ARCTIC LNG 2 PROJECT

ENVIRONMENTAL, SOCIAL AND HEALTH IMPACT ASSESSMENT

PART 3

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ACRONYMS AND ABBREVIATIONS

AANII	Arctic and Antarctic Research Institute
AEPS	Arctic Environmental Protection Strategy
AEWA	African-Eurasian Migratory Waterbirds
AGRU	Acid Gas Removal Unit
AIDS	Acquired Immune Deficiency Syndrome
AIIB	Asian Infrastructure Investment Bank
AIS	Automatic Identification System
ALP	Artificial Land Plot
AMAP	Arctic Monitoring and Assessment Programme
AoI	Area of Influence
AP	Action Plan
AS	Anionic Surfactants
AWOU	Automated Wireless Observer Unit
AZRF	Arctic Zone of Russian Federation
BAP	Benz[a]pyrene, Biodiversity Action Plan
BAT	Best Available Technologies
BCC	Biodiversity Conservation Centre
BIMS	Brash Ice Management System
BOD	Biochemical Oxygen Demand
CAFF	Conservation of Arctic Flora and Fauna
CDP	Carbon Disclosure Project
CGTP	Complex Gas Treatment Plant
CIA	Cumulative Impact Assessment
CIS	Commonwealth of Independent States
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CL	Combustible Liquids
CMP	Construction Management Plan
CNODC	China National Oil and Gas Exploration and Development Company
CNOOC	China National Offshore Oil Corporation
CNPC	China National Petroleum Corporation
COD	Chemical Oxygen Demand
CPS	Compressor Pumping Station
CRA	Cryogenic Risk Assessment
CRZ	Conservation Reserve Zone
CS	Compressor Station
DCA	Detrended Correspondence Analysis
DCM	Dispersion Calculation Methods

DEGP&HP	Dangerous Exogenous Geological Processes and Hydrological Phenomena
DPP	Diesel Power Plant
DPRR YNAO	Representatives of YNAO Government
DWW	Drilling Wastewater
E&RA	Evacuation and Rescue Analysis
EBRD	European Bank for Reconstruction and Development
EBSA	Ecologically and Biologically Significant Areas
ECA	Export Credit Agency
EDPS	Emergency Diesel Power Station
EEZ	Exclusive Economic Zone
EGP	Exogenous Geological Process
EHS	Environmental, Health, and Safety
EIA	Environmental Impact Assessment
EP	Equator Principles
EPDR	Emergency Prevention, Preparedness and Response
EPF	Early Phase Facilities
EPFI	Equator Principles Financial Institutions
ERA	Explosion Risk Analysis
ERC	Emergency Response Centre
ERIS	Effluents Re-Injection Site
ESHIA	Environmental, Social and Health Impact Assessment
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
ESP	Environmental and Social Policy
ESS	Environmental and Social Standards
ESSA	Emergency Systems Survivability Analysis
EU	European Union
EWE	Extreme Weather Events
FAF	Federal Agency for Fishery
FC	Field Camp
FEED	Front-end Engineering Design
FPIC	Free, Prior, and Informed Consent
FRA	Fire Risk Analysis
FSBSI	Federal State Funded Research Institution
FWCC	Federal Waste Classification Catalogue
GBIF	Global Biodiversity Information Facility
GBS	Gravity-Based Structures
GFN	Good Faith Negotiation

GGN	Gas-Gathering Network
GHG	Greenhouse Gases
GIIP	Good International Industry Practice
GIS	Geographical Information System
GN	Hygiene Standards
GOST	State Specific Standard
GPH	Good Practice Handbook
GRP	Gross Regional Product
GT	Gas Turbine
GTCPP	Gas Turbine Compressor Power Plant
GTG	Gas Turbine Generator
GTPP	Gas Turbine Power Plant
GWP	Gas Well Pad
HADCRUT4	Hadley Centre and University of East Anglia
HAZOP	HAZard and Operability
HC	Hydrocarbons
HFL	Highly Flammable Liquid
HIF	Hazardous Industrial Facilities
HIV	Human Immunodeficiency Virus
HNS	Hazardous and Noxious Substances
HOB	Hydrocarbon-Oxidizing Bacteria
HRA	Health Risk Assessment
HSE	Health, Safety & Environmental
HSES	Health, Safety, Environmental and Social Protection
HVAC	Heating, Ventilation and Air Conditioning
ICAO	International Civil Aviation Organisation
ICAO	International Civil Aviation Organisation
ICES	International Council for the Exploration of the Seas
ICP	Informed Consultation and Participation
IEM	Industrial Environmental Monitoring
IEMC	Integrated Emergency Management Course, Industrial Environmental Monitoring and Control
IEP	Integrated Environmental Permit
IFC	International Financial Corporation
IFI	International Financial Institutions
ILO	International Labour Organisation
IMO	International Maritime Organization
IMS	Integrated Management System, Ice Management System
IPCC	Intergovernmental Panel on Climate Change
IPDP	Indigenous People Development Plan

ISPN	Indigenous Small-Numbered Peoples of the North
ITS	Information and Technical Reference Documents
ITSO TB	Transport Safety System Facilities
IUCN	International Union for Conservation of Nature
JBIC	Japan Bank for International Cooperation
JOGMEC	Japan Oil, Gas and Metals National Corporation
KBA	Key Biodiversity Areas
KOT	Key Ornithological Territories
LA	License Area
LDAR	Leak Detection and Repair
LEM	Local Environmental Monitoring
LEPM	List of Environmental Protection Measures
LFG	Liquefied Flammable Gases
LLC	Limited Liability Company
LNG	Liquefied Natural Gas
LOC	Loss of Containment
LTS	Low-Temperature Sepatration
MAC	Maximum Allowable Concentrations
MAE	Maximum Allowable Emission
MAL	Maximum Allowable Levels
MARPOL	International Convention for the Prevention of Pollution from Ships
MDEA	Methyldiethanolamine
MIA	Ministry of Internal Affairs
MMC	Marine Mammal Council
MPC	Maximum Permissible Concentrations
MTPA	Million Tonnes Per Annum
NLR	Northern Latitudinal Railway
NSR	Northern Sea Route
NSR	Northern Sea Route
NTS	Non-technical Summary
OBM	Oil-Based Clay Drilling Mud
OCC	Operations control Complex
OCS	Operations Control System
OEC	Operational Environmental Control/Monitoring
OECD	Organization for Economic Cooperation and Development
OGCF	Oil-Gas Condensate Field
OHS	Occupational Health and Safety
OSCY	Offshore Superfacility Construction Centre
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic

OSPRP	Oil Spill Prevention and Response Plan
OST	Industry Specific Standard
PAH	Polyaromatic Hydrocarbons
PAME	Protection of the Arctic Marine Environment
PCB	Polychlorinated Biphenyls
PFHI	Publicly Funded Health Institution
PGTP	Primary Gas Treatment Plant
PHN	Content of Phenols
PJSC	Public Joint Stock Company
POL	Petroleum, Oil and Lubricants
PR	Permafrost Rocks
PS	Performance Standard, Project Standards
PSR	Project Specific Requirements
PSZ	Protective Sanitary Zones
PTS	Package Transformer Substation
QRA	Quantitative Risk Assessment
RC	Reinforced Concrete
RCIA	Rapid Cumulative Impact Assessment
RD	Reference Documents
RF	Russian Federation
SanPiN	Sanitary-Epidemiological Rules and Norms
SC	Startup Complex
SCWQI	Specific-Combinatorial Water Quality Index
SDM	Spent Oil-Based Clay Drilling Mud
SDWG	Sustainable Development Working Group
SEP	Stakeholder Engagement Plan
SGC	Stabilized Gas Condensate
SIL	Safety Integrity Level
SMCIW DS	Solid Municipal, Construction and Industrial Waste Disposal Site
SNiP	Civil Engineering Norms and Rules
SOLAS	International Convention for the Safety of Life at Sea
SP	Code of Rules
SPI	State Public Institution
SPNA	Specially Protected Natural Areas
SPZ	Sanitary Protection Zone
SR	Scoping Report
STD	Sexually Transmitted Diseases
STF	Sewage Treatment Facility
STGCF	South-Tambey Gas-Condensate Field

STL	Seasonally Thawed Layer
TAC	Temporary Accommodation Camp
TEA	Turbo-Expanding Assembly
TFCD	Task Force on Climate-Related Financial Disclosures
TLC	Takeoff-Landing Cycle
TPS	Territorial Planning Scheme
TRTF	Transmitting Radiotechnical Facilities
TS	Topside Structures
TSF	Temporary Site Facilities
TTS	Thermal Treatment System
UNCLOS	United Nations Convention on the Law of the Sea
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
URZ	Use-restricted Zone
USA	United States of America
USSR	Union of Soviet Socialist Republic
VEC	Valuable Environmental and Social Components
VOC	Volatile Organic Compounds
WBM	Water-Based Clay Drilling Mud
WITF	Water Intake and Treatment Facilities
WPZ	Water Protection Zone
WTF	Water Treatment Facilities
WWF	World Wildlife Fund
WWTP	Wastewater Treatment Plant
YNAO	Yamalo-Nenets Autonomous Okrug

BASIC TERMS AND DEFINITIONS

Customer, Company	Arctic LNG 2, LLC
Consultant	Ramboll CIS LLC, an independent environmental and social consultant
Project Operator	The organization responsible for managing the project at the construction, commissioning, operation and decommissioning phases (Arctic LNG 2, LLC)
Stakeholders	Persons or groups directly or indirectly affected by the Planned activity, as well as those who may be interested in its implementation and / or are able to influence it in a favorable or unfavorable way
GBS LNG & SGC Plant (Complex)	The gravity-based structure Complex for production, storage and offloading of liquefied natural gas and stabilised gas condensate, which includes three process trains and onshore infrastructure
Process Train	The gravity-based structure Complex will include three process trains for the production, storage and offloading of liquefied natural gas (LNG) and stabilised gas condensate (SGC) with a stated annual capacity of about 6.6 million tons of LNG each. The total peak capacity of SGC production can be as much as 1.6 million tons per year
Associated facilities	Facilities that meet the following conditions: 1) they are not funded by the Project (by the planned activity); 2) they would not be built or expanded without the Project (the Planned activity fails to be implemented); 3) they ensure the viability of the Project (Planned activity)
Arctic LNG 2 Project (Project)	The Project, including, along with the GBS LNG & SGC Plant construction of the Utrenniy Terminal (Port) and development of the Salmanovskoye (Utrenneye) oil and gas condensate field (OGCF) (Project Operator – 'Arctic LNG 2' LLC)
Utrenniy Terminal (Port)	A section of the Sabetta seaport, the purpose of which is to provide offshore logistics for gas carriers and tankers for LNG and SGC offloading, reception and storage of processing and construction cargo
Salmanovskiy (Utrenniy) license area	A subsoil plot of federal importance, including the Salmanovskoye (Utrenneye) oil and gas condensate field, within which Arctic LNG 2 LLC was licensed to use the subsoil resources – License No. CFL 15745 NE dated 06.20.2014 for the exploration and production of hydrocarbons
Field	Facilities and activities involved in setting up the Salmanovskoye (Utrenneye) OGCF to ensure production and preparation of raw materials for production of LNG and SGC, and providing engineering resources to all the facilities of the Arctic LNG 2 Project
Principles of the Equator	The internationally accepted environmental and social risk management system for financial organizations, including 10 key provisions (principles)[1]
IFC Performance Standards	A set of environmental and social sustainability requirements of the International Finance Corporation which the organizations to be funded must follow throughout the lifecycle of an investment project. Available at: http://www.ifc.org/performancestandards

[1] The Equator Principles. A financial industry benchmark for determining, assessing and managing environmental and social risk in projects. The Equator Principles Association, 2019.

Environmental, social and health impact assessment (ESHIA)	In the IFC terminology, the process of identifying, predicting and assessing the significance of favorable (positive) and adverse (negative) environmental and social project impacts, including a description of the project implementation conditions, analysis of alternative options for the Planned activity, consideration of global, transboundary and cumulative impacts including their possible quantitative representation, an impact management programme. In the terminology of the International Association for Impact Assessment (IAIA[2]) - the process of identifying, predicting, assessing and mitigating environmental and social impacts, as well as other adverse effects of the Planned activity, before making a decision on its implementation
Planned activity's (Project's) area of influence[4]	The land and water area, including: 1) land plots and water area sections, within which the Planned activities are directly implemented; 2) other land and water areas used or controlled by the Project's operator and its subcontractors (contractors); 3) land and water areas where the associated facilities are sited (see the corresponding definition); 4) land and water areas that may be subjected to cumulative impacts from the Planned activity; 5) land and water areas potentially affected by impacts from unplanned but predictable developments caused by project-related activities that may occur later or at a different location. The Project's area of influence does not include the area of dispersion of impacts which can be observed with a no-project version (abandonment of the Planned activity) or without the Project
The area of influence of air pollutant emission sources[5]	For a sole air pollutant emission source it is the circumference of the largest of the two radii, the first of which is equal to ten times the distance from the source to the point of the ground level concentration of the pollutant having the greatest prevalence (among the pollutants emitted by this source), and the second one is equal to the distance from the emission source to the most distant contour line of the ground level concentration of the pollutant, equal to 0.05 one time MPC. For the totality of air pollutant emission sources it is land or water areas that include all single source influence areas within this totality, as well as the 0.05 one time MPC contour for the estimated total concentration of each pollutant emitted by the totality of sources
Areas with controlled habitat quality indicators	Areas, where the existing hygienic air standards for chemical, biological and physical factors must be strictly followed. These include areas such as residential development, cottage development, sports and children's playgrounds, landscape and recreational areas, recreation areas, resorts, sanatoriums, rest homes; horticultural partnerships, collective or individual dachas and garden plots; sports facilities; educational and childcare facilities; general medical treatment and rehabilitation facilities
Social impact area	Areas and communities that may experience positive and negative impacts of the planned (project related) and associated activities

[2] Global leader among best practice networks as regards impact assessment for informed decisions concerning policies, programs, plans, and projects (http://www.iaia.org/).

[4] The definition is consistent with the IFC terminology (IFC Policy & Performance Standards and Guidance Notes. Glossary and Terms - http://www.ifc.org/). In this and all other common cases, the term "project" is a traditional synonym of the phrase "planned activity". As applicable to the ESHIA subject, the term **Project** (capitalized in the text) covers the activity under assessment designated as "Arctic LNG 2" to include Salmanovskoye (Utrenneye) OGCF **Facilities Setup**, construction and operation of the GBS LNG & SGC Plant (LNG **Complex)**, and construction and operation of the **Port** (Utrenniy Terminal).

[5] In the terminology of MRR-2017 (Dispersion Modeling of Harmful Air Pollutants. Approved by the Russian Ministry of Nature Order 273 dated June 006, 2017).

9. ENVIRONMENTAL IMPACT ASSESSMENT

9.1 Impact on Air

9.1.1 Atmospheric air at the proposed sites of the Arctic LNG 2 Project

According to the information presented in Chapter 7, the conditions of the near-ground atmosphere at the proposed sites of the Arctic LNG 2 Project (Ob Estuary water area, Gydan Peninsula) are characterized by an air pollution level close to the region's background level and a high potential of atmospheric self-purification from pollutants entering the air with emissions.

In particular, the predominance of the cyclonic type of weather during most of the year promotes active mixing and dynamic lateral and vertical movements of air, ensuring effective dispersal of emission components in the atmosphere and a rapid decrease in their near-ground concentrations as the distance from the source increases.

Among the beneficial conditions of the Project's proposed location is the significant remoteness – tens or hundreds of kilometres – of the proposed sites of the Project facilities from the nearest regulated areas.

This section devoted to the analysis of the impact of the Project on the atmospheric air quality within the land and water areas under review is prepared on the basis of information provided by the Company on the sources and composition of pollutant emissions during construction and operation of the Project facilities comprising the Utrenniy Terminal, GBS LNG&SGC Plant, and Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup.

9.1.2 Pollution emissions during the construction phase

Air impact of the construction activities in the concerned area will typically consist of pollution emissions from operation of machinery and vehicles, and in relation to welding and other construction processes, refueling of machinery and motor vehicles.

Emission sources in relation to construction of the Terminal will also include running watercraft engines, and handling of bulk materials.

Operation of construction machinery and mechanisms, welding and other construction activities in the area will result in emission of such pollutants as nitrogen oxides, carbon monoxide, etc.

Most sources of emissions at the Project construction phase are fugitive, diesel-driven generator units being the only exception.

Pollution emissions during development of quarries will have a minor impact on air quality within the license area, due to the remote location of quarries in relation to each other and the main construction sites, and the small quantity of emissions (1-6 tons during the whole period of construction).

9.1.2.1 Pollution emissions during construction of the Terminal

The Terminal to be constructed will include federal ownership facilities (FOF) and investor's (Company's) facilities (IF).

Pollution emissions during the construction activities will be produced by running engines of construction machinery, vehicles, fleet technical equipment, and diesel power plants.

Total emissions from construction of the onshore facilities and hydraulic structures will amount 3135 TPA from the FOF and 4739 TPA from IF. Total emissions from construction of FOF and IF in the Port water area will amount 2434 TPA and 63 TPA, respectively. The main pollutants are nitrogen oxides, carbon oxides, soot, kerosene, and sulphurous anhydride (Table 9.1.1).

Table 9.1.1: Pollution emissions during construction of the Terminal

Pollutants	Emissions of pollutants, tons			
	Construction of onshore facilities and hydraulic structures		Construction in the water area	
	FOF	IF	FOF	IF
Nitrogen dioxide	1131	1749	821	21
Nitrogen monoxide	184	284	134	3
Carbon char (sooth)	154	292	34	1
Sulphur dioxide (sulphurous-acid anhydride)	269	261	429	11
Carbon oxide	1093	1681	804	21

Pollutants	Emissions of pollutants, tons			
	Construction of onshore facilities and hydraulic structures		Construction in the water area	
	FOF	IF	FOF	IF
Kerosene	301	468	212	5

Pollution dispersion analysis for the Terminal construction demonstrated that pollution levels at the boundary of TAC are unlikely to exceed the permissible limits. Nitrogen dioxide concentration is expected to come down to the level of 1*MAC at the distance of 950 m from the work site.

9.1.2.2 Pollution emissions during construction of facilities at the Salmanovskoye (Utrenneye) OGCF

During the construction phase, the impact on ambient air is associated with such types of work as:

- Operation of motor vehicles and road construction machinery;
- Materials handling during site grading;
- Handling of inert materials;
- Welding;
- Painting;
- On-site refueling of machinery and motor vehicles.

The construction activities will result in emission of 30 pollutants in the total quantity of 1488 tons over the whole period of construction. Most pollutants will be emitted by running construction machinery and vehicles, including:

- Nitrogen dioxide – 381 tons;
- Nitrogen oxide – 62 tons;
- Carbon char (soot) – 73 tons;
- Sulphurous anhydride – 45 tons;
- Carbon monoxide – 422 tons;
- Xylene – 48 tons, etc.

The impact of pollutant emissions on the environment during the construction phase has been assessed through air pollution calculations.

