

Величины коэффициентов фильтрации для грунтов приняты по материалам изученности аналогичных грунтов.

Коэффициенты фильтрации для исследуемых грунтов, следующие:

- для суглинков - 0,09-0,5 м/сут.
- для песков средней крупности - 3,65-5,90 м/сут.
- для глин -0,0014-0,005м/сут

По химическому составу грунтовые воды сульфатно-натриевые, щелочные, умеренно жесткие. По минерализации подземные воды слабосолоноватые (содержание растворимых веществ 1383 мг/дм3)

По содержанию ионов SO42- и CO31- подземные воды слабоагрессивны к бетонам марки W4 ГОСТ 10178, по содержанию CI неагрессивны к железобетонам (при постоянном погружении). СНиП РК 2.01-19-2004 таблицы № 6;7.

Выделение инженерно-геологических элементов проведено по литологии, генезису и физико-механическим свойствам грунтов согласно ГОСТ 25100-95 и ГОСТ 20522-96.

2. Оценка воздействия на окружающую среду.

Источниками воздействия на окружающую природную среду, в частности на грунты, подземные и поверхностные воды могут являться сточные воды предприятий, нерациональное накопление и захоронение твёрдых отходов, технологические нарушения (проливы нефтепродуктов).

При строительстве ёмкостных сооружений необходимо выполнять гидроизоляцию подземных частей для уменьшения просачивания поверхностных вод с последующим уменьшением возможности загрязнения подземных вод, а также предусмотреть строительство дренажа, так как в результате нормативных утечек из ёмкостных сооружений (0,003м/сут) будет происходить подъём уровня грунтовых вод.

При возможном вскрытии грунтовых вод с последующей организацией строительного водопонижения, необходимо производить организованный сбор воды с отводом её в арычную сеть или специальные пониженные участки местности в соответствии с ТУ.

Разработанные грунты необходимо повторно использовать на нужды строительства

Данные по натурным замерам показателей загрязнения воздушной среды отсутствуют. Воздействие на воздушный бассейн будет оказано только в период выполнения строительных работ.

Основными источниками загрязнения атмосферы в период строительства будут:

- Земляные работы;
- Газовые выбросы от спецтехники;
- Передвижная электростанция;
- Электросварочные работы.

Источниками будут выбрасываться в атмосферу следующие вещества:

Оксиды железа, марганца, диоксид азота, сажа, сернистый ангидрид, фтористый водород, формальдегид, пыль, и др.

Состояние растительного покрова связано с хозяйственной деятельностью человека;

Под ёмкостными сооружениями возможен подъём уровня грунтовых вод.

Особых воздействий на животный мир и его ареал обитания не произойдёт.

В период строительства необходимо соблюдать следующие мероприятия с целью предотвращения отрицательного воздействия на окружающую среду:

- Организовать специальную стоянку для строительной техники;
- Загрязнённые участки поверхности земли от случайно пролитых ГСМ немедленно убирать и утилизировать;
- Временный склад ГСМ обваловать;
- Во время производства работ поливать подъездные автодороги;
- Бытовой мусор и оставшуюся упаковочную тару утилизировать с соблюдением установленных норм и вывозить на свалку;
- Обеспечить рекультивацию и восстановление растительного слоя на участке работ.

Выводы

Климат района резко континентальный с холодной продолжительной зимой и жарким сухим летом. Максимальная абсолютная температура воздуха 39°С, абсолютная минимальная температура -40°С.

Средняя годовая температура воздуха 2,9°С, среднемесячная температура самого холодного месяца (январь) –14,5°С, самого теплого месяца (июль) +20,4° С. Температура воздуха наиболее холодных суток обеспеченностью 0,92 - 37° С, наиболее холодной пятидневки, обеспеченностью 0,92 - 32° С .

По климатическому районированию для строительства территория расположена в районе I В.

По снеговым нагрузкам территория относится к III району.

По средней скорости ветра в зимний период относится к V району.

По давлению ветра территория относится к III району.

В геоморфологическом отношении участок работ расположен на денудационно-цокольной равнине. Рельеф равнины характеризуются выровненной или слабовсхолмленной поверхностью, на которой выделяются группы низких сопок.

В геологическом строении участка до изученной глубины принимают участие:

почвенно-растительный слой-мощность от 0,2 -0,3м

насыпные грунты-мощность от 1,0 до 3,2м;

суглинки- вскрытая мощность 0,2-2,2 м.;

пески средней крупности- вскрытая мощность 1,8-3,3 м.

неогеновые отложения-глины мощность их колеблется от 1,1 до 13,5 метров.

Грунтовые воды на площадке вскрыты на глубине 1,4-1,8 м. (абсолютные отметки 501,80-502,70 м). Установившийся уровень грунтовых вод на 06.10.19 г. составляет 1,4-1,8 м. На исследуемой площадке вскрыты грунтовые воды, приуроченные к четвертичным отложениям.

По химическому составу грунтовые воды сульфатно-натриевые, щелочные, умеренно жесткие. По минерализации подземные воды слабосолоноватые (содержание растворимых веществ 1383 мг/дм3)

По содержанию ионов SO42- и CO31- подземные воды слабоагрессивны к бетонам марки W4 ГОСТ 10178, по содержанию CI неагрессивны к железобетонам (при постоянном погружении).

По содержанию ионов CI и SO_4 грунты до глубины 2,5 м. неагрессивны к железобетонам и неагрессивны к бетонам марки W_4 на портландцементе.