The maximum nitrogen dioxide GLC defined by the dispersion analysis is 11.6*MACo.t. at the work sites. Elevated concentrations are expected within the radius of 2.0-2.3 km from the work sites where simultaneous presence of multiple units of construction machinery is possible, e.g. CGTP and PGTP sites. The combined area of influence of all construction sites with pollution level over 0.05*MAC can be as large as 13-16 km.

Pollution emissions during the construction will be short-term and local, and will not result in a significant deterioration of atmospheric air quality.

9.1.2.3 Pollution emissions from construction of the GBS LNG&SGC Plant

Pollution emissions during the construction activity are related to running machinery and vehicles, grading works, handling of dust-forming materials, as well as welding, painting and other construction works.

The Plant construction will take 7 years, from year 2020 to 2026 (including the early phase activities).

After commissioning of the Plant onshore infrastructure facilities and Process Train No.1 in QIII 2023, construction phases 2 and 3 will be implemented parallel with operation of the completed production facilities. Planned time for putting into operation of Process Train No.2 is QII 2024, Process Train No.3 - QII 2026.

During the whole period of construction (2020-2026), total annual emissions quantity will vary from 4 TPA (in 2026) to 1103 TPA (in 2022)/ The main pollutants will be nitrogen dioxide and monoxide, carbon monoxide, sulphur dioxide, kerosene and soot (Table 9.1.2). These substances will account for 95-99% of the total emissions quantity.

Table 9.1.2: Pollution emissions from construction of the GBS LNG&SGC Plant

Pollutant	Emissions of pollutants, tpa						
	2020	2021	2022	2023	2024	2025	2026
Nitrogen dioxide (nitrogen (IV) oxide)	52	150	339	310	2	290	2

Nitrogen (II) oxide (nitrogen oxide)	8	24	55	50	0	47	0
Carbon char (sooth)	9	26	28	23	0	20	0
Sulphur dioxide (sulphurous-acid anhydride)	6	18	110	107	0	104	0
Carbon oxide	51	145	424	394	2	374	2
Kerosene	16	42	127	118	1	112	1
Total:	**145**	**427**	**1103**	**1010**	**7**	**955**	**4**

Emissions dispersion analysis has been conducted to inform the estimation of the air impact of the construction in the area of the planned activity. The calculation is based on the highest pollution emissions over the construction period – year 2022.

The dispersion analysis resulted in pollution levels outside the construction sites under the MAC level for all pollutants, with the exception of inorganic dust and nitrogen dioxide that will develop the areas of influence of 242 m and 2.6 km, respectively. Ground level concentrations of all pollutants in the reference points at the boundary of TAC during the construction activities will meet the hygienic air quality standards for residential areas. For instance, nitrogen dioxide will have the greatest impact on air quality at the construction phase, however, ground level concentration of the substance in the reference point at the TAC boundary will stay below the limit value – 0.4*MAC.

Furthermore, the dispersion analysis identified the areas of influence (i.e. areas where maximum ground level air pollution caused by emissions from the planned activity is greater than 0.05*MAC) for all pollutants emitted to the air in the Plant construction area. The simulation results have demonstrated that nitrogen dioxide will have the greatest area of influence during the construction phase – 28 km from boundary of the construction site.

As regards the Project in general, the contribution of the construction period to air pollution within the Project area will be relatively small, since most of the construction and installation work (manufacturing of the Process Trains) will be performed at remote technical sites elsewhere in the Russian Federation and abroad.

9.1.2.4 Pollution emissions during construction of the Power Supply Complex No.2

The following facilities will be constructed to provide fuel gas for the power supply facilities to support construction, soil jetting and drilling operations at the Salmanovskoye (Utrenneye) OGCF:

- Gas and condensate well pad No.16 (including wellhead connections of two wells);
- Gas flowline from GWP No.16 to power supply complex No.2;
- Power supply complex No.2.

The temporary power supply complex No.2 will use portable automated power plants PGTPP-2500 to produce power for the drilling and construction activities, and for operation of dredgers during the whole period of the respective works.

Gas for power supply complex No.2 will be provided from well pad No.16, gas condensate wells No.1601 and No.1602.

The following activities will produce pollution emissions at different stages of construction of the planned facilities:

- Unloading of dust-forming materials (crushed stone, ground) from dump trucks to heap;
- Welding and gas cutting of metal;
- Painting and drying of painted surfaces;
- Operation of portable diesel power plants at the construction sites of TSF No.1, TSF No.5, and the temporary water intake facilities;
- Filling construction machinery tanks with diesel fuel;
- Running vehicles and construction machinery.

Total quantity of pollution emissions during the construction of the power supply facilities for the construction, soil jetting and drilling operations at the Salmanovskoye (Utrenneye) OGCF is estimated at 144 tons, the main components being nitrogen oxides (53 tons), carbon monoxide (46 tons), kerosene (20 tons) and sulphur dioxide (8 tons).

Estimated level of air pollution in the construction area of the power supply facilities for the construction, soil jetting and drilling operations at the Salmanovskoye (Utrenneye) OGCF is defined through dispersion analysis.

Simulation is based for the period of highest construction activity when all types of operations are conducted simultaneously (unloading of dust-forming materials, welding, painting and drying of painted surfaces, bitumen pouring, running DPP and construction machinery, fueling of construction machinery).

The dispersion analysis for the period of construction of the planned power supply facilities for the construction, soil jetting and drilling operations at the Salmanovskoye (Utrenneye) OGCF showed that maximum concentrations of pollutants at the industrial sites will not exceed the workplace hygienic standards, and that hygienic standards of air quality in residential airs will be met at the boundaries of TSF Nos. 1, 2 and 5.

More specifically, estimated concentration of nitrogen dioxide at the boundaries of TSF Nos. 1, 2 and 5 will not exceed 0.6*MAC, of carbon monoxide – 0.5*MAC. Concentrations of other pollutants will stay within 0.1-0.2*MAC.

9.1.2.5 Minimisation of pollution emissions during the construction phase

At the Project construction stage, it is proposed to implement the following measures to minimize air emissions:

- Ensuring strict adherence to the relevant work performance techniques and construction schedule;
- Using modern diesel generators that meet the applicable project emission standards;
- Regular maintenance of fixed and mobile equipment, vehicles (automotive emissions should comply with the requirements of GOST 33997-2016 and GOST 17.2.2.02-98);
- Monitoring the operation of machinery during downtime or service breaks (parking of vehicles during such periods is only allowed if the engine is not running);
- Using construction equipment that meets environmental standards;
- Using fully serviceable machinery and mechanisms with well-tuned fuel combustion systems making sure that the emission of pollutants with exhaust gases is kept within the prescribed standard range;
- Using low-sulphur diesel fuel;
- Using closed containers for the storage of fuels and lubricants;
- Storing volatile chemicals and bulk materials in closed containers;
- Prohibition of burning of any wastes except for disposal in designated incinerators;
- Using dust suppression methods in areas designed for loading and unloading bulk materials.

9.1.3 Air impact during operation

Air quality during operation of the Arctic LNG 2 Project will be defined by emissions from stationary sources at the Process Trains and the onshore facilities of the GBS LNG&SGC Plant, Salmanovskoye (Utrenneye) OGCF Facilities Setup, particularly CGTP1, CGTP2, and PGTP3. Contribution from the stationary emission sources at the Utrenniy Terminal will be relatively small.

Local conditions are supportive for dispersion of pollutants, as the sources are distributed in a fairly large area, with a minimum distance of 2 km between them.

9.1.3.1 Pollution emissions during the operation of the power supply facilities for the construction, soil jetting and drilling operations at the Salmanovskoye (Utrenneye) OGCF

The main sources of pollution emissions during the operation of the power supply facilities for the construction, soil jetting and drilling operations at the Salmanovskoye (Utrenneye) OGCF include:

- Site of well pad No.16:
  - Horizontal flare system for purging of wells;
  - Stack of the emergency diesel power station;
- Site of Power Supply Complex No.2:
  - Stacks of PGTPP-2500;
  - Boiler house stacks of the fuel gas treatment facility;
  - Stack of TTS incinerator;
  - Stacks of emergency diesel power plants.

The main sources of emissions are the stacks of PGTPP-2500. PGTPPs will be put into operation in two stages that reflect the power supply needs during the construction:

- Phase 1 (June 2019) – commissioning of eight PGTPPs;
- Phase 2 (June 2020) – commissioning of further eight PGTPPs.

Total annual emission quantity during the period 2019-2025 will vary between 99 TPA (in 2023) and 732 TPA (in 2022). Power Supply Complex No.2 accounts for 92-99% of the total quantity of emissions from the power supply facilities for the construction, soil jetting and drilling operations at the Salmanovskoye (Utrenneye) OGCF.

The main pollutants are nitrogen oxides and carbon monoxide which make up 98-99% of the total emissions (Table 9.1.3).

Table 9.1.3: Pollution emissions during the operation of the power supply facilities for the construction, soil jetting and drilling operations at the Salmanovskoye (Utrenneye) OGCF

Pollutant emitted to air	Total annual emissions, TPA						
	2019	2020	2021	2022	2023	2024	2025
	Gas and condensate well pad No.16						
Nitrogen dioxide	0.8	0.9	0.3	0.4	0.4	0.4	0.2
Nitrogen (II) oxide	0.8	0.9	0.3	0.4	0.4	0.4	0.2
Sulphur dioxide	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Carbon monoxide	11.4	14.1	3.2	4.7	5.2	4.9	2.8
Methanol	0.01	0.02	0.02	0.02	0.02	0.02	0.02
Total:	13.0	15.9	3.8	5.5	6.0	5.7	3.3
	Power supply complex No.2						
Nitrogen dioxide	37.9	92.9	92.9	143.4	14.0	14.2	43.3
Nitrogen (II) oxide	36.9	90.6	90.6	139.8	13.6	13.8	42.2
Sulphur dioxide	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Carbon monoxide	116.9	280.4	280.4	436.9	59.0	62.6	137.7
Methanol	0.7	0.9	0.9	1.2	1.1	1.1	0.9
Total:	192.9	465.4	465.4	721.8	88.2	92.3	224.7
Total:	**210**	**486**	**473**	**732**	**99**	**103**	**232**

Pollution dispersion analysis in ground level air during operation of the power supply facilities for the construction, soil jetting and drilling operations at the Salmanovskoye (Utrenneye) OGCF was conducted in 2022 (maximum emissions related to the largest number of PGTPP-2500 units in operation).

Calculated pollution levels at the boundary of 1000 m SPZ of well pad No.16 and power supply complex No.2 meet the standard requirements for air quality.

9.1.3.2 Pollution emissions during operation of the Terminal

During operation of the Utrenniy Terminal, pollutants will be emitted in relation to the following activities:

- Loose ground handling in the open site for storage of construction cargoes;
- Operation of load-handling machinery at the general-purpose berth;
- Tug escorting of mooring vessels;
- Operation of the port icebreaker during the ice season;
- Handling of bulk cargoes at the quay;
- Unloading diesel fuel and methanol from tanker to general-purpose berth, and pumping of diesel fuel and methanol to respective storage facilities.

Total emissions from operational Terminal are estimated at 29 TPA, including 8 tons of nitrogen dioxide, 4 tons of sulphurous anhydride, 9.5 tons of carbon monoxide, etc.

Dispersion analysis for the Terminal operation phase shows that all controlled parameters outside the Terminal site will meet the MAC standards.

9.1.3.3 Pollution emissions during operation of the Salmanovskoye (Utrenneye) OGCF Facilities Setup

Air impact of operation of the Salmanovskoye (Utrenneye) OGCF Facilities Setup will be related to the emissions from process equipment and auxiliary facilities. The impact is planned, and its intensity is defined by the design.

The air pollution sources during operation of the designed facilities are located at the main and auxiliary sites of the three “domes”: Northern (including the Shore), Central and Southern.

Operation of the designed field facilities will be associated with annual release of 7097 tons of pollutants to air.

The main sources of pollution emissions during operation of the Salmanovskoye (Utrenneye) OGCF Facilities Setup are:

- Well pads:
    - Pilot burners of the well clusters;
    - Main burners of the well clusters;
    - Diesel generators EDPS;
- Sites of CGTP-1, CGTP-2 and PGTP-3:
    - Emissions through leaks in process equipment piping;
    - LP and HP flare systems;
    - Horizontal flare system at the CGTP (PGTP) site;
    - Fired gas heater of methanol recovery units;
    - Fuel gas treatment unit for the boiler house;
    - Methanol tank farm;
    - Automatic DPPs;
    - Boiler houses of CGTP-1 and CGTP-2;
- Gas turbine power plant comprising six gas turbine units (five duty and one backup) with a power capacity of 12 MW and heat capacity of 17.7 MW, each;
- Fuel depot;
- Methanol storage;
- Two EDPSs and a package modular boiler house with a capacity of 20 MW at the temporary accommodation camp;
- EDPS at the sites of water treatment facilities, Data Processing Center / Telecoms Center, Emergency Rescue Center, field camp, administrative area, sewage treatment facilities;
- Thermal treatment system at the solid municipal, construction and industrial waste disposal site.

Total mass emission from the operational Salmanovskoye (Utrenneye) OGCF Facilities Setup will amount 7098 TPA, including:

- Nitrogen dioxide – 604 tons;
- Nitrogen oxide – 658 tons;
- Carbon char (soot) – 18 tons;
- Sulphurous anhydride – 18 tons;
- Carbon monoxide – 5604 tons;
- Methane – 133 tons;
- Mixed saturated hydrocarbons C1-C5 – 78 tons;
- Methanol – 19 tons, etc.

The impact of pollutant emissions on the environment during the operation phase was assessed through air pollution calculations.

The dispersion analysis was conducted for fully developed facilities with the maximum number of air pollution sources. Simulation took into account non-simultaneity of operation of the equipment (EDPS are started and run for short time at different sites).

Operation of the Power Supply Complex No.2 near the GTPP site was also considered in the dispersion analysis. Inventory of the air pollution emission sources within Power Supply Complex No.2 was included in the design documentation titled "Salmanovskoye (Utrenneye) OGCF Facilities Setup. Gas supply for the power supply facilities to support construction, hydraulic filling and drilling operations".

Outputs of the dispersion simulation show that maximum GLC during the operation phase is expected for nitrogen dioxide: 1.6*MAC at the Central Dome; 1.4*MAC at the Southern Dome; 1.8*MAC at the onshore facilities, considering the background level.

At the TAC site, maximum GLC of polluting substances are within the permitted levels. The maximum concentration in residential area air - 0.94*MAC including the background - is expected for nitrogen dioxide.

The area of influence of the pollution emissions from the field facilities (0.05*MAC) can be up to 7-9.5 km from the outer sites of the field facilities, on different sides.

9.1.3.4 Pollution emissions from operation of the GBS LNG&SGC Plant

The main sources of pollution emissions from operation of the GBS LNG&SGC Plant are:

- Process Trains:
  - Mixed refrigerant compressor gas turbines;
  - Power plant gas turbines;
  - Emergency diesel generators;
  - Flares within the GBS topside;
- Onshore facilities:
  - Cold flare;
  - Warm flare;
  - Emergency cold flare;
  - Auxiliary boiler house;
  - IMS boiler house[3].

A part of VOC emissions is related to fugitive emissions from valves and flanges, and point emissions from vent stacks and respiratory pipes of the tanks.

Since the Plant will be put into operation in three phases, its bulk pollution emissions will be increasing as more process trains become operational. The total quantity of emissions from all sources at the Plant after commissioning of the third process train is estimated at 11,719 TPA. The main pollutants are nitrogen oxides (24% of total mass of emissions), carbon monoxide (19%), methanol (11%), methane (9%), soot (3%) and mixed saturated hydrocarbons C_6H_{14}-$C_{10}H_{22}$ (32%). The above substances account for 97% of the total mass of pollution emissions (Table 9.1.4).

Table 9.1.4: Pollution emissions from operation of the GBS LNG&SGC Plant

Pollutant	Total emissions, TPA		
	Phase 1 (2021)	Phase 2 (2024)	Phase 3 (2026)
Nitrogen dioxide (nitrogen (IV) oxide)	871	1742	2600
Nitrogen (II) oxide (nitrogen oxide)	112	225	335
Carbon char (sooth)	64	128	191
Carbon oxide	755	1479	2187
Methane	371	741	1108
Mixed saturated hydrocarbons C_6H_{14}-$C_{10}H_{22}$	1238	2477	3715
Methanol (methyl alcohol)	411	822	1234
Total	**3939**	**7856**	**11719**

Dispersion analysis has been conducted for the pollutants emitted by the Plant operations using the reference points at the boundaries of the TAC facilities, in order to inform estimation of the air impact of the planned activity in the Plant location area.

The dispersion analysis showed that concentrations of all pollutants within the area of influence will be below the respective MAC levels. The highest estimated GLC of 0.57*MAC was identified for nitrogen dioxide; at the TAC boundary, concentration of NO_2 is 0.26*MAC.

9.1.3.5 Pollution emissions during operation of the Utrenniy Airport

The main sources of pollution emissions during operation of the Utrenniy Airport are:

- Stationary sources:
  - Diesel power stations;
  - Fuelling stations;
  - Boiler house;
  - Fuel depots;
  - Diesel fuel pumping stations, etc.;
- Aircraft at the runway and apron;
- Motor vehicles and specialized machinery, etc.

[3] IMS – Brash Ice Management System

Total annual pollution emissions at the Utrenniy Airport are estimated at 204 TPA, including 153 TPA from the aircraft. The main pollutants are carbon monoxide (142 TPA), nitrogen oxides (28 TPA), and sulphur dioxide (20 TPA).

Calculation of pollution emissions from sources at the Utrenniy Airport was based on the standard takeoff-landing cycle (TLC) which covers all operations with the aircraft from starting the engines to the height gain of 915 m, and from approach at the height of 915 m to stopping the engines after the airplane landing.

The preliminary dispersion analysis shows that the area of influence of the air chemical pollution factor - the isoline of 1.0 MAC - is located 40-120 m to the north and 10-45 m to the north-west; in all other directions, the isoline position is within the site boundaries.

At the TAC boundary, estimated pollution concentrations are within the permissible limits; concentration of nitrogen oxides is at the level of 0.3*MAC, carbon monoxide - 0.5*MAC. Concentrations of other pollutants are 0.1*MAC or lower.

9.1.4 Air pollution emission control measures

Project document containing maximum allowable emission (MAE)[4] standards will be developed for of the Project facilities, establishing standards for air emissions of pollutants, taking into account:

- Technical emission standards;
- Background air pollution;
- Region's physiographic conditions;
- Relative locations of the emission sources at the Plant, its associated facilities and in regulated areas (in this case, the latter are located tens or hundreds of kilometres away from the emission sources and therefore will probably be excluded from consideration).

Pending the establishment of the relevant MAE standards, the Russian and internationally recognized technical and environmental standards will be applied, including those envisaged by the International Finance Corporation Environmental, Health and Safety Guidelines (2007). Table 9.1.5 shows the requirements as to pollutant emissions from various types of gas turbines.

Table 9.1.5: NOx emission requirements for gas turbines with various output capacities

Output capacity	Fuel type	Maximum allowable concentration in emissions, mg/m³
From 50 MW (th)[5]	Natural gas	25 ppm
From 15 to 50 MW (th)	Natural gas	25 ppm
From 3 to 15 MW (th)	Natural gas	42 ppm (power plant) 100 ppm (drive unit)

The IFC Guidelines document (Environmental, Health, and Safety General Guidelines, IFC, 2007) bases its recommended emission standards for small fuel combustion units (3-50 MW) on the US requirements as to emissions from gas turbines (40 CFR, Part 60, Standards of Performance for Stationary Combustion Turbines; Final Rule[6]). However, the IFC Guidelines do not specify emission standards for gas turbines operated beyond the Arctic Circle, while the US legislation prescribes specific standards for gas turbines operating in the Far North (Table 9.1.6).

Table 9.1.6: Requirements as to pollutant emissions for gas turbines operated beyond the Arctic Circle

Type of gas turbine	Gas turbine power output	NOx emission standard
Turbines operated north of the Arctic Circle (north of 66,5 degrees of north latitude)	≤ 30 MW	150 ppm / 289 mg/m³
Turbines operated north of the Arctic Circle (north of 66,5 degrees of north latitude)	≥30 MW	96 ppm / 183 mg/m³

The Project will use gas turbines with NOx level in the turbine exhaust gas below 50 -150 mg/m³.

[4] For the facilities that are by present commissioned for operation (berth structures and well stock), MAE volumes have been approved, and emission permits are in place.
[5] IFC Thermal Power Plants Environmental, Health and Safety Guidelines. ☐ International Finance Corporation, 2008. https://www.ifc.org/
[6] https://www.gpo.gov/fdsys/pkg/FR-2006-07-06/pdf/06-5945.pdf

Therefore, the concentration of NOx in the exhaust of the gas turbines intended for the Project facilities will be two times less than the prescribed values mentioned in the US regulations for gas turbines operated beyond the Arctic Circle.

9.1.4.1 Project impact assessment, mitigation and monitoring measures

To assess the Project's air quality area of influence, the relevant MRR-2017 criteria is used - isoline of 0.05*MAC of the pollutant with the highest estimated dispersion from emission sources (excluding the baseline values).

According to the dispersion modelling for the Project, the isoline 0.05 of the priority pollutants (NOx) MAC is located within the range of 6 to 21 km from the main stationary sources of emissions.

The effectiveness of the measures depends on the equipment capacity, environmental conditions, process parameters (temperature, pressure, flow rate), fuel characteristics, etc.

In accordance with the standards of the World Bank Group[7], the following prevention and control measures should be provided for gas flaring:

- Using effective burner tips to ensure combustion efficiency of at least 98%;
- Maximizing combustion efficiency by proper control and optimization of flare fuel/air/steam flow rates to ensure the correct ratio of assist stream to flare stream;
- Ensuring smoke-free and odour-free operation of flares;
- Placing the flare at a safe distance from local residents and workers, including workers' accommodation camps;
- Implementing proper burner maintenance and replacement programs to ensure maximum flare efficiency;
- Keeping record of the volumes of gas flared;
- Minimizing liquid carry over and entrainment in the gas flare stream by ensuring a suitable liquid separation system is in place;
- Limiting the estimated gas velocity at the burner tip;
- Using reliable electronic ignition systems;
- Optimizing the process to minimize flaring caused by process disruptions;

Uncontrolled emissions from pumps, compressors, flanged connections, etc. should be minimized using the best available technologies[8]:

- The number of connections should be limited to the necessary minimum for safe and practicable operation and maintenance;
- When selecting proper valves, flanges, fittings, seals and packings, their ability to reduce gas leaks and uncontrolled emissions as well as the safety and applicability requirements should be taken into account;
- Where applicable, pumps with double mechanical seals or without seals should be used, and dry gas seals should be used in compressors;
- Hydrocarbon vapours must either be collected or sent back to the process system, depending on the process pressure;
- Good international industry practice (GIIP) includes implementation of the leak detection and repair (LDAR) program for continuous monitoring of uncontrolled emissions to detect leaks;
- Pressure in the tank and the vapour space must be kept constant by reducing breathing losses through the use of insulated tanks to prevent and limit VOC emissions from storage.

During production, storage and transportation of liquefied natural gas, boil-off gas is inevitably formed as a result of higher ambient temperatures, tank pumps operation, and atmospheric pressure fluctuations.

In accordance with the requirements defined in the EHS Guidelines for Natural Gas Liquefaction Plants[9] (IFC, 2017):

- Boil-off gas will be captured by a collection system and returned for liquefaction or used as fuel for the fuel-combustion equipment at the GBS LNG & SGC Plant;

[7] A Voluntary Standard for Global Gas Flaring and Venting Reduction. Global Gas Flaring and Venting Reduction Report No.29555. ☐ World Bank Group, 2004.
[8] General Environmental, Health, and Safety Guidelines. ☐ International Finance Corporation, 2007. https://www.ifc.org/
[9] Environmental, Health, and Safety Guidelines for Liquefied Natural Gas Facilities. ☐ IFC, 2017. https://www.ifc.org/

- Flare system will be used only in abnormal or emergency situations, and during regular maintenance.

9.1.5 Designs for the sanitary protection zones

According to the laws of the Russian Federation[10], sanitary protection zones (SPZ) should be designed at all stages of the development of urban planning documentation, projects for construction and operation of individual production facilities or industries and/or groups of facilities or industries. The procedure for establishing a sanitary protection zone in the Russian Federation requires a consecutive development of designs for (preliminary) sanitary protection zones based on calculations of pollutant dispersion and physical impact (noise, vibration, electromagnetic fields), assessment of the risk to public health due to the anticipated degradation of air quality, and subsequent approval of the final SPZ based on the results of field observations and measurements to verify the calculated parameters.

The size of a sanitary protection zone should ensure compliance with the maximum allowable concentrations (MAC) of pollutants for the atmospheric air of populated areas and the maximum allowable levels (MAL) of physical impact on the atmospheric air. At the same time, for groups of industrial sites or production facilities, or for industrial hubs, sanitary regulations prescribe the establishment of a common estimated and final sanitary protection zone taking into account the total quantity of air emissions and the physical impact of the sources at the industrial sites and production facilities within the common zone.

Categorization of the facility by its combined impact on the atmospheric air is performed based on SanPiN 2.2.1 / 2.1.1.1200-03, according to which the Project facilities are categorized as a hazard class I hazardous industrial facility with a tentative SPZ size of 1000 m.

The Russian sanitary regulations allow for extension or reduction of standard SPZ of a designed industrial site, subject to proper justification by calculations and/or field observations and measurements.

Based on the pollution dispersion analysis and considering the factor of noise impact (refer to Section 9.2), the SPZ dimensions were increased compared to the standard size for the following Project facilities:

- SPZ of the Power Supply Complex No.2 (to 1250-1500 m to toe south-west, west and north-west);
- SPZ of the GBS LNG & SGC Plant: from 1410 m to 1900 m to the south and south-east.

For several Project facilities (well pads No. 11 and No. 16, CGTP-1, CGTP-2 and PGTP-3), the size of designed SPZ in some directions was reduced to 500 m (Figure 9.1.1).

Data analysis shows that no rotation camps will be built within the SPZs of the facilities that have the greatest impact on the ground-level air quality. Given the fact that there are no population centers within the area of influence of the facilities, the significance of the impact of pollutant emissions on public health can be assessed as **low**.

[10] SanPiN 2.2.1/2.1.1.1200-03. Sanitary protection zones and sanitary classification of enterprises, installations and other facilities. Sanitary and epidemiological rules and regulations. As amended by the Chief Sanitary Officer of the Russian Federation Order No.31 dated April 25, 2014.

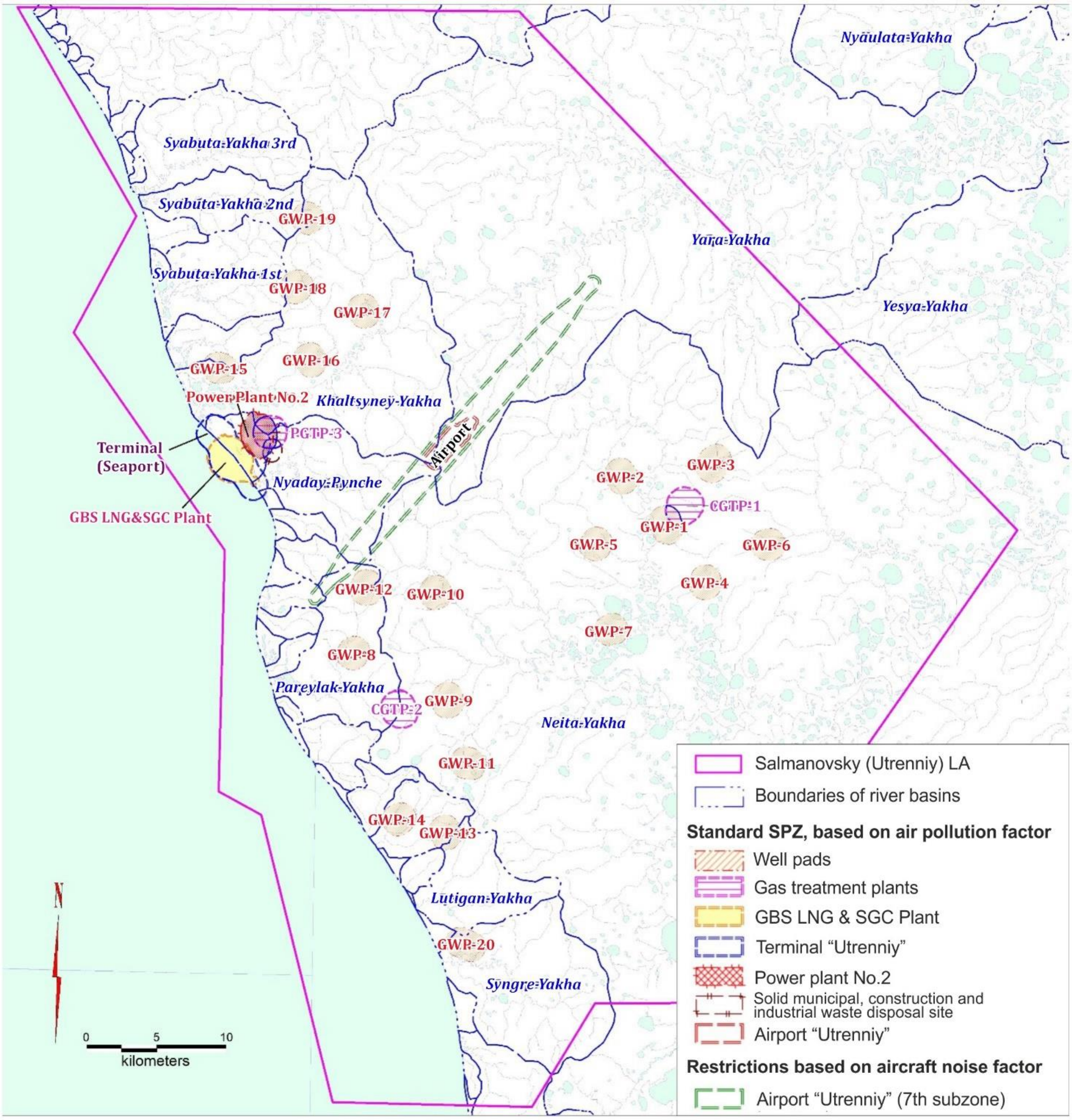

Figure 9.1.1: Sanitary protection zones and sanitary clear zones of the Project facilities and the Utrenniy Airport

9.1.6 *Air quality monitoring during the Project operation*

The main objectives of air quality monitoring during the Project operation are:

- Getting regular, accurate and prompt updates, including automated ones, on pollutant emissions and air quality condition within the Project's area of influence;
- Monitoring compliance with environmental requirements established by Russian laws and regulations and standards of international financial institutions.

In order to attain the goals specified above, the Project will implement an Industrial Environmental Monitoring and Control (IEMC)[11] Program, which will include the quality control of atmospheric air. For emission sources, the IEMC objectives include monitoring the concentrations and volumes of emissions of harmful (polluting) substances from the main sources in order to establish their compliance with the

[11] Operational OECM is conducted at the berth structures since 2017

relevant data sheets and MAE standards. Emissions of pollutants should be reported in order to assess the impact of air pollution sources on the atmosphere within the facilities sites and to prevent pollutant concentrations from exceeding the current hygienic standards.

A preliminary analysis showed that the main components of air emissions to be monitored are as follows:

- Nitrogen dioxide;
- Nitrogen monoxide;
- Sulphur dioxide;
- Carbon monoxide;
- Benz[a]pyrene;
- Particulate matter;
- Hydrocarbons (by fractions);
- Hydrogen sulphide.

The air monitoring stations will be located at the boundaries of SPZ and residential areas (TAC).

Classification of Project components as Category I facilities by the level of negative environmental impacts[12] will trigger the need to continuously record emission parameters of the gas turbine units and flares through automated stationary systems. In addition, the programme of operational environmental monitoring will provide for collection of air quality data at the boundary of the standard SPZ, in shift camps and other facilities within the Project area of influence.

A list of all monitored emission sources and parameters, as well as the monitoring frequency, will be determined at the development of the Operational Environmental Control Program for the operation phase.

In order to verify the sufficiency of the designated SPZ for the Project, and to confirm the established standards, the quality of atmospheric air will be monitored at the SPZ boundaries and in the rotation camp. The air sampling frequency and the list of monitored parameters will be determined in the Environmental Monitoring and Control Program.

9.1.7 Modelling of point sources emissions from LNG and SGC Plant based on Gaussian dispersion model

When designing the LNG&SGC Plant by TechnipFMC (2019), estimating of dispersion of emissions of several pollutants by point sources of the Plant at the stage of its operation was performed. Contribution of flare systems was scoped off, since no permanent or long-term operation is provided for them; emissions associated with Terminal and the sources of the gas field were also not included. As a basic variant, the standard (accident-free) operation of all trains of the Plant was accepted; the alternative variant for which the parallel calculation was performed, provides for shutdown of gas turbine compressors and discharge of acid gases containing H_2S through the corresponding blowdown lines directly into the atmosphere.

Mathematical algorithm provided by the ADMS 5.0 software, one of the most widespread and advanced variants of the Gaussian plume model of atmospheric dispersion of pollutants (developed by Cambridge Environmental Research Consultant, www.cerc.co.uk) was used. Computational area with the size of 12x12 km and the grid spacing of 40 m were accepted for the model.

Operating parameters of gas turbine generators and gas turbines of compressors timed to three process lines (trains) of the Plant have been set as emission sources. Carbon oxide (CO), nitrogen dioxide (NO_2), suspended solids with aerodynamic particle size less than 10 microns (PM10) and hydrogen sulfide (H_2S) were taken as marker pollutants for which the dispersion modelling is required.

In addition, with the help of SIEMENS STAR-CCM+ software package, gas-dynamic calculation of potential concentrations of several gases and vapors (carbon monoxide and dioxide, nitrogen dioxide, hydrogen sulfide, benzene, sulfur dioxide, methanol, toluene, and xylene) in the air of the working areas of the Plant was performed.

The relevant technical report[13] illustrated by the dispersion charts for the working areas and surroundings of the Plant was prepared. According to its results, the operation of the Plant is unable to have a significant impact on the air quality outside the normative sanitary protection buffer zone 1 km wide, and the concentrations of pollutants in the air of the working spaces will also be safe for the personnel (with the

[12] Criteria established by the RF Government Decree No. 1029 of 28.09.2015.

only exception of the above-limit NO_2 levels of in some working zones during the LNG or SGC loading due to the accumulation of emission components of the engines of the moored tanker).

The calculations also confirmed the sufficiency of the 84-meter height of the Plant’s chimneys for discharging exhaust gases into the atmosphere for efficient, environmentally and technologically safe dispersion of the predicted pollutants.

9.1.8 Summary

The impact of the Project construction on air quality will be limited to the construction sites and areas immediately adjacent to them. At the construction phase, air quality at the TAC site will meet the quality standards for atmospheric air in residential areas.

Contribution of the GBS LNG&SGC Plant to air pollution within its site during the construction period should be recognized as relatively small, since most of the construction and installation work will be performed at remote technical sites elsewhere in the Russian Federation and abroad.

Given the nature of pollutant emissions during the Project operation and the absence of rotational camps intended for personnel accommodation within the SPZ, and provided that mitigation measures are implemented (Table 9.1.7), the residual impact of emissions on atmospheric air during the operation phase can be assessed as being of low significance.

Table 9.1.7: Summary of air impacts and mitigation measures

Impact	Sign	Receptor	Receptor Sensitivity	Stage	Impact significance	Design solutions and mitigation	Residual impact
Impact on air quality	N	Personnel (rotational camp) Environment	M	C	M	• Ensuring strict adherence to the relevant work performance techniques and construction schedule • Using modern diesel generators that meet the applicable project emission standards • Regular maintenance of fixed and mobile equipment, vehicles (automotive emissions should comply with the requirements of GOST 33997-2016 and GOST 17.2.2.02-98) • Monitoring the operation of machinery during downtime or service breaks (parking of vehicles during such periods is only allowed if the engine is not running) • Using construction equipment that meets environmental standards • Using fully serviceable machinery and mechanisms with well-tuned fuel combustion systems making sure that the emission of pollutants with exhaust gases is kept within the prescribed standard range • Using low-sulphur diesel fuel • Using closed containers for the storage of fuels and lubricants • Storing volatile chemicals and loose materials in closed containers • Prohibition of burning of any wastes except for disposal in designated incinerators • Using canvas covers for transportation of loose materials, to reduce dust emissions • Inventorying all emission sources and calculating emission volumes using a pollutant dispersion model	M (for NOx) L (for other pollutants)
	N	Personnel (rotational camp) Environment	M	O	M	• Pollution emission parameters must comply with applicable Russian and international technological emission standards • Using effective burner tips to ensure combustion efficiency of at least 98% • Maximizing combustion efficiency by proper control and optimization of flare fuel/air/steam flow rates to ensure the correct ratio of assist stream to flare stream • Placing the flare at a safe distance from local residents and workers, including workers' accommodation camps • Implementing proper burner maintenance and replacement programs to ensure maximum flare efficiency • Keeping record of the volumes of gas flared • Minimizing liquid carry over and entrainment in the gas flare stream by ensuring a suitable liquid separation system is in place	M

Impact	Sign	Receptor	Receptor Sensitivity	Stage	Impact significance	Design solutions and mitigation	Residual impact
						• Limiting the estimated gas velocity at the burner tip • Using reliable electronic ignition systems • Optimizing the process to minimize flaring caused by process disruptions • The number of connections should be limited to the necessary minimum for safe and practicable operation and maintenance • When selecting proper valves, flanges, fittings, seals and packings, their ability to reduce gas leaks and uncontrolled emissions as well as the safety and applicability requirements should be taken into account • Where applicable, pumps with double mechanical seals or without seals should be used, and dry gas seals should be used in compressors • Hydrocarbon vapours must either be collected or sent back to the process system, depending on the process pressure • Good international industry practice (GIIP) includes implementation of the leak detection and repair (LDAR) program for continuous monitoring of uncontrolled emissions to detect leaks • Pressure in the tank and the vapour space must be kept constant by reducing breathing losses through the use of insulated tanks to prevent and limit VOC emissions from storage	

9.2 Harmful Physical Impacts

Harmful physical impacts may occur at any stage of the Arctic LNG 2 Project lifecycle and differ in duration, extent and severity. This section examines harmful impacts of noise and vibration. The impact of the flare heat radiation on thawing is assessed in Section 9.4. Assessment of the impact on fauna from flares and light nuisance is covered in Section 9.5.