Грунты до глубины 2,5 метра обладают высокими коррозирующими свойствами к стали.

Изучаемый участок работ расположен на Казахском щите, на котором не проявляются тектонические явления и поэтому её территория не является сейсмоактивной.

При проектировании водонесущих коммуникаций предусмотреть защиту стальных трубопроводов от коррозионной активности грунтов, или замену на более современные виды материалов.

При земляных работах в песках, предусмотреть соблюдение угла откоса в песках для избегания обрушения склонов траншей.

При проектировании фундаментов и подземных водонесущих коммуникаций предусмотреть глубину промерзания грунтов.

Средняя глубина проникновения «0» в грунты: для глинистых грунтов - 193см, песчаных грунтов- 225см, щебенистых и крупнообломочных грунтов-252см.

По условиям ручной разработки СН РК 8.02-05-2002 грунты относятся к следующим группам:

- суглинки - 2
- пески средние - 1
- глины - 3

ГЕОЛОГО-ЛИТОЛОГИЧЕСКОЕ ОПИСАНИЕ СКВАЖИН

Приложение № 2/1

16			Абсолютная отметка устья 501 . 50 м	
Геологич. индекс, возраст	Глубина подошвы от повер. абс.отм. м	Мощность слоя, м	Описание грунтов	УГВ, м
tQ_{IV}	1,00	1,00	Насыпные грунты (суглинок , кирпич, строительный мусор)	1,80
aQ_{II-III}	500,50 3,20	2,20	Суглинки коричневые, тугопластичные, с глубины 2,0м мягкопластичные, с прослойками песка средней крупности мощностью до 10 см.	
	498,30 6,50	3,30	Пески средней крупности водонасыщенные, полимиктовые	
$e(J_2)$	495,50 20,00 481,50	13,50	Глины пестроцветные (желтые, серые, бурые, сиреневые) твердые омарганцованные, ожелезненные, с включениями гравия и гальки до 25-30%.	

Приложение № 2/2

17			Абсолютная отметка устья 502 , 05 м	
Геолог. индекс, возраст	Глубина подошвы от повер. / абс.отм. м	Мощность слоя, м	Описание грунтов	УГВ, м
tQ_{IV}	3,20	3,20	Насыпные грунты (суглинок , кирпич, строительный мусор)	1,40
aQ_{II-III}	498,85 5,00 497,05	1,80	Суглинки коричневые, твердые, с прослойками песка средней крупности мощностью до 10 см.	

Приложение № 2/3

16			Абсолютная отметка устья 503 , 80 м	
Геоло-гич. индекс, возраст	Глубина подошвы от повер. / абс.отм. м	Мощ-ность слоя, м	Описание грунтов	УГВ, м
tQ_{IV}	1,40 / 502,40	1,40	Насыпные грунты (суглинок , кирпич, строительный мусор)	2,00 / 501,80
aQ_{II-III}	3,20 / 500,60	1,80	Суглинки коричневые, тугопластичные, с глубины 1,70м мягкопластичные, с прослойками песка средней крупности мощностью до 10 см.	
	5,00 / 498,82	1,80	Пески средней крупности водонасыщенные, полимиктовые	

Приложение № 2/4

19			Абсолютная отметка устья 502 , 75 м	
Геологич. индекс, возраст	Глубина подошвы от повер. / абс.отм. м	Мощность слоя, м	Описание грунтов	УГВ, м
aQ_{II-III}	0,30 / 502,45	0,30	Почвенно-растительный слой	1,50
	2,20 / 500,55	1,90	Суглинки коричневые, тугопластичные, с прослойками песка средней крупности мощностью до 10 см.	
	3,70 / 499,05	1,50	Пески средней крупности водонасыщенные, полимиктовые	
$c(J_2)$	5,10 / 497,65	1,40	Глины пестроцветные (желтые, серые, бурые, сиреневые) твердые омарганцованные, ожелезненные, с включениями гравия и гальки до 25-30%.	

Приложение № 2/5

20			Абсолютная отметка устья 503 , 95 м	
Геоло-гич. индекс, возраст	Глубина подошвы от повер. абс.отм, м	Мощ-ность слоя, м	Описание грунтов	УГВ, м
aQ_{II-III}	0,20	0,20	Почвенно-растительный слой	1,70
	503,75 2,10	1,90	Суглинки коричневые, твердые, с прослойками песка средней крупности мощностью до 10 см.	
	501,85 3,80	1,70	Пески средней крупности водонасыщенные, полимиктовые	
$e(J_2)$	500,15 5,00 498,95	1,20	Глины пестроцветные (желтые, серые, бурые, сиреневые) твердые омарганцованные, ожелезненные, с включениями гравия и гальки до 25-30%.	

Приложение № 2/8

21			Абсолютная отметка устья 504 , 75 м	
Геологич. индекс, возраст	Глубина подошвы от повер. абс.отм. м	Мощность слоя, м	Описание грунтов	УГВ, м
tQ_{IV}	1,80	1,80	Насыпные грунты (суглинок , кирпич, строительный мусор)	1,80
aQ_{II-III}	500,50 3,40	1,60	Суглинки коричневые, полутвердые, с прослойками песка средней крупности мощностью до 10 см.	
	501,35 4,50	1,10	Пески средней крупности водонасыщенные, полимиктовые	
$e(J_2)$	500,25 8,00 496,75	3,50	Глины пестроцветные (желтые, серые, бурые, сиреневые) твердые омарганцованные, ожелезненные, с включениями гравия и гальки до 25-30%.	

Использованные материалы:

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