Noise

The project is being implemented at a considerable distance from the nearest population centers. Consequently, the potential noise impact will affect:

- People employed by the Project, both during the construction and operation of the facilities and when in residential premises during off-hours;
- Reindeer herders, if their migration routes pass in the immediate vicinity of the Project sites (such impacts will be short in duration);
- Terrestrial fauna (including seabirds) and marine (underwater) fauna.

Vibration

Impacts associated with vibration may result in:

- Deterioration of the working conditions and disturbance caused to the terrestrial fauna;
- Disturbance caused to the marine fauna due to underwater noise (see noise impact).

Ionizing and electromagnetic radiation

Ionizing and electromagnetic radiation that may have an adverse environmental or social impact during the implementation of the Project is absent and therefore is not discussed in this document in detail.

As shown in Section 7.2, Radiation-ecological conditions at the designed locations of the Field, Plant and Port are generally favourable and environmentally safe. The surveyed areas meet the sanitary and hygienic safety standards in terms of gamma radiation exposure rates for construction of any facilities without restrictions.

Electromagnetic fields are generated during operation of electrical and radio equipment.

The design provides for the use of certified electrical equipment with a maximum voltage of 6.3 kV and frequency of 60 Hz, certified communication equipment and systems with valid registration of radio-electronic equipment and authorization for the use of radio frequencies or RF channels, which serves a guarantee of safety of personnel and community exposed to electromagnetic radiation.

RF units of radio transmitters and microwave oscillators are equipped with shields and installed in dedicated equipped compartments. Shielding elements are also provided at the feeder installations. Unshielded units are equipped with automatic illuminated indicator panels. Positions of radio communication control rooms and radio antennas are selected in compliance with the applicable regulations.

Transmitting radiotechnical facilities (TRTF) will be used during operation of the Utrenniy Aerodrome. Sub-zone 7 of the aerodrome (equivalent of SPZ) is defined considering the boundaries of the areas of impact of the radio-technical support systems for aircraft flights and aeronautical telecommunication specified in the air navigation passport of the aerodrome. Calculation of electromagnetic fields show that the zone of negative TRTF impact outside Sub-zone 7 is within the permissible standard for human health.

9.2.1 Construction

9.2.1.1 Airborne noise

Plant

The main sources of airborne noise during the construction phase of the Plant onshore facilities will include mobile and stationary construction equipment as well as motor vehicles. Given the openness of the construction site and the fact that in some cases the Project standards are likely to be exceeded (for example, when working with portable air compressors, jackhammers, etc.), the negative impact of noise on the workers can be assessed as moderate.

According to the results of noise propagation simulation, a maximum radius of noise discomfort zone (night time sound pressure above 45 dBA) during the construction is expected to be 3400 m. Since the TAC site location is more 4 km away from the Plant construction site, the adverse impact of noise during the construction phase will be low.

Utrenniy Terminal

The design provides for construction in seven phases during three years. According to the design documentation, the peak of construction activity is expected in 2019-2020, when all phases will be active.

The main sources of airborne noise during the construction of the Utrenniy Terminal and the development of the berth structures will include a pile drilling rig, a hydraulic hammer, mobile and stationary construction equipment, vehicles, diesel power plants (DPP) and compressor stations.

Pile drilling rig and hydroblock hammer can be sources of high acoustic impact, to which workers may be exposed.

The extent of the acoustic impact of the designed facilities construction on the environment has been assessed by noise propagation simulation. The resulting sound pressure isolines are used to estimate distances from the construction site boundaries at which the level of sound comes down to standard value.

According to the acoustic calculations, equivalent levels of sound of 55 dBA are expected at the distance of 410 m from the site boundary, and equivalent levels of sound of 45 dBA - at 1670 m from the boundary.

The maximum sound level isolines of 70 dBA are within the construction site boundaries. Maximum levels of sound of 60 dBA will be achieved at the distance of 260 m from boundary of the construction site.

Noise impact from the operation of mobile and stationary construction equipment and vehicles can be assessed as moderate.

Salmanovskoye (Utrenneye) OGCF

The main sources of airborne noise at the Salmanovskoye (Utrenneye) OGCF during the infrastructure development stage are:

- Vehicle engines;
- Engines of machinery used for site grading, excavations, etc.;
- Drilling rigs;
- Power generating units;
- Welding;
- Earthworks.

The radius of acoustic discomfort zones of noise sources during the construction period has been assessed. Calculated maximum radius of noise discomfort zone is 175 m.

Expected levels of noise at the TAC site will meet the standards for day and night noise levels.

Noise impact on personnel from the operation of mobile and stationary construction equipment and vehicles can be assessed as moderate.

Noise impact of aircraft on people and fauna is possible both at take-offs and landings and in flight. Noise exposure will be brief, but the peak sound level in the area beneath the passing aircraft may exceed the Project standards. Consequently, the acoustic impact of aircraft in the absence of mitigating measures may potentially be moderate or high, depending on the intensity of air traffic and the presence of reindeer herders and sensitive fauna species on helicopter routes.

Conclusion. Given the openness of the Project construction sites and the likelihood of temporary exceedance of the Project standards in some cases, the adverse impact of noise on the workers during the construction phase can be assessed as moderate. High sound levels will not propagate over long distances, and therefore the adverse impact on rotation camps, reindeer herders' camps and local fauna is expected to be low. Moderate/high impact is only likely during aircraft flights.

9.2.1.2 Vibration

The main sources of vibration are construction equipment/machinery and drilling operations. Potential receptors include workers and nearby fauna. Vibration intensity is assessed as medium. Vibration is temporary/short-term and local. Therefore, the overall vibration impact will be low.

9.2.1.3 Underwater noise

Underwater noise can have a potential impact on marine life, including pinnipeds, cetaceans and fish. The main sources of underwater noise during the construction phase are dredging and piling operations in the vicinity of the terminal and berth structures. To assess the impact, audiograms and critical sound levels for marine fauna species typical for the Project implementation area, as well as the acoustic characteristics of the dredging and piling operations have been analysed.

Audiograms and critical sound levels for marine fauna in the Project area

- White whale, *Delphinapterus leucas*

The hearing threshold of the white whale varies from 40 to 140 dB/1μPa. The peak of audibility is observed in the frequency range from 10 to 100 kHz. Temporary hearing damage in the form of hearing threshold shift may occur at levels over 165 dB/1μPa in the frequency range from 11.2 to 90 kHz[14]. According to the US National Marine Bioresource Management Service[15], the traumatic acoustic effect on cetaceans begins at sound levels above 180 dB / 1μPa.

- Ringed seal, *Phoca hispida*

The hearing threshold of the ringed seal in the frequency range from 1 to 20 kHz varies from 70 to 80 dB/1 μPa. The hearing threshold increases to 90 dB/1 μPa at frequencies below 1 kHz, and to almost 120 dB/1 μPa[16] at frequencies above 20 kHz. According to NMFS, the traumatic acoustic effect on the pinnipeds begins at sound levels above 190 dB/1μPa.

- Ichthyofauna

Fish can be considered as most vulnerable to impact of noise, as it has a large gas-filled swimming bladder. When exposed to the impact, fish move multiple kilometres[17] off the powerful noise sources. Reportedly[18], catches of cod and haddock drop down by 70% at a distance of 3 miles from source of noise, and by 45% at a distance of 18 miles. The hearing threshold of the herring (*Clupea harengus*) in the frequency range from 30 to 1300 Hz varies from 80 to almost 140 dB/1 μPa. The peak of audibility is observed in the frequency range from 30 to 1000 Hz. Marine fish recognise and react to low frequency sound of 50-3 000 Hz[19] and have a hearing threshold at 125 dB/1 μPa. Therefore, fish can detect sources of anthropogenic noise at long distances. Also, fish can determine general direction to noise source[20]. It is assumed that the noise level that is likely to cause a reaction in fish is 132 dB/1 μPa per 1 m (according to ICES[21]). The analysis of noise from piling operations revealed that the traumatic effect of sound on fish is observed at 180 dB/1 μPa, according to NMFS, and at 208 dB/1 μPa according to Popper et al (2006)[22]. It has been demonstrated[23] that sound levels of 226-234 dB rupture of swimming bladder in Salmonidae, and 192-198 dB paralyse salmon (though the fish recover after 30 minutes). According to different sources, fish start demonstrating abient response to increasing level of sound at 130-142 dB/1 μPa. Higher levels of noise cause startle and fleeing response[24][25] or reaction of withdrawal from source of noise[26]. In shallow water sound is reflected from water surface and seabed multiple times and fish are not always capable of detecting

[14] Popov et al. Hearing threshold shifts and recovery after noise exposure in beluga whales, *Delphinapterus leucas*. Journal of Experimental Biology, 2013. 216 (Pt 9), pp. 1587-1596

[15] National Marine Fisheries Service (NMFS). Official Web-site at https://www.fisheries.noaa.gov/

[16] Sills J.M., Southall B.L., Reichmuth C. Amphibious hearing in ringed seals (*Pusa hispida*): underwater audiograms, aerial audiograms and critical ratio measurements. Journal of Experimental Biology, 2015. pp. 2250-2259.

[17] Skalski J. R., Pearson W. H., Malme C. I. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (Sebastes spp.) //Canadian Journal of Fisheries and Aquatic Sciences. 1992. Vol. 49. No. 7. P. 1357-1365

[18] Engås A. et al. Effects of seismic shooting on catch and catch-availability of cod and haddock. – 1993.

[19] Platt, C. and A.N. Popper. 1981. Fine structure and function of the ear, p.3-38. In W.N. Tavolga, A.N. Popper and R.N. Fay [eds.]. Hearing and sound communication in fishes. Springer-Verlag, New York, NY

[20] Hawkins, A.D. 1981. The hearing abilities of fish, p.109-133. In W.N. Tavolga, A.N. Popper and R.R. Fay. Hearing and sound communication. Springer-Verlag, NY, NY.

[21] International Council for the Exploration of the Sea (ICES). Official website at http://www.ices.dk/

[22] Popper A.N., Carlson T.J., Hawkins, A.D. Southall, B.L., Gentry R.L. Interim criteria for injury of fish exposed to pile driving operations: a white paper, 2006, 15 p

[23] Turnpenny, A.W.H. and J.R. Nedwell. (1994). The effects on marine fish, diving mammals and birds of underwater sound generated by seismic surveys. FCR 089/94. Fawley Aquatic Research Labs. Ltd., Southampton, UK. 52 p

[24] Karlsen, H.E., Piddington, R.W., Enger, P.S., Sand O. Infrasound initiates directional fast-start escape responses in juvenile roach Rutilus rutilus // J. Exp. Biol. 2004. 207. P. 4185-4193.

[25] Popper A.N., Carlson T.J. Application of sound or other stimuli to control fish behaviour // Transactions of the American Fisheries Society. 1998. 127 (5). P. 673-707.

[26] Dalen J. Effects of seismic surveys on fish, fish catches and sea mammals. Report for the Cooperation group - Fishery Industry and Petroleum Industry Report No.: 2007-0512.

correct direction to the source of noise and therefore may stay in the exposure zone for a long time[27]. No specific studies have been conducted for determination of critical levels of anthropogenic noise for fish species typical of the Project water area. Considering the common mechanisms of bone fish response to anthropogenic noise, the above critical levels of noise can be also applied to these species.

Acoustic characteristics of the impact sources

The maximum sound level from *dredging operations* in shallow water is 177 dB/1μPa and is characterized by frequencies of 80-200 Hz[28]. Loss of noise transmission in coastal waters occurs according to the spherical propagation principle. This means that for every tenfold increase in the distance from the dredging site, the sound level drops by 20 dB (Table 9.2.1).

Table 9.2.1: Estimated noise propagation distances during dredging operations

Distances from source (m)	Noise level (dB per 1 μPa)
1	177
10	157
100	137
1000	117

Pile driving operations are characterized by a wide frequency range (20Hz-20kHz) peaking at 100-200 Hz[29]. The sound level from piling operations depends on the diameter of the piles and, as a rule, the greater the diameter the higher the sound level. Thus, when piles with diameters from 208 mm to approximately 4 m were being driven, the noise from the sources varied from 192 to 261 dB/1 μPa per 1 m[30].

Impact assessment

- *Dredging operations*

The hearing distance of dredging operations is one kilometer for a white whale, and a few kilometers for a ringed seal with the ear sensitive to low-frequency sound signals.

The appearance of individual species within hearing distance of dredging operations may contribute to a change in their behavioural responses, although at the moment there is no contemporary reliable evidence of such an effect[31].

Traumatic acoustic effects on marine mammals will be limited to locations within close proximity (less than 1 m) to the dredging site. The width of the Ob Estuary in the project area (in excess of 40 km) is sufficient for individual species to be able to avoid approaching the work site. Therefore, the traumatic impact is very unlikely. In the event of such impact, it will be of moderate significance with low risk.

The risk of injury or death of fish due to the noise impact of underwater dredging is extremely low. Reportedly, even powerful sources of noise, such as seismic source points used in seismic studies only cause behavioural response in fish[32][33], and injury is possible at a very close distance (few metres) to the source. Therefore, it is expected that fish will avoid the work area. However, a traumatic impact is possible near the dredging site, and therefore the noise impact on those species can be assessed as low.

- *Pile driving operations*

Pile driving operations are characterized by a higher noise level than that of dredging operations and, as a result, they will be audible to marine mammals and fish over long distances. At the moment, there is no documented evidence of the traumatic impact of piling operations on marine mammals[34]. In the context of Project implementation, such impact is practically impossible due to the sheer width of the Ob Estuary. In

[27] Wardle C.S., Carter T.J., Urquhart G.G., Johnstone A.D.F., Ziolkowski A.M., Hampson G. Mackie D. Effects of seismic air guns on marine fish // Cont. Shelf Res. 2001. P. 1-23.
[28] Nedwell J. and Howell D. A review of offshore windfarm related underwater noise sources. Report No. 544 R 0308. Collaborative Offshore Wind Energy Research Into the Environment (COWRIE), 2004, 57 p
[29] Overview of the impacts of anthropogenic underwater sound in the marine environment. Report of the OSPAR Commission, 2009. 133 p
[30] Nedwell J. and Howell D. A review of offshore windfarm related underwater noise sources. Report No. 544 R 0308. Collaborative Offshore Wind Energy Research into the Environment (COWRIE), 2004, 57 p
[31] Overview of the impacts of anthropogenic underwater sound in the marine environment. Report of the OSPAR Commission, 2009. 133 p
[32] Weinhold, R.J. and R.R. Weaver. 1972. An experiment to determine if pressure pulses radiated by seismic air guns adversely affect immature coho salmon. Alaska Dept. of Fish and Game.
[33] Falk M.R., Lawrence M.J. Seismic exploration: its nature and effect on fish // Technical report series No CEN-T-73-9, 1973, 51 P. 12 FIG, 4 TAB, 21 REF. – 1973.
[34] Overview of the impacts of anthropogenic underwater sound in the marine environment. Report of the OSPAR Commission, 2009. 133 p

the event of such impact, it will be of moderate significance with low risk. The traumatic impact of piling operations on fish is possible and is expected to be felt at distances around 100 m, therefore such a noise impact can be assessed as moderate.

- *Shipping activity*

At the construction phase, underwater noise impacts are also expected in relation to vessels moving in the water area, including during the ice season. This impact is examined in more detail in sub-section 9.2.2.3.

9.2.1.4 Mitigation of potential impact

Design solutions and actions

Mitigation and prevention of impact from exposure to noise at the construction phase will be achieved through the following design solutions and actions:

- Using PPE for noise protection;
- Always using fully serviceable construction machinery and mechanisms, conducting technical inspections and maintenance of special equipment and carrying out preventive repairs of machinery in a timely manner;
- Choosing machinery with the lowest noise levels;
- Provision of mufflers on engines;
- Using silencers in forced ventilation and air conditioning systems;
- Planning organizational measures (choosing proper modes of operation, limiting the time of work, etc.);
- Equipping diesel generators with vibration insulators, installing exhaust silencers, heat insulating exhaust pipes and silencers, equipping ventilation openings on DPP enclosures with louvers and guards;
- Installing vibrating equipment on vibration isolation pads;
- Daytime air traffic schedule.

Recommended actions

For early detection of the initial signs of occupational hearing disorders in workers exposed to excessive production-related noise, it is necessary to conduct preliminary and repeated medical examinations with mandatory audiometric hearing tests. Workplace noise assessment for the Project will be covered by the special workplace assessment (SWA) which is a mandatory requirement of Russian law.

Due to the fact that under the influence of noise and vibration, the vitamin content of the human body is significantly reduced, it is advisable to take steps to prevent vitamin deficiency in workers exposed to noise hazard[35]. In the context of the Arctic LNG 2 Project, the main factors of vitamin deficiency in personnel will be related to natural factors - cold climate and low natural light, which determine the main requirements for vitamin therapy. Based on the results of SWA, the basic vitamin complex and diet for personnel in the areas with high vibroacoustic load can be supplemented with components that increase resilience of nervous system and organism in general in the conditions of high impact of noise.

Measures to reduce noise exposure from aircraft may include:

- Restricting flights over the rotation camp, deer herds, wetlands;
- Limiting flights along coastlines and river valleys to the minimum (to avoid impact on nesting birds, moulting concentrations and resting grounds on the birds migration routes).

Residual impact assessment

Provided that all project solutions and recommendations/actions are complied with, residual impact on workers, reindeer herders' camping grounds, terrestrial and marine fauna can be assessed as low.

9.2.2 Operation

9.2.2.1 Airborne noise

Plant

The main sources of noise at the operating Plant are related to the process equipment including:

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[35] Krupnov P. A., Kushnir L.A., Gorbunov N.V., Shaydakov M.G. Sanitary and hygienic study of occupational hearing disorders in drilling workers. Human Ecology. 2007. No. 12 p. 53-58

- Pump equipment;
- Compressors;
- Gas turbines;
- Air coolers;
- Flare units.

Near the listed sources there are no permanent jobs, so the noise impact on workers will be minimal. Short-term noise exposure can be expected during equipment health checks. However, the noise level near sources is not sufficient for a negative impact on personnel in a short period of time.

The noise level calculations for the Plant operation show that equivalent sound pressure at the TAC boundary attributed to the concerned sources will be 29.3 dBA, and respective maximum sound pressure – 30.5 dBA.

Consequently, the negative noise impact of the Plant on the camps, reindeer herders camping grounds and local fauna can be assessed as low.

Utrenniy Terminal

The main local noise sources at the site of the Utrenniy Terminal and berth structures are:

- Utility and process equipment;
- Vessels traffic in the port water area, unloading operations;
- Port cargo-transfer equipment at the berth;
- Motor vehicles.

Noise sources in the port water area will include three berthing tugs, one cargo vessel for shunting operations, one tanker for fuel unloading, and one passenger vessel for transportation of personnel.

According to the acoustic calculations for the Terminal operation period, expected equivalent level of noise at a distance of 300 m from the boundary is 38-45 dBA, expected maximum level of noise is 44-53 dBA, i.e. within the permissible day and night time limits for the areas immediately adjacent to residential premises.

Consequently, the negative noise impact of the terminal and berth structures on the rotation camps, reindeer herders' camps and local fauna can be assessed as low.

Salmanovskoye (Utrenneye) OGCF

The main local sources of noise within the Salmanovskoye (Utrenneye) OGCF are:

- Gas well pads:
  - Aerodynamic noise at gas purging to flare;
  - Methanol pumping stations;
- Sites of CGTP1, CGTP2 and PGTP3:
  - Pumps;
  - Compressors;
  - Gas transfer units;
  - Turbo-expanders;
  - Air coolers;
  - Transformers;
  - Boiler house;
  - EDPS;
- Effluents re-injection site:
  - Pumping station;
- Helicopter pad;
  - Helicopter;
- Gas turbine power plant:
  - GTPP - 6 units installed indoors;
  - PGTPP-2500;
- Solid municipal, construction and industrial waste disposal site:
  - Specialised machinery;
  - Equipment;
  - Waste incineration facilities, etc.

Acoustic discomfort zone of noise sources has been assessed for the operation period.

The facilities will operate round the clock, therefore, calculations are performed for day and night time. At night, waste reception and disposal activities at the waste disposal site are stopped and only incineration system functions.

At other sites, calculation takes into account all sources, except for emergency diesel power stations, with scheduled starts of EDPS during daytime.

Calculated levels of noise at the TAC site match the standards for day and night noise levels. The calculated values are 47-49 dBA at night and 49-54 dBA at daytime.

As in the previous cases, the impact on the workers, rotation camps, reindeer herders' camps (including reindeer calving grounds) and local fauna is expected to be low.

Power supply facilities for the construction, soil jetting and drilling operations at the Salmanovskoye (Utrenneye) OGCF

The main sources of noise impact during the operation of the power supply facilities for the construction, soil jetting and drilling operations at the Salmanovskoye (Utrenneye) OGCF are:

- Gas turbine power plants;
- Transformer substations;
- Equipment for various technological processes related to transfer of liquid or gas media - pumps, air blowers, compressor units.

Acoustic calculations for the site of Power Supply Complex No.2 showed that the sound level in some areas will exceed 80 dBA (up to 100 dBA).

Such areas are located to the north-west, west and south-west of the shelters of Power Modules No.1 and No.2. Similar high levels of sound are expected inside the shelters of Power Modules No.1 and No.2 - up to 106 dBA. In the rest of the site of Power Supply Complex No.2 used for movement of operating personnel, the levels of noise will stay within the permissible limits.

In areas with sound level or equivalent sound level above 80 dBA, mandatory safety signs "Hearing protection must be worn" should be provided. Personnel working in the immediate vicinity of the areas with elevated noise emissions must use hearing protective equipment (ear muffs, noise-protection anti-phones, earphone-headsets, insert hearing protectors).

At the boundary of standard SPZ, sound pressure levels in the north-western, western, south-western and southern directions do not match the sanitary standard for residential areas and are higher then established noise limits for residential areas at night time. In the aforementioned directions, the standard SPZ (1000 m) must be increased to match the dimensions of the noise impact area, to the following distances from the site boundary of Power Supply Complex No.2 (Figure 9.2.1):

- To the north 920 m;
- To the north-east 850 m;
- To the east 530 m;
- To the south-east 820 m;
- To the South 1300 m;
- To the south-west 1130 m;
- To the west 1380 m;
- To the north-west 1280 m.

Final dimensions of the SPZ for Power Supply Complex No.2 are defined by the Sanitary Protection Zone Design Document "Salmanovskoye (Utrenneye) OGCF Facilities Setup. Gas supply for the power supply facilities to support construction, hydraulic filling and drilling operations" (refer to Section 9.1.5).

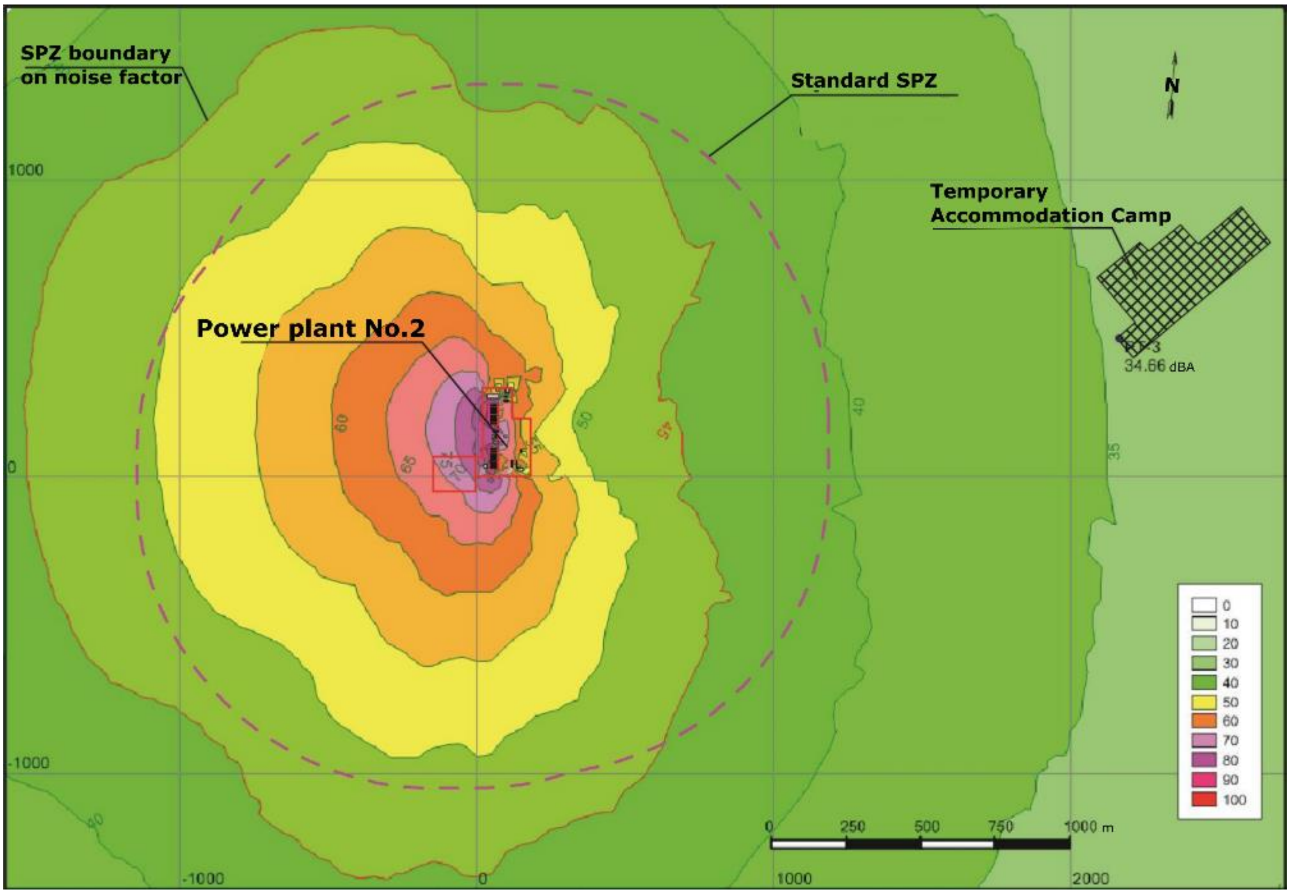

Figure 9.2.1: Simulation map of noise propagation in the territories adjacent to the site of Power Supply Complex No.2 during the operation period (14 PGTPP-2500 units in operation)

Utrenniy Airport

This Section is prepared using the feasibility studies for the Sub-zone 7 of the Utrenniy Airport.

Boundaries of Sub-zone 7 are determined by calculations that take into account the following factors:

- In terms of electromagnetic impact - Boundaries of the areas of impact of the radio-technical support systems for aircraft flights and aeronautical telecommunication specified in the aerodrome design documentation;
- In terms of concentration of air pollutants and noise impacts - considering the type of aircraft in use, takeoff, landing and maneuvering paths of aircraft in the aerodrome area at daytime.

Boundaries of Sub-zone 7 are delineated considering the negative impact of the aerodrome equipment and aircraft flights on human health and the environment. The determining factor of the negative impact within the aerodrome environs (compared to the impact of the radio-technical support systems for aircraft flights, and impact of air pollutants from the aircraft traffic) is the aircraft noise. Aircraft taking-off, landing and maneuvering along the respective paths in the aerodrome area produce equivalent daytime aircraft noise level is 55 dBA.

Outputs of the EMF calculations[36] were used for determining the boundaries of SPZ and restricted development areas, based on the factor of electromagnetic radiation from TRTF for the Utrenniy Airport operation.

Contour lines of the aviation noise zone (LAeq=55 dBA) are significantly wider than the contours of the area affected by TRTF operation[37]. It should be noted that no regulated development objects are present within SPZ of the TRTF at the aerodrome of the Utrenniy Airport.

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[36] EMF – electromagnetic field

[37] 37 TRTF - transmitting radiotechnical facilities

Pollution dispersion analysis for the airborne sources showed that air quality at the aerodrome boundary meets the standard requirements - calculated concentrations of pollutants at the reference points are within the applicable MAC limits.

Concentration fields of the pollutants contained in emissions from the aircraft in lineup position are generated within and in the immediate vicinity of AR[38].

Boundaries of the aviation noise area of impact have been calculated as the combined outer contour line of equivalent levels LAeq.-55DBA along the established aircraft traffic routes, in accordance with the standard (established) departure routes. Calculation of the equal sound level contours did not consider possible deviations from the established aircraft traffic routes.

Based on the above, a confident conclusion can be made that during the examined period of year 2019 and in the future, the identified estimated boundaries of the contour of Sub-zone 7 will be determined by the dimensions of contour line of equivalent daytime aviation noise of LAeq=55 dBA generated in the aerodrome environs by aircraft moving along the established routes, in accordance with the standard (established) routes of departure, landing and maneuvering in the area of the Utrenniy Airport (Figure 9.2.2).

No significant impact of aviation noise on residential areas and other regulated territories is expected in relation to the aircraft flight operations.

[38] AR - Aircraft runway

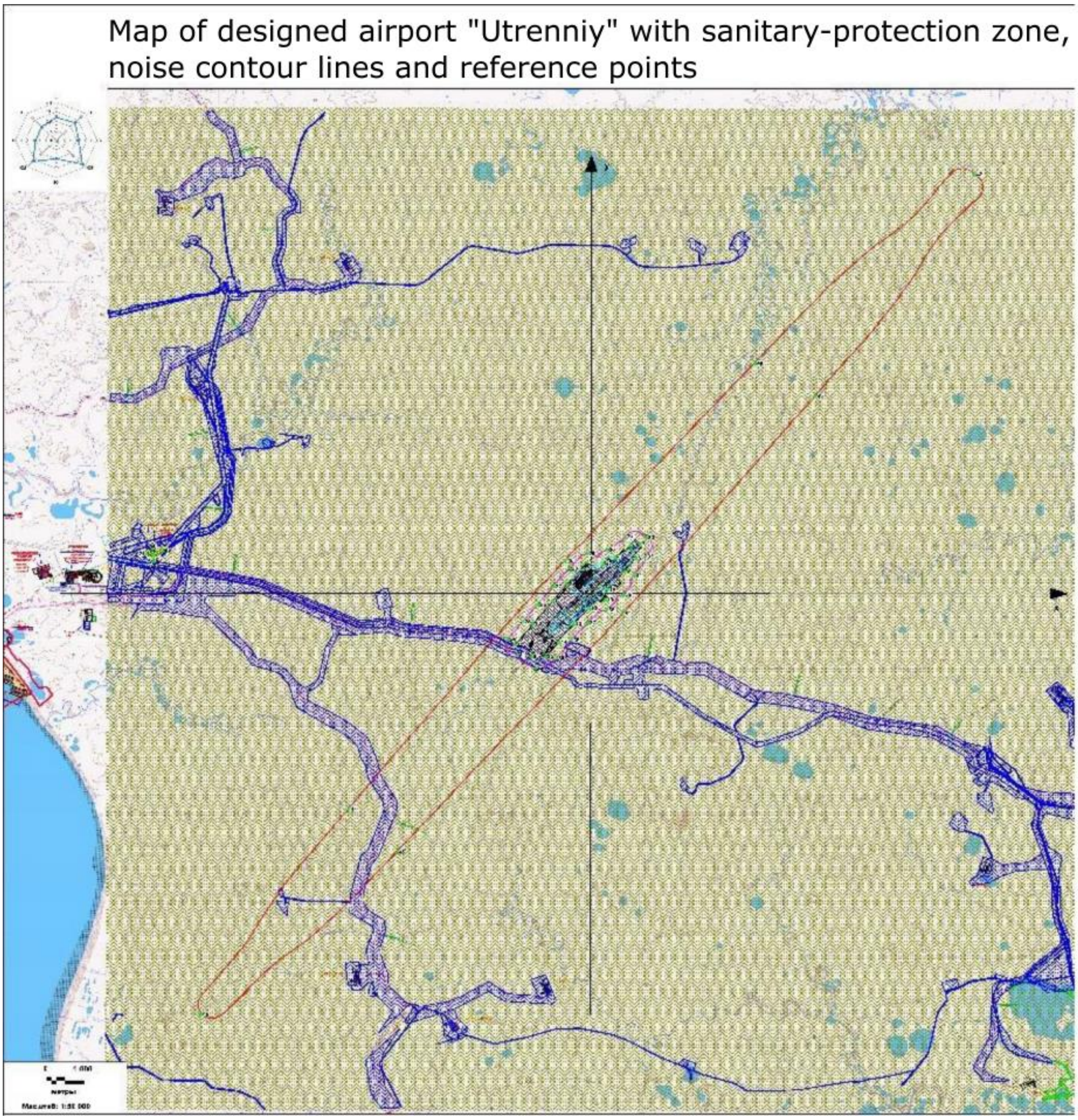

Figure 9.2.2: Zone of achieving permissible level of sound 45 dBA near the Utrenniy Airport

9.2.2.2 Vibration

Due to the absence of significant sources of vibration among the equipment being operated (machine units, manually operated machinery, etc.), its impact on the workers is assessed as negligible.

9.2.2.3 Underwater noise

The main source of underwater noise during the operation phase is vessels navigation. The level of underwater noise from sea vessels varies in the range of 160-190 dB/1 μPa depending on their size[39]. Given the presence of large gas tankers within the Project implementation area, the magnitude of the acoustic impact will reach its upper limit. Moreover, the impact will be enhanced by icebreaking when the vessel is moving. The noise is generated both by propeller cavitation and by the air bubbler system designed to clear the path. The bubbler noise level is estimated at 192 dB (at 1 μPa per 1 m between 0.1 and 20 kHz), the noise level of the screw during icebreaking is up to 197 dB (at 1 μPa per 1 m between 0.1 and 22 kHz)[40].

[39] Overview of the impacts of anthropogenic underwater sound in the marine environment. Report of the OSPAR Commission, 2009. 133 p

[40] Erbe C. and Farmer D. M. Zone of impact around icebreakers affecting beluga whales in the Beaufort Sea. Journal of Acoustic Society America, 2000. Vol. 108, №3, pp.1332 – 1340

Icebreaking simulation showed that at 20 km the noise level is reduced to approximately 120 dB (Overview of the impacts…, 2009). The sound level of 120 dB is the maximum hearing threshold for the white whale in the frequency range generated by icebreaking. Therefore, of course, the white whale will hear those sounds at a distance of more than 20 km. According to Erbe and Farmer (2000), the audibility distance of the Canadian icebreaker *Henry Larsen* was 35-78 km, depending on the depth and topography of the terrain.

Communication signals masking in white whales and changes in their behaviour are observed at a distance of 14-71 km and 29-62 km, respectively[41]. Behavioural changes include moving away from the source of noise, changing communication sounds, changing behaviour when submerging and diving, and avoiding the area of influence for the next two days[42].

According to Cosens and Dueck (1988), white whales would not approach an icebreaking site to a distance sufficient for the noise to damage their hearing systems. Thus, taking into account possible behavioural changes and masking of communication impulse signals, the noise impact of ships on white whales can be assessed as moderate. No threats exist to the population size or the integrity of the species.

The impact of noise generated by icebreakers on ringed seals and pinnipeds has not been generally studied. In this regard, in order to assess the impact, the noise of vessels other than icebreakers is taken as an analogue.

According to Richardson et al (1995)[43], a ship's noise has a minor effect on pinnipeds (seal, sea lion, fur seal and walrus) which are already in the water and which demonstrate various types of behaviour when disturbed. At the same time, a negative effect of ship engines' noise on harp seals (*Pagophilus groenlandicus*), which led to masking of their communication signals and possible further behavioural changes, was discovered in the Gulf of St. Lawrence[44]. Thus, given the ambiguity of the conclusions about the acoustic effect of vessels on pinnipeds and the possibility of additional noise from icebreaking, the Consultant goes along with the most rigorous assessment and considers the noise impact of icebreakers on the ringed seal as moderate.

Noise from operating vessels impacts marine mammals by masking their communication signals, causing changes in behaviour potential temporary hearing damage[45]. The latter depends on the duration of noise exposure, its frequency characteristic, the acoustic sensitivity of a particular fish species. Taking into account the high sound level during icebreaking, particularly in low frequencies, and low density of fish in winter, the noise impact of icebreakers on the fish fauna can be assessed as low.

9.2.2.4 Mitigation of potential impact

Design solutions and actions

Mitigation and prevention of impact from exposure to noise at the construction phase will be achieved through the following design solutions and actions:

- Using noise protection PPE by workers;
- Monitoring of acoustic impact – quarterly;
- Using low-noise technological processes and equipment;
- Ensuring timely equipment repairs;
- Using soundproofing enclosures (particularly for pump units), silencers (particularly for engines, on exhaust and suction pipes of gas turbine power plants, in forced ventilation and air conditioning systems);
- Soundproofing noise-generating pipelines and equipment;
- Limiting time spent by members of the staff in areas with high noise levels;
- Installing vibrating equipment on vibration isolation pads, installing vibration-proof foundations and shock absorbers for equipment;

[41] Erbe C. and Farmer D. M. Zone of impact around icebreakers affecting beluga whales in the Beaufort Sea. Journal of Acoustic Society America, 2000. Vol. 108, №3, pp.1332 – 1340

[42] Cosens Susan E., Dueck Larry P. Responses of Migrating Narwhal and Beluga to Icebreaker Traffic at the Admiralty Inlet Ice-Edge, N.W.T. in 1986. Port and Ocean Engineering Under Arctic Conditions. Symposium on Noise and Marine Mammals. 17-21 August, 1987, University of Alaska Fairbanks. Eds. W.M. Sackinger and M.O. Jeffries. Fairbanks: UAF, 1988. 27-38

[43] Richardson W.J., Greene C.R., Hanna J.S., Koski W.R., Miller G.W., Patenaude N.J., Smultea M.A. Acoustic effects of oil production activities on bowhead and white whales visible during spring migration near Pt. Barrow, Alaska-1991 and 1994 phases: Sound propagation and whale responses to playbacks of icebreaker noise. Herdon, Virginia: Minerals Management Service, 1995

[44] Terhune J. M., Stewart R. E. A., Ronald K. Influence of vessel noises on underwater vocal activity of harp seals. Canadian Journal of Zoology, 1979. Vol. 57, № 6, pp. 1337-1338

[45] Overview of the impacts of anthropogenic underwater sound in the marine environment. Report of the OSPAR Commission, 2009. 133 p.

- Using vibration-damping and anti-vibration coatings;
- Daytime air traffic schedule.

Recommended actions

Given the significance of hydroacoustic impact on the marine biota, it is recommended to monitor underwater noise for the assessment of impact of this factor on the Ob Estuary ecosystems. Acoustic monitoring during construction of oil and gas industry facilities is successfully conducted in the continental shelf areas. In particular, in Russia such monitoring is practiced in the Sea of Okhotsk in the offshore area of Sakhalin island, within the scope of investment projects of Exxon Neftegas Limited and Sakhalin Energy Investment Company Ltd. The results of these studies are published[46][47][48][49]. Suitable methods for underwater noise studies include spot measurements in water with hydrophone, as well as long-term background noise logging with seabed acoustic stations. The measured data are used for acoustic analysis, mass numerical simulations, building of maps with isolines of acoustic impacts on the environment, and assessment of cumulative effects using statistical analysis and percentile distribution techniques. Methods are proposed that allow registration of both anthropogenic noise and vocalisation of cetaceans[50][51].

Residual impact assessment

If all project and recommended solutions / activities are observed, the residual impact on workers, reindeer herders camping grounds, and land fauna can be assessed as low and negligible. Moderate exposure is possible when flying aircraft. The marine fauna may be subject to moderate noise exposure during the movement of vessels, which is an associated activity in the project.

9.2.3 Summary

Harmful physical impacts may occur at any stage of the Arctic LNG 2 Project lifecycle and differ in duration, extent and severity. Noise and vibration will be the most significant factors, while the effects of electromagnetic fields and radioactivity are disregarded in this ESIA as being negligible.

The highest intensity and largest extent of noise and vibrations are commonly associated with construction activities, due to high concentration of machinery and vehicles, operation of drilling and piling rig, portable generators and other equipment with significantly higher levels of noise, compared to stationary equipment with similar functions.

As applied to the Plant, the various construction stage associated impacts on the sensitive recipients of the Ob Estuary and the Gydan Peninsula are minimized by carrying out most of the work at remote shipyards and other construction sites. On the other hand, the associated construction activities with regard to the Port and FIELD facilities, as well as associated marine operations, are recognized as the most significant factor on physical impacts on the land and water area adjacent to their sources.

According to the calculations provided in the design documentation, during the construction phase the integral aboveground zone of acoustic discomfort with a noise level of over 45 dB will not expand to the residential facilities at the TAC site. Sources of the most intense acoustic effects of the construction will include piling, loading and unloading operations, most of which are limited in time to the construction phase, as well as air traffic in the form of infrequent one-off sonic events.

Due to the considerable remoteness of the majority of receptors, including the most sensitive ones (nomadic population and permanent residents, terrestrial vertebrates), the significance of this impact is generally assessed as **low**.

[46] A. N. Rutenko, V. A. Gritsenko. Anthropogenic acoustic noise monitoring in the shelf area of Sakhalin island // Acoustic Journal, 2010, vol. 56, No. 1, pp. 77-81

[47] A. N. Rutenko, S. V. Borisov, D. G. Kovzel, V. A. Gritsenko. Radio-hydroacoustic station for monitoring of parameters of anthropogenic pulse and noise signals in offshore areas // Acoustic Journal, 2015. Vol. 61. No. 4. pp. 500-511

[48] A. N. Rutenko, V. G. Uschipovskiy. Assessments of acoustic noise generated by support vessels operating with oil platforms // Acoustic Journal. 2015. Vol. 61. No. 5. pp. 605-605.

[49] V. Ye. Nevayuk et al. Results of acoustic monitoring of convoying of barges with oversized equipment to Piltun Estuary // Applied Hydroacoustic and Hydrophysical Technologies. 2018. pp. 569-572.

[50] Rutenko A.N., Vishnyakov A.A. Time sequences of sonar signals generated by a beluga whale when locating underwater objects. Acoustical Physics, 2006. Vol. 52, N. 3, P. 314-323.

[51] A. I. Vedenev, O. Yu. Kochetov, A. V. Shatravin. Development of hydroacoustic platform for monitoring of industrial noise and presence of marine mammals using a distributed network of acoustic buoys with radio-telemetric equipment // Marine Mammals of Holarctic Region. 2015. pp. 122-125.

A special category of physical impacts is underwater noise affecting sensitive marine fauna. Its main source are offshore activities using various floating craft, and underwater technical operations - dredging, dumping, and other offshore and onshore construction activities.

In general, the adverse physical impact of the offshore operations contemplated under the Project on the fish fauna and marine mammals can be assessed as **moderate**. The significance of hydroacoustic impact of underwater operations is estimated as **low** due to the absence of any immediate threat to the prevalence/abundance of marine mammals, the low likelihood of them suffering damage or changing their behaviour, the relatively short duration of the construction phase, the recorded absence of marine mammals foraging grounds near the Plant and the Terminal, and the many years of operation of the berth structures in that area.

Table 9.2.2: Summary of harmful physical impacts and mitigation actions

Impact	Receptor	Project Phase	Impact significance	Design solutions and mitigation	Additional measures recommended by Ramboll	Residual impact
Airborne noise	Workers	Construction	Moderate	• Using PPE for noise protection; • Always using fully serviceable construction machinery and mechanisms, conducting technical inspections and maintenance of special equipment and carrying out preventive repairs of machinery in a timely manner; • Installing mufflers on engines; • Using silencers in forced ventilation and air conditioning systems; • Planning organizational measures (choosing proper modes of operation, limiting the time of work, etc.); • Installing exhaust silencers on DPPs, heat insulating exhaust pipes and silencers, equipping ventilation openings on DPP enclosures with louvers and guards; • Daytime air traffic schedule.	• Conducting preliminary and repeated medical examinations with compulsory audiometric examination of the worker's hearing organs, prevention of vitamin deficiency; • Restricting flights over the rotation camp, deer herds, wetlands • Offshore hydroacoustic studies and building 3D numeric models of anthropogenic acoustic fields, identification of receptors of acoustic impact, and development of proposals for the impact minimisation. • Using vibration methods in all cases where soil conditions allow it.	Low
	Ichthyofauna		Moderate			
Vibration	Workers	Construction	Low	• Equipping diesel generators with vibration insulators; • Installing vibrating equipment on vibration isolation pads.	• Using PPE (vibration protective gloves); • Decreasing time of the workers' exposure to vibration sources.	Negligible
	Deer herders		Negligible			
	Fauna		Low			
Vibration	Workers	Operation	Negligible	• Identifying vibrating equipment; • Installing vibrating equipment on vibration isolation pads; • Providing vibration-proof foundations and shock absorbers for equipment (particularly, ventilation equipment) to prevent vibration from being transmitted onto building structures; • Using vibration-damping and anti-vibration coatings.		
	Deer herders					
	Fauna					

9.3 Impact on Surface Water

9.3.1 Introduction

This Section discusses impacts of the planned activity in the course of construction and operation of the Project and associated facilities (see Chapter 5).

During construction of the Salmanovskoye (Utrenneye) OGCF Facilities Setup, surface waterbodies such as lakes, rivers, streams and bogs may be exposed to local negative impact. Construction without special impact mitigation measures may entail the degradation of soils and disturbance of natural surface drainage. These create conditions for a suspended particulate matter wash-off from the construction site by storm and melt water into natural terrain depressions and further uncontrolled discharge of suspended solids to watercourses and give rise to accelerated shore erosion.

Also, waterbodies may appear polluted as a result of incomplete collection and/or inadequate treatment of storm and melt water, mud fluids, spent water from flow tests, accidental spills of petroleum products, lubricants and chemical agents, where improperly handled, and because of soil contamination followed by a carry-over of pollutants with surface runoff to waterbodies.

River and stream flows and melt waters may carry pollutants to the Ob Estuary which is a waterbody that falls under the top fishery category.

Impact of the Plant and Port (Utrenniy Terminal) construction on the marine environment of the Ob Estuary is expected in relation to dredging and soil dumping activities in the water area. Main impact will be caused by the associated activities (as defined in Chapter 5); in particular, construction of the facilities of federal ownership – construction of the approaching channel and dredging activities in the Port area, soil dumping in the Ob Estuary area, construction of ice barriers, while preparation of the GBS bedding, and GBS installation (Company's ownership) will require ten time less dredging and dumping.

Violation of the regulations for activities within water protection zone may result in pollution of marine water during the construction of the Port and Plant onshore facilities on the artificial land plot and on the shore of Ob Estuary.

Key potential impacts on waterbodies during the Project operation are water abstraction from surface waterbodies and risk of waterbodies pollution with wastewater and liquid waste. Impacts are possible in relation to operating procedure violations at water intake and treatment facilities, emergency discharges of untreated water to waterbodies, accidental leaks of process products from pipelines and tanks and their subsequent migration down to river channels and lakes by sloping terrain and further on to the Ob Estuary.

A reason for the planned enlargement of the navigation channel in the north of the Ob Estuary (section where the channel route intersects with the Ob bar) is growth of cargo traffic intensity on the route with account for the future cargo turnover of three terminals – Sabetta, Utrenniy, and Arctic Gate. The channel dimensioning is defined by the design vessel parameters of the Yamal LNG Project. Implementation of the Arctic LNG 2 Project will not cause any change in the range of vessels (the only difference is potential increase of draught by 0.1 m for one vessel category), however it will cause an increase of ship journeys. Impacts related to the potential enlargement of the navigation channel in the north of the Ob Estuary and increased navigation traffic in the Ob Estuary are considered in Chapter 13: Cumulative Impacts.

Impacts on the marine flora and fauna in the Ob Estuary due to the dredging and soil dumping activities in the Port area are considered in Section 9.5: Impact on Biodiversity in this Chapter.

9.3.2 Impact on inland waterbodies

9.3.2.1 Construction

Impact on inland waterbodies is largely related to construction of the areal and linear facilities in the framework of the Salmanovskoye (Utrenneye) OGCF Facilities Setup, however this impact is expected to be local and short-term. Adverse effects of the planned activity on inland surface waters during construction may manifest themselves in:

- Changes in the hydrogeological regime of the territory caused due to the terrain transformations and geocryological modifications; groundwater flow, supply and discharge conditions;
- Disturbed hydrochemistry of waterbodies: a lot of contaminants migrate to the water environment during water crossings construction;

- Disturbance of the morphological structure of river channels, of terrain and moss vegetation cover on river floodplains and valley slopes during construction of water crossings;
- Disturbance of the morphology of lacustrine shelves and higher turbidity of water resulting from construction of quarries for building material (sand) production;
- Changes in the surface water runoff buildup and distribution in locations of the sites and linear facilities and, consequently, development of erosion processes;
- Water depletion due to abstraction of natural water for water supply;
- Discharge (as a result of accidents) of untreated and inadequately treated wastewater to waterbodies or terrain;
- Pollution of the water catchment and aquatic environment caused basically by hydrocarbons from emergency spills of oily products and lubricants.

Modification of hydrological conditions in the territory of the Salmanovskiy (Utrenniy) LA

Major impact on hydrology results from man-caused restructuring of terrain and compaction of soils under filled heaps during construction of well pads and water crossings (motor roads and pipelines). If the facilities' positions are selected without due consideration of hydromorphous system functions and surface runoff directions, and without appropriate environmental mitigation, such terrain transformations may damage the landscape components structure, particularly microrelief, surface runoff, hydrological conditions, and entail changing of the surface water flow direction and nature with increase risk of waterlogging.

Engineering structures that often function as impermeable barriers divert natural migration pathways of internal drainage and support overwetting or intensive waterlogging. Bogging and erosion processes also enhance in the areas of building machinery traffic.

Measures to minimise impact on natural surface runoff include:

- compliance with environmental requirements for earthworks in the floodplains and onshore sections of crossings specified in the construction regulations for earthwork structures;
- keeping the works strictly within designated territories;
- site preparation and main civil and installation works are conducted during winter construction season;
- strict compliance with the design during the grading and civil and installation works;
- advance filling of access roads;
- reinforcement of slopes against water erosion, managing the surface runoff to prevent stagnation of surface water;
- according to the design, works to be conducted first at the site preparation stage are surface filling and grading, including arrangements for removal of surface runoff;
- collection of all wastewater generated on site and their transfer to treatment;
- riverbed erosion will be prevented by reinforcement of shores and provision of overflow troughs;
- implementation of systems for separate collection and treatment of domestic wastewater, industrial wastewater, and surface runoff;
- operations resulting in suspension of solids are not conducted during the subglacial period;
- waterproofing of all pipelines.

After the impact minimisation measures, residual impact can be assessed as **local, short-term and low**.

Water environment pollution

Key potential chemical contamination sources for surface waterbodies are likely to be oil and chemicals storage facilities, gas filling stations, etc. Pollutants may penetrate into a waterbody (either directly or with the wash-off from the catchment area) because of leaks through non-sealed segments of shutoff valves, bunding failure or emergency spills. Furthermore, temporary construction sites for linear facilities' crossings, well pads, development of quarries etc., if not adequately managed, may provoke uncontrolled migration of pollutants (bottom sediments, hydrocarbons, etc. transported by surface runoff) into water bodies.

Contamination of watercourses and waterbodies by effluents from motor roads occurs where there is uncontrolled wash-off of dust, alongside with tire and brake shoe wear products settled on the road paving, of deicing and dedusting materials, etc.

Measures to prevent pollution of waterbodies include:

- Compliance with rules and restrictions for works in water protection zones, including:
  - Prohibition of off-road traffic (except for specialised vehicles); traffic is only permitted on temporary and permanent access roads;
  - Prohibition of fuel and lubricants storage, filling stations (except for placing fuel storage facilities and filling stations in the port's area)[52] operation of vehicle maintenance and washing facilities;
- respecting restrictions applicable in the coastal protection belts, including prohibition of the following practices:
  - Vehicles parking, refuelling, washing and repair of machinery;
  - Earthworks without immediate reclamation of disturbed land;
- Collection, accumulation and treatment of domestic wastewater for subsequent discharge to nearby waterbodies or into geological horizons;
- Prevention of discharge of untreated and/or insufficiently treated wastewater;
- Provision of vessels for collection of spent POL and wastewater at the construction sites;
- Keeping activities within the boundaries of the areas allocated for the construction;
- Arranging facilities, such as POL storage sites, machinery refuelling and washing facilities, etc. outside the water protection zones of waterbodies, on bunded sites with impermeable paving;
- Technical washing facilities are equipped with closed-cycle water supply systems;
- Surface runoff from polluted areas of the construction sites will be collected by grade elevation open gutters at site perimeters, to holding tanks. The holding tanks capacities are designed for peak (maximum daily) surface water flows - in waterlogged areas, pipelines construction will be conducted after sufficient freezing of soils;
- Temporary waste accumulation at dedicated sites with waterproof paving;
- Collection and timely removal of the building and domestic wastes by specialised contractors;
- During the quarries development, watercraft engaged in soil production are equipped with suitable holding tanks for collection of domestic wastewater, and also for domestic and industrial wastes;
- Riverbed erosion will be prevented by reinforcement of shores and provision of overflow troughs;
- Grading industrial sites areas to provide a slope toward a drainage ditch, to prevent spillage of rain, snowmelt water and wastewater outside the site territory;
- Before commencement of drilling activity at the well pads, bunds are filled using imported sand along the whole site perimeter to the height of 1.5 m - to prevent contamination of adjacent areas with drilling wastes and contaminated stormwater runoff from the drilling sites;
- Monitoring the technical state of process equipment (integrity of pipelines and vessels, operation of the control and measuring instruments and automatic process control systems);
- Monitoring of the technical state of the waste accumulation facilities (integrity of containers, vessels, bunding of the process site and drilling wastes holding basin, etc.);
- Immediate cleaning of areas affected by spills of oil and other toxic liquids; reclamation of disturbed land;
- Monitoring of the status of surface and ground water through a system of monitoring stations.

If all applicable environmental requirements are complied with, the residual impact can be assessed as **local, short-term and low.**

<u>Disturbance of the morphological structure of river channels, terrain, soil and vegetation on river floodplains and valley slopes during construction of water crossings</u>

The impact of road construction activities on surface waterbodies will be related to the construction of embankments and surface drainage systems. This may modify the existing and induce new terrain-forming processes. In particular, fill banks may, in certain positions, stop surface runoff and provoke waterlogging.

The negative effects of construction of water crossings for linear facilities (roads, power lines, pipelines – refer to Figure 9.3.1) may include:

- Mechanical damage of segments of floodplains and river channels resulting in increased water turbidity;
- Occurrence and activation of dangerous channel and slope scouring and erosion processes;

[52] Water Code of the RF dated June 3, 2006, No. 74-FZ, Ch.65 "Water protection zones and coastal protection belts".

- Destruction of natural soil deposits providing natural feeding environment, which leads to the deterioration of habitats and reproduction conditions of aquatic fauna, or its death.

The impact mitigation measures include:

- Compliance with rules and restrictions for works in water protection zones;
- Respecting restrictions applicable in the coastal protection belts;
- River sections for construction of crossings are selected in areas with highest resilience to deformations, on the basis of maps and field surveys;
- To avoid release of additional quantity of loose material from eroding channel and denudating banks and valley slopes, which results in a sharp increase of water turbidity, construction of underwater crossings is conducted during winter season;
- Riverbed erosion will be prevented by reinforcement of shores and provision of overflow troughs;
- Strengthening Khaltsyney-Yakha River channel with in-situ concrete;
- To prevent waterlogging and bogging of adjacent areas during construction of access motor roads, metal tubes will be installed in the relief lows for passage of surface (flood) water;
- Gas flow-line across rivers will be constructed above surface, on pile supports. No piers or trenches in channels are designed;
- To prevent damage of gas flow-line during ice drift on rivers, the crossing beam structures will be installed on piles with ice guards.

Subject to strict observance of the designed measures during the construction activity, and implementation of adequate environmental measures, the negative environmental impact will be **local, medium-term and low.**

<u>Disturbance of the morphology of lacustrine shelves and higher turbidity of water resulting from construction of quarries for building material production</u>

In the course of construction work, quarries will be required for the extraction of building materials, including production of sand from surface water bodies, mainly from lakes (Figure 9.3.1). Overall it is planned to construct 14 quarries that will impact lakes' area of 633,4550 ha in total (Annex 11). These activities may be responsible for negative impacts such as:

- Disturbance of the morphology of lacustrine shelves;
- Pollution of surface and ground water with fuel and lubricants;
- Water body pollution as a result of inadequate management of wastes and hazardous materials stored within water protection zone;
- Water pollution with suspended solids from jet quarrying activity will affect aquatic plants, zoobenthos, zooplankton, and fish.

The impact mitigation measures include:

- Subsoil conservation by strict observance of the boundaries and complete development of the quarry, surveying control of compliance with the designed geometry of the exploited sections of the field, including staking-out and fixation of the latter on the surface with floating marks, to ensure continuous monitoring of compliance with the development boundaries, location of the mining equipment, adequacy of the production volumes in relation to the recoverable reserves of ground (sand, clayey loam) in the exploited sections;
- Strict observance of the measures to prevent pollution of waterbody with wastewater and oily water, dry rubbish and food wastes;
- To prevent deterioration of sanitary and hygienic quality of waterbody, the detailed design requires that watercraft engaged in soil production are equipped with suitable holding tanks for collection of domestic wastewater, and also for domestic and industrial wastes;
- Pollution of river with petroleum products and oily water is prevented by providing leakproof connections and closed systems for vessels bunkering with fuel and lubricants;
- The design provides for reclamation of disturbed land at the end of production activity.

Provided the above requirements are met, residual negative impact from quarrying can be assessed as **local, medium-term, and low**.

However, the benefits of hydraulic production of materials in lakes in the Arctic lakes should also be noted. Surveys of depleted quarries in Nadym Municipal District of YNAO indicate that abandoned pits, owing to their depth down to 12-15 m and intensified water exchange, are characteristic of higher annual average water temperature, better water saturation with oxygen, and absence of fish kill incidence. Natural fish stocking in waterbodies begins after two or three years and, moreover, there emerges a freshwater source suitable for year-round potable water supply.

Acquisition of land for the Plant in floodplains and channels of streams

The Plant construction in the water area and water protection zone of the Ob Estuary, and in the floodplains and channels of watercourses will have a range of inevitable impacts, which, besides abstraction of water, will include the following:

- Acquisition of 8.5615 ha of floodplain land for the Plant;
- Acquisition of 1.1834 ha of stream channels for the Plant;
- Acquisition of 1840.07 m^2 of stream channels for construction of the drainage channel (new channel of streams);
- Damage of 115.43 m^2 of stream channels by the drainage channel construction activity;
- Acquisition of 1228.8 m^2 of the Ob Estuary water area for installation of concrete mattresses for the channel;
- Damage of 298.54 m^2 of floodplain sections by the channel construction activity;
- Acquisition of 12,981.09 m2 of floodplain area for the new drainage channel[53].

The impact of transformation of channels and estuarian sections of streams is inevitable and irreversible. The natural discharge of two streams will be blocked by the Plant site. However, the discharge to the Ob Estuary will be provided via the artificial drainage channel. The main function of the channel is to protect the Plant territory from the negative impact of surface runoff transported by creeks 1 and 2, and bypass the flow during flood events with 1% probability.

The negative impact of the planned facility on the water bodies will be prevented by a system of environmental measures:

- Observing work regulations for water protection zones:
  - Prohibition of traffic (except for specialised machinery) outside temporary and newly built access roads;
  - Prohibition of fuel and lubricants storage, filling stations (except for placing fuel storage facilities and filling stations in the port's area)[54], operation of vehicle maintenance and washing facilities;
- Observing work regulations for coastal protection belts, i.e. prohibition of:
  - Parking, vehicles and machinery filling, wash and maintenance;
  - Earth works not followed by immediate reclamation of disturbed areas;
- Keeping activities within the boundaries of the areas allocated for the construction;
- Conducting construction activities during cold season, as far as possible, considering the local climate;
- Maintaining and supporting the natural direction of surface runoff;
- Strict control of adequate technical state of machinery.

Given that residual impact of acquisition of floodplain and channel sections of streams will be **long-term** but **local**, the above mitigation measures will bring its magnitude down to **low.**

Natural water abstraction for water supply

During the designed facilities' construction, water will be consumed for the following purposes:

- Household and drinking;
- Processes;
- Firefighting;
- Hydraulic testing.

The design provides for construction of several surface water intake facilities to supply technical and potable water for the FIELD consumers during the construction phase. Most part of the water will be abstracted from lakes that do not freeze to the bottom in winter. In some cases, abstraction of water for technical water supply will be arranged in soil-based construction materials quarries.

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[53] GBS Plant for production, storage and offloading of liquefied natural gas and stabilised gas condensate. Design documentation. Section 8. Book 1. Vol. 8.1. List of environmental protection measures – Moscow: NIPIgaspererabotka JSC, 2019, 597 p.

[54] Water Code of the RF dated June 3, 2006, No. 74-FZ, Ch.65 "Water protection zones and coastal protection belts".

During the hydraulic quarrying activities, a filtration ditch with a bottom gradient toward the main drainage channel along the header, will be excavated at the site perimeter, to stop spillage of spent water to ground and collect filtration water, under stock piles. The drainage channel will recycle the water back into the lake. Spillage of turbid water from quarry (lake) on adjacent terrain is unlikely, as dredgers will only use water from lake and do not need makeup.

To preserve the natural quality of surface water and prevent potential contamination of water body, in accordance with SanPiN 2.1.4.1110-02 "Protective sanitary zones of drinking water supply sources and pipelines", the designed facilities must be surrounded with protective sanitary zones (PSZ) comprising three belts.

Water supply during the construction phase will be arranged as follows:

Northern dome

- Drinking water – bottled water supply;
- Domestic water supply – transported by road from the temporary water intake facility at quarry No.9G. December 2019 – December 2020 – Imported water from the water intake and treatment facilities (WITF 3) (Phase 1). After December 2020 - Imported water from WITF 3 (Phase 2). Water will be pre-treated before use at the portable temporary water treatment facility (WTF) installed on ground surface at the site of TSF;
- Technical water (e.g. for testing) - Until December 2019 - imported water from the temporary water intake facility at quarry No.9G. December 2019 – December 2020 - Imported water from WITF 3 (Phase 1). After December 2020 - Imported water from WITF 3 (Phase 2).

Central dome

- Drinking water - bottled water supply;
- Domestic water supply - Imported water from the temporary water intake facilities at Quarry No.31N, pre-treated at the portable temporary WTF installed on ground surface at the site of TSF;
- Technical water - Imported water (e.g. for washing and testing) from the temporary water intake facility at quarry No.31N.

Southern dome

- Drinking water - bottled water supply;
- Domestic water supply - Imported water from the temporary water intake facilities at Quarry No.31N, pre-treated before use at the portable temporary WTF installed on ground surface at the site of TSF;
- Technical water - Imported water from the temporary water intake facility at quarry No.31N.

Positions of the water intake and treatment facilities are shown in Figures 5.5a-5.5.f in Chapter 5.

Total construction water demand:

- Domestic – **716.4 m^3/day; 2,267,406 m^3/construction period**;
- For operations - **99 m^3/day; 313,335 m^3/construction period**[55].

Given the small volume of water abstraction, the impact on surface water bodies can be assessed as **local, medium-term and low.**

<u>Change in surface water quantity and quality due to wastewater discharge at the construction phase</u>

GBS LNG & SGC Plant

Drainage systems of the Plant are designed in accordance with the "Zero Discharge" principle, which means that all effluents from the Plant are transported by pipelines and in road tankers to the Sewage Treatment Facilities at the Salmanovskoye (Utrenneye) OGCF (Figure 9.3.1). Treatment processes at WWTP include mechanical, physical-chemical and biological treatment with discharge of effluent treated to meet regulatory standards to nonfreezing surface water body.

[55] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

Associated formation water, construction brine solutions and major part of industrial wastewater will be injected into intake formations.

The Plant construction activities will produce industrial wastewater (from hydraulic testing) and domestic effluents. Estimated volumes of wastewater during the period of construction: wastewater from hydraulic tests – **1388.6 m^3**; domestic wastewater – **64,274 m^3** [56].

Wastewater from hydraulic testing does not contain any harmful or toxic substances. Wastewater will be removed by vacuum trucks to the STF at the onshore facilities' construction camp.

During the main period of construction, runoff water will be collected by the designed gutters to three designed tanks at the wastewater PS (without connecting the pump station to the pressure sewer system). Removal of the collected wastewater will be provided by road tankers with pumps.

Utrenniy Terminal

During construction, the Terminal facilities will generate the following wastewater streams that will be collected by the temporary wastewater networks:

- Domestic wastewater;
- Industrial wastewater;
- Surface runoff (storm, melt water).

Domestic wastewater from the activities of building workers of the onshore facilities will be produced in volumes comparable to the domestic water demand - 106.76 m^3/day, 169,333 m^3/period of construction. Wastewater from washbasins, showers, toilets and other domestic facilities are collected at mobile treatment facility BB-80SF, and treated effluent is subsequently transported to the main site of the Salmanovskoye (Utrenneye) OGCF Facilities Setup.

Domestic wastewater from the activities of the vessels' crew will be accumulated in tanks that will be available at each vessel, and transferred to disposal at the home ports. Total amount of domestic wastewater from vessels will make 18.68 m^3/day, 1,852 m^3/construction period.

Industrial wastewater is bilge water from the technical fleet vessels. The total volume of industrial wastewater (considering the daily maximums) is 6.28 m^3/day, or 0,594 m^3/period of construction. Similarly to the domestic wastewater from vessels, bilge waters are transferred for disposal at the home ports.

A surface runoff drainage system will be provided in hard-paved areas of construction sites, including a network of roads with crushed-stone surface (2.615 ha) and sites of the construction camp, materials and equipment storage paved with RC slabs (10.370 ha). The design flow rates of surface runoff are as follows:

- Daily rain water flow rate – 125.90 m^3/day;
- Daily melt water flow rate – 151.37 m^3/day;
- Annual flow rate – 12,001 m^3/year.

Surface runoff will be collected by gutters to holding tanks and subsequently removed by specialised vehicles to the sewage treatment facilities at the Salmanovskoye (Utrenneye) OGCF Facilities Setup.

Utrenniy Airport

Domestic wastewater will be generated during the airport construction. Washrooms and toilet facilities will be provided at the construction site. Domestic wastewater will be collected in holding tanks located near the sanitary facilities. Wastewater will be evacuated from the holding tanks on a daily basis by sewage vacuum truck and transported to the sewage treatment facilities at the Salmanovskoye (Utrenneye) OGCF Facilities Setup[57].

Salmanovskoye (Utrenneye) OGCF Facilities Setup

The Field facilities will generate the following wastewater streams during construction:

- Domestic wastewater;
- Industrial wastewater;
- Surface runoff (storm, melt water);

[56] GBS Plant for production, storage and offloading of liquefied natural gas and stabilised gas condensate. Design documentation. Section 8. Book 1. Vol. 8.1. List of environmental protection measures – Moscow: NIPIgaspererabotka JSC, 2019, 597 p.

[57] Positive conclusion of the State Expert Review. "Utrenniy" Airport" Project documentation and results of engineering surveys. GLAVGOSEKSPERTIZA. 2019.

- Hydraulic test water;
- Waste methanol-water.

During the period of construction, domestic wastewater (from the construction sites) and contaminated runoff water will be collected in special vessels and transported for disposal to the wastewater treatment facilities at the Field. The volume of domestic sewage disposal corresponds to the domestic and drinking water demand - about **716.4 m³/day; 2,267,406 m³/construction period.**

For the construction needs, water will be spent irreversibly at the rate of **99 m³/day; 313,335 m³/construction period**[58] (for concrete and mortars, watering, charging, washing, etc.). Vehicles washing will be provided at dedicated stations with closed-loop water supply systems.

Surface runoff water flows follow irregular seasonal patterns, and are contaminated with suspended solids and specific surface pollutants (petroleum products). The rain generation volume is estimated on the basis of long-term average annual precipitation and total surface drainage area.

Wastewater treatment stations will be constructed at all sites with significant wastewater streams (otherwise, storage tanks are provided for collection and transportation of wastewater to STFs at other sites).

Contaminated industrial stormwater runoff will be collected in gutters in surface lows at the site perimeters, and transferred to accumulation tanks.

During the period of construction, domestic wastewater (from the construction sites) and contaminated runoff water will be collected in special vessels and transported for disposal to the wastewater treatment facilities at the Contractor's TSF located in the territory of construction support bases.

Domestic sewage and surface runoff will be treated to the fishery standards. It is planned that during the period between December 2019 and December 2020 they will be transported to STF-3 and released via a temporary discharge pipeline to Nyaday-Pynche River. Respective consents and approvals by competent authorities of the RF are already in place.

The treatment facilities reliably treat the flow to meet the quality requirements for discharges to fishery water bodies. Information about the composition of sewage treatment facilities and their capacity is provided in sub-section 9.3.2.2.

Pollution levels in treated effluents meet the water quality standards for fishery water bodies (MACfish), which is confirmed by the facility datasheet, therefore, discharge to water bodies is allowable (Tables 9.3.1, 9.3.2).

Table 9.3.1: Domestic wastewater treatment performance

Description	MAC $_{fish}$ mg/l	Wastewater quality, mg/l	
		Before treatment	After treatment
BOD	3.0	150-350	3.0
Suspended solids	10.0	300	10.0
Ammonia nitrogen	0.4	8 – 35.0	0.39
Phosphates	0.2	13.5	0.2

Source: NIPIGAZ JSC, 2019[59]

Table 9.3.2: Storm water runoff treatment performance

Description	MAC $_{fish}$ mg/l	Wastewater quality, mg/l	
		Before treatment	After treatment
Suspended solids	10.0	400	10.0
Petroleum products	0.05	10-30	0.05

[58] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.
[59] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

BOD	3.0	20-30	3.0

Source: NIPIGAZ JSC, 2019[60]

Completed pipelines and vessels are subject to testing (for sealing and impermeability). The design provides for hydraulic and pneumatic testing of the natural gas pipelines (gas flow-lines). For the hydraulic tests, water will be delivered from the temporary water intakes at the nearest waterbodies. Water demand for washing and hydraulic testing of gas pipelines is estimated at **17,442 m^3**[61]. Spent water from hydraulic testing will be collected in settling basin for removal of suspended solids, and then discharged to surface waterbodies nearby.

Thus, at the construction stage, sanitary and contaminated storm water generated at the Project facilities is accumulated in storage tanks / septic tanks, and later is either transported to the treatment facilities of the Third Party (Urengoy Vodokanal) under an agreement, or is treated at the treatment facilities to the fishery standards and discharged into a water body based on the Decision on the provision of a water body for use for the discharge of treated effluents. The Company will continuously monitor compliance with wastewater management requirements under the Wastewater Management Plan for the construction phase.

Given that the designed treatment facilities are capable of treating all wastewater flows to the fishery standard, the impact on surface water can be assessed as **local, medium-term, and low.**

[60] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

[61] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

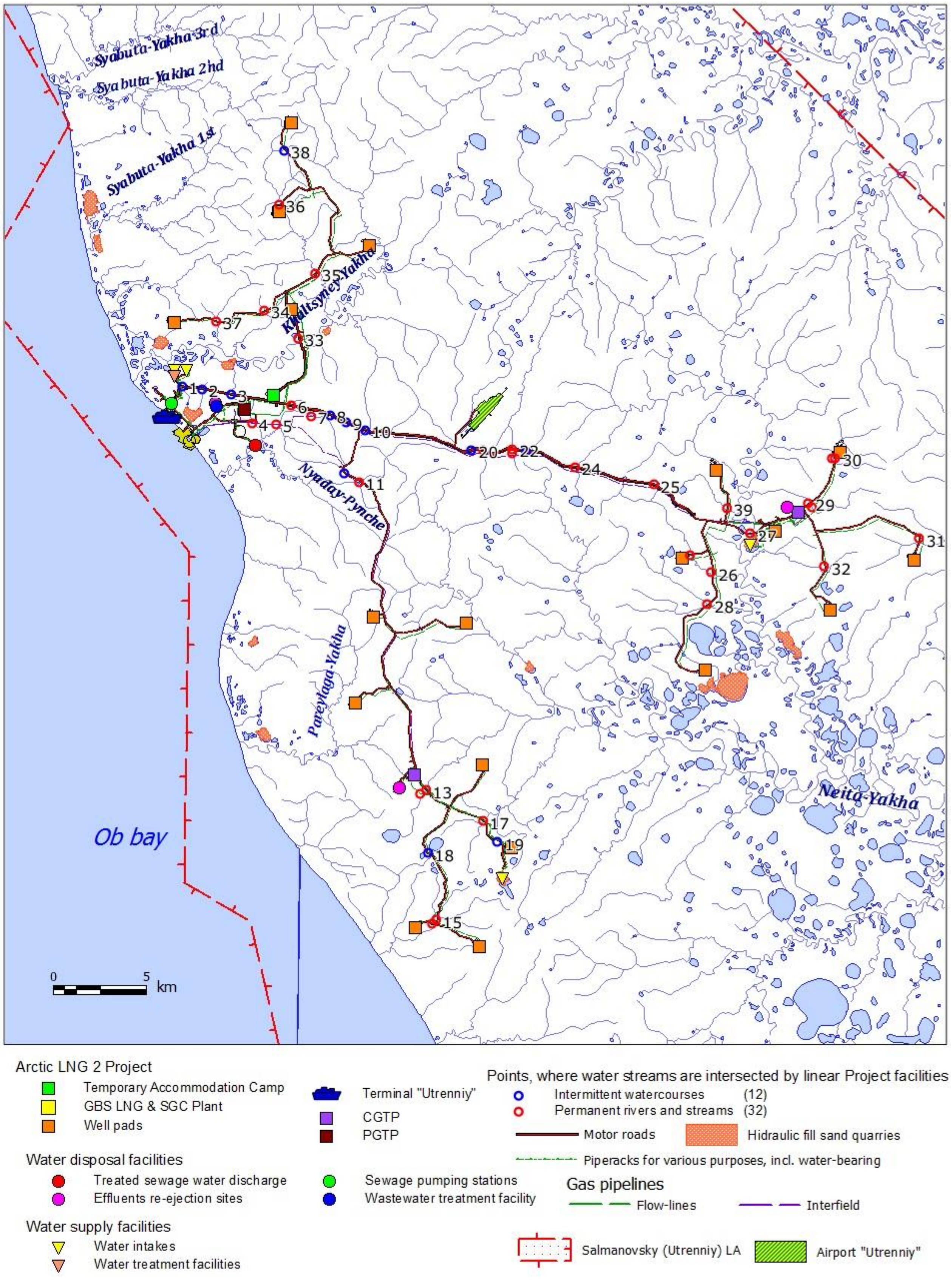

Figure 9.3.1: Potential impact sources of the Arctic LNG 2 Project on surface waterbodies.

Source: Ramboll, 2020

9.3.2.2 Operation

During the facilities' operation, the impact on surface water will be less marked than at the construction phase. It can be notable in relation to the water intake (for domestic, drinking and process needs), disposal of treated effluents (injection to formation), and also in case of accidental loss of integrity of pipelines during the period of operation. This impact may alter hydrological conditions in the waterbodies, and surface water quality.

Natural water abstraction for water supply

Water for domestic, drinking, process and firefighting needs can be taken from a surface water source.

The following water intake facilities are designed:

Northern dome

Water intake 3.1, 3.2 with water treatment facilities - unnamed lake (meander lake at Khaltsyney-Yakha River, water intake 3.1), and sand quarry No.25N (water intake 3.2). This water intake is intended to supply water to PGTP3, GBS LNG&SGC Plant, Untrenniy Terminal, temporary accommodation camp (TAC), administrative area, Emergency Rescue Centre (ERC), field camp (FC), water treatment plant (WTP-3), process and fire water pump station at the sewage treatment facilities (STF-3). Capacity of water intake facility No.3.1 on the unnamed lake (meander lake at Khaltsyney-Yakha River) and No. 3.2 at sand quarry No.25N is **85 m³/hour**.

Two pipelines installed on rack above ground (with thermal insulation and trace heating) will transport water from water intake No.3.1 on the Khaltsyney-Yakha River meander to

- WTP-100, for household and drinking water supply (construction Phase 1);
- Water treatment plant WTP-3, for household, drinking, process and fire water supply (construction Phase 2).

Water intake facility No.3.2 is a backup facility for water intake No.3.1. It will abstract water from surface source (sand quarry No.25N) and transport it by two offsite pipelines V34e with nominal diameter 150 (above-ground installation on racks, with thermal insulation and trace heating) to water treatment plant WTP-3, for household, drinking, process and fire water supply (construction Phase 2).

Central dome

Water supply for CGTP1 site will be provided from water intake No.1 on quarry No.31N. Capacity of water intake facility No.1 at sand quarry No.31N is **40 m³/hour.**

The 1st lift pumping station 40 m^3/h at water intake facility No.1 at sand quarry No.31N will transfer water by two pipelines (above ground installation on rack, with thermal insulation and trace heating) to the raw water storage tanks V=100 m3 (2 units) at the water treatment facility at the site of CGTP1. From the raw water tanks, water is fed to pre-treatment unit capacity 1050 m^3/day for process needs, and to water treatment unit WTP-100 capacity 100 m^3/day serving the demand of CGTP1 for drinking water. Treated water is supplied to the process and fire water storage tanks V=2000 m^3 (2 units) and subsequently pumped to consumers of process and fire water at the site of SGTP1 with a pump group at the water treatment unit.

Southern dome

Water supply for CGTP2 site will be provided from water intake No.2 on quarry No.2G. Capacity of water intake facility No.2 at sand quarry No.2 is **40 m³/hour.**

The 1st lift pumping station 40 m^3/h at water intake facility No.2 at sand quarry No.2G will transfer water by two pipelines (above ground installation on rack, with thermal insulation and trace heating) to the raw water storage tanks V=100 m^3 (2 units) of the water treatment facilities at CGTP2 site (WTP CGTP2). From the raw water tanks, water is fed to water treatment facilities comprising a pre-treatment unit capacity 1050 m^3/day for the site process needs, and drinking water treatment unit capacity 110 m^3/day serving the demand of CGTP1 for drinking water. Pre-treated water will be supplied to process and fire water storage tanks V=2000 m^3 (2 units), and drinking water will be pumped to domestic and drinking water tanks V=75 m^3 (2 units).

To preserve the natural quality of surface water and prevent potential contamination of water body, in accordance with SanPiN 2.1.4.1110-02 "Protective sanitary zones of drinking water supply sources and pipelines", the designed water abstraction facilities are surrounded by protective sanitary zones (PSZ) comprising three belts.

Summary of the Project facilities water demand:

- CGTP-3 (Northern dome) – **370,862 m³/year** (including process demand 53,551 m³/year); domestic and drinking water 317,311 m³/year);
- CGTP-1 (Central dome) – **15,046 m³/year** (including process demand 6,974 m³/year); domestic and drinking water 8,072 m³/year);
- CGTP-2 (Southern dome) – **15,602 m³/year** (including process demand 7,194 m³/year); domestic and drinking water 8,408 m³/year)[62];

Permitted volume of water abstraction in the water management section WMS 15.05.00.002[63] (WMS where the water intake facilities of the Arctic LNG 2 Project are located) is 4106 M m³/year.[64] Water intake for the Project operation will make up about 0.03% of the permitted volume of abstraction. Therefore, the impact on waterbodies of the Gydan Peninsula caused by water abstraction for domestic, drinking and process needs of the Arctic LNG 2 Project operation will not exceed the allowable limits of impact approved for the water catchment area by Lower Ob Basin Authority of the Federal Water Resources Agency.

Of the established water abstraction limits are complied, and considering the small volume of consumption compared to the permitted volume of water abstraction, residual impact on surface water can be assessed as **local, long-term, low.**

<u>Change in surface water quantity and quality due to wastewater management at the operation phase</u>

Negative impact on surface water during the facilities' operation is possible in case of incorrect wastewater management practices (discharge of polluted water from industrial sites, accidental uncontrolled discharge of untreated and/or inadequately treated wastewater).

Pollution of the environment will be prevented by providing adequate utility systems for collection and disposal of all wastewater flows from the Project facilities: domestic sewage, industrial and fire, and process wastewater drainage networks.

Drainage systems of the Project are designed in accordance with the "Zero Discharge" principle, which means that all effluents from the Plant are transported by pipelines and in road tankers to the Sewage Treatment Facilities (STF) at the Salmanovskoye (Utrenneye) OGCF. It is supposed to install treatment plants at STF for:

- Domestic wastewater;
- Storm/melt water,
- Industrial wastewater and storm water;
- Chemically contaminated wastewater.

Domestic sewage and storm/melt water will be treated at the STF using mechanical, physical-chemical and biological processes (with mandatory disinfection). Effluent treated to meet the established standard will be discharged to Nyaday-Pynche River.

Associated formation water, construction brine solutions and major part of industrial wastewater will be injected into intake formations (designed location of the respective facilities is near the sites of CGTP1, CGTP2 and PGTP3, Figure 9.3.1). Hydrogeological conditions of the Salmanovskoye (Utrenneye) OGCF are tentatively considered to be conducive for disposal of formation water and utility/process water; the apt-alb-senomansky aquifer system is best suited for the purpose. Also, the lost circulation stratum is well isolated from the surface, therefore, it has sufficient capacity for long-term disposal of large quantities of wastewater.

Total volumes of wastewaters managed at the Salmanovskoye (Utrenneye) OGCF facilities are shown in Table 9.3.7.

The design provides for several different systems for wastewater disposal:

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[62] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

[63] Rivers in the Kara Sea catchment area, from north-eastern boundary of Taz River catchment to boundary of Yenisei Estuary of Taz

[64] The Federal Agency for Water Resources "Standards of permissible impact on surface water in the water management sections of Taz River catchment area. Standards of permissible impact on water management section 15.05.00.002" [online resource]. URL: http://nobwu.ru/index.php/ndvskiovo

Northern dome

Disposal systems for the following wastewater streams will be provided at the **Plant** site:

- Domestic wastewater;
- Industrial wastewater and storm water;
- Storm water;
- Industrial wastewater;
- Waste methanol-water.

Industrial wastewater and storm water runoff will be pumped to the onshore facilities and further to the site of STF-3. Domestic wastewater from buildings/modules will flow by gravity to cylindrical steel vessels with a rated capacity of 105 m^3 accommodated in the interior of each Process Train. From the vessels, material will be regularly removed by road tankers and transported to the STF-3.

Wastewater management systems at the sites of **Utrenniy Terminal** are intended to handle the following wastewater streams:

- Domestic wastewater;
- Industrial wastewater;
- Storm water.

Domestic and industrial wastewater and stormwater from the sites will be transported by road to STF-3 (Figure 9.3.1).

Wastewater management systems at the sites of the **Utrenniy Airport**[65] are intended to provide separate management of the following wastewater streams: domestic, industrial, storm water.

Domestic wastewater are collected in the site domestic wastewater network of gravity and pressure pipelines, and directed to the local holding tanks which are provided near each building. Grease separators are provided for treatment of wastewater from the cafeteria and canteen. From the local holding tanks, wastewater is pumped to two holding tanks, 100 m^3 each. When accumulated, domestic wastewater is removed by specialised vehicles to the sewage treatment facilities at the Salmanovskoye (Utrenneye) OGCF Facilities Setup.

Two tanks 25.0 m^3 each are provided for collection of technical wastewater from the boiler plant, from where wastewater is removed to the sewage treatment facilities at the Salmanovskoye (Utrenneye) OGCF Facilities Setup.

Industrial sewerage system (K3) is designed for disposal of potential accidental spills of propylene glycol from the premises of ventilation chambers. Cast iron traps are provided in the floors, to collect spills and emergency discharges of propylene glycol from the premises of ventilation chambers, with further transfer to portable 50 m^3 steel drums. The collected liquid is then transferred for disposal.

Wastewater with mechanical impurities from vehicles washing (K5) is designed to collect contaminated wastewater from parking garages No.1 and No.2, vehicle maintenance shops, and to transfer the collected wastewater to the water treatment and recycling system. The treatment system includes mechanical screening of debris and suspended solids, removal of petroleum products, chemical treatment and flotation, and polishing filtration. Treated water is recirculated to the washing facility for reuse.

The storm water system is designed to collect and remove rain and snow-melt water. Contaminated surface runoff from the territory of apron, service area, bunded POL storage site, roof of the air terminal building is collected in holding tanks for settlement, after which water is pumped to the local treatment facilities at the Utrenniy Airport. Treated wastewater is directed to a 2150 m^3 holding tank and utilised for technical needs of the Airport (watering of the territory).

A special site is provided at the Airport for de-icing of aircraft in winter, with a system of gutters and grates for collection of de-icing fluid (DIF). At the special site, wastewater with DIF will be collected in a 5m^3 metal tank, and removed for disposal when the tank is full.

The **site of PGTP-3** will be equipped with separate systems for

- Domestic wastewater;
- Industrial wastewater and storm water;

[65] Utrenniy Airport. DD. Section 8. List of Environmental Protection Measures. Part 1. Book 1. Design Institute KRASAEROPROEKT

- Chemically contaminated wastewater.

Wastewater from the designed industrial facilities will be removed by a combined pumped transport system for domestic wastewater, industrial and storm water, and chemically-contaminated wastewater.

Three treatment units are provided at the site of STF-3:

- Domestic wastewater;
- Industrial wastewater and storm water;
- Chemically contaminated wastewater.

The STF-3 facilities include the following elements:

- Domestic wastewater treatment station, rated capacity 1000 m^3/day, backup capacity 1200 m^3/day;
- Industrial wastewater and storm water runoff treatment unit, capacity 3000 m^3/day, backup capacity 3600 m^3/day;
- Chemically contaminated wastewater treatment unit, rated capacity 2000 m^3/day, backup capacity 2400 m^3/day;
- Dewatered sludge temporary storage site;
- Domestic wastewater drainage station;
- Storm water drainage station;
- Industrial wastewater and runoff equalization tanks No.1, No.2 V=5000 m^3;
- Recovered petroleum products tank V=100 m^3;
- Chemically contaminated wastewater equalization tanks No.1, No.2 V=1000 m^3;
- Chemically contaminated wastewater drainage station;
- Treated effluent equalization tanks No.1, No.2 V=700 m^3;
- Site drainage network.

The sewage treatment facilities are intended for reception, treatment of domestic, industrial (contaminated with chemicals and petroleum products), runoff wastewater from the process facilities at the sites of WTP-100, WTP-3, STF-100, STF-3, GTPP, fuel depot, methanol storage, solid municipal, construction and industrial waste disposal site, process and fire water supply system at PGTP3, and PGTP3, before disposal.

The rate of domestic wastewater generation is 689 m^3/day; 236,765 m^3/year. Industrial wastewater generation rate is 728.51 m^3/day; 110,831.5 m^3/year. The rate of storm water runoff generation is 11,750.8 m^3/day, 243,399 m^3/year[66].

Central dome

At the **site of CGTP1**, the design provides for separate systems for the following wastewater streams:

- Domestic wastewater;
- Potentially contaminated wastewater from firefighting;
- Industrial wastewater and storm water.

At the CGTP1, STF facilities include the following elements:

- Sewage bio treatment plant capacity 20 m^3/day;
- Industrial wastewater and storm water treatment plant capacity 800 m^3/day;
- Two industrial wastewater and runoff equalization tanks V=1000 m^3 each;
- Two treated effluent equalization tanks V=400 m^3 each;
- Petroleum products collection tank V=10 m^3;
- Industrial wastewater collection tank with a pump, V=25 m^3 (1 unit);
- Domestic wastewater filling station V=50 m^3.

The collection tank with a pump for potentially polluted wastewater is intended to collect potentially contaminated wastewater from internal firefighting in buildings at the site of CGTP1. From the tanks, wastewater will be transferred to the industrial wastewater and storm runoff equalisation tanks at the CGTP1 STF.

The industrial wastewater and storm runoff collection tanks are intended for collection and pumping of industrial wastewater and surface runoff contaminated with petroleum products, methanol and gas

[66] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

condensate, and for collection of pump seal oil, leaks from the boiler house, etc. From these tanks, wastewater will be transferred to the industrial wastewater and storm runoff equalisation tanks at the CGTP1 STF.

The wash water effluent tank with a pump is intended for accumulation and neutralisation of wash water from the water treatment facilities, before transfer to the industrial wastewater and storm runoff equalisation tanks at the CGTP1 STF, or to the raw water storage tanks at the WTP.

The WTP facilities at CGTP1 - water treatment plant and WTP-100 unit - will be provided with collection systems for wastewater from washing of floors and drainage devices, and sludge discharged at emptying of tanks. Wastewater will flow by gravity underground network to the industrial wastewater collection tanks, and further transferred to the industrial wastewater and storm runoff equalisation tanks at the CGTP1 STF.

Treated effluent will be directed to the effluents re-injection site (ERIS-1).

The rate of domestic wastewater generation is 10.25 m^3/day; 3753 m^3/year. Generation rate of industrial wastewater is 214.94 m^3/day; 9318 m^3/year, of storm water runoff - 139 m^3/day; 1211 m^3/year[67].

Southern dome

At the **site of CGTP2**, the design provides for separate systems for the following wastewater streams:

- Domestic wastewater;
- Potentially contaminated wastewater from firefighting;
- Industrial wastewater and storm water.

The WTP and STF are provided as part of CGTP2. The CGTP2 STF facilities include the following elements:

- Sewage bio treatment plant capacity 20 m^3/day;
- Industrial wastewater and storm water treatment plant capacity 800 m^3/day;
- Two industrial wastewater and runoff equalization tanks V=1000 m^3 each;
- Two treated effluent equalization tanks V=400 m^3 each;
- Petroleum products collection tank V=10 m^3;
- Industrial wastewater collection tank with a pump, V=25 m^3 (1 unit);
- Domestic wastewater filling station V=50 m^3.

The collection tank with a pump for potentially polluted wastewater is intended to collect potentially contaminated wastewater from internal firefighting in buildings at the site of CGTP2. From the tanks, wastewater will be transferred to the industrial wastewater and storm runoff equalisation tanks at the CGTP2 STF.

The industrial wastewater and storm runoff collection tanks are intended for collection and pumping of industrial wastewater and surface runoff contaminated with petroleum products, methanol and gas condensate, and for collection of pump seal oil, leaks from the boiler house, etc. From these tanks, wastewater will be transferred to the industrial wastewater and storm runoff equalisation tanks at the CGTP2 STF.

The water treatment plant and industrial and fire water pumping station at CGTP2 will be provided with collection systems for wastewater from washing of floors and drainage devices, and sludge discharged at emptying of tanks. Wastewater will flow by gravity underground network to the industrial wastewater collection tanks, and further transferred to the industrial wastewater and storm runoff equalisation tanks at the CGTP2 STF.

Treated effluent will be directed to the effluents re-injection site (ERIS-2).

The rate of domestic wastewater generation is 10.28m^3/day; 3760 m^3/year. Generation rate of industrial wastewater is 311.52 m3/day; 10140 m3/year, of storm water runoff – 6 m3/day; 1703 m3/year[68].

The sewage treatment facilities will reliably treat domestic wastewater and storm runoff to meet the standard requirements for discharge to fishery waterbodies (Tables 9.3.3-9.3.6).

[67] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

[68] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

Table 9.3.3: Domestic wastewater treatment performance

No.	Pollutant	Unit	Pollution concentration		MAC fish
			Before treatment	After treatment	
PGTP3					
1	Suspended solids	mg/l	80 ÷ 260	10.0	10.0
2	BODtot	mgO_2/l	90 ÷ 400	3.0	3.0
3	Ammonia nitrogen	mg/l	40 ÷ 80	0.4	0.4
4	Phosphates (P)	mg/l	8 ÷ 15	0.2	0.2
5	Surfactants	mg/l	3 ÷ 4.5	0.5	0.5
6	Nitrite ion	mg/l	0.02 ÷ 0.05	0.08	0.08
7	Nitrate ion	mg/l	1 ÷ 10	0.5	40
8	Hydrogen index		6.5 ÷ 8.5	6.5÷8.5	In line with the background values
CGTP1/CGTP2					
1	Suspended solids	mg/l	80 ÷ 260	10	10.0
2	BODtot	mgO_2/l	90 ÷ 400	3.0	3.0
3	Ammonia nitrogen	mg/l	40 ÷ 80	1.5	0.4
4	Phosphates (P)	mg/l	1 ÷ 10	0.2	0.2
5	Surfactants	mg/l	0.02 ÷ 0.05	0.5	0.5
6	Nitrite ion	mg/l	8 ÷ 15	3.5	0.08
7	Nitrate ion	mg/l	3 ÷ 4.5	0.5	40
8	Hydrogen index		6.5 ÷ 8.5	6.5÷8.5	In line with the background values

Source: NIPIGAZ JSC, 2019[69]

Table 9.3.4: PGTP3 storm water runoff treatment performance

Description	Wastewater quality, mg/l		MAC fish
	Before treatment	After treatment	
Suspended solids	4000	10.0	10.0
Petroleum products	75	0.05	0.05
BOD	110	3.0	3.0

Source: NIPIGAZ JSC, 2019[70]

Table 9.3.5: Parameters of chemically contaminated wastewater (continuous mode) at the inlet of PGTP3 chemically contaminated wastewater treatment unit

Pollutant	Inlet concentration, mg/l	Concentration before reinjection, mg/l, maximum	Disposal
Methanol	50,000	40,000	Injection into deep formation (ERIS-3)
Salts	15,000	14,000	
Suspended solids	500	300	
Amines	500	400	
Glycol	500	400	

[69] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

[70] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

Pollutant	Inlet concentration, mg/l	Concentration before reinjection, mg/l, maximum	Disposal
Heating oil	500	150	
Dissolved oxygen	0.4	0.5	
BOD	-	100	
COD	-	1900	

Source: NIPIGAZ JSC, 2019[71]

Table 9.3.6: Parameters of chemically contaminated wastewater (continuous mode) at the inlet of chemically contaminated wastewater treatment unit at CGTP1 and CGTP2

Pollutant	Inlet concentration, mg/l	Concentration before reinjection, mg/l, maximum	Disposal
Methanol	50000	40000	Injection into deep formation (ERIS-1 and ERIS-2)
Salts	15000	14000	
Suspended solids	500	300	
Amines	500	400	
Glycol	500	400	
Heating oil	500	150	
Dissolved oxygen	0.4	0.5	
BOD	-	100	
COD	-	1900	

Source: NIPIGAZ JSC, 2019[72]

Given that the designed treatment facilities will treat domestic wastewater and storm runoff to fishery standard before discharge to Nyaday-Pynche River, and that industrial wastewater and storm water runoff from the Project operational facilities will be injected into deep formation, residual impact on surface water can be assessed as **local, long-term, low.**

[71] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

[72] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

Table 9.3.7: Combined water and wastewater balance of the Salmanovskoye (Utrenneye) oil, gas, and condensate field

Consumer	Water demand, m^3				Wastewater disposal, m^3				Permanent losses, m^3		Storm runoff, m^3	
	Domestic and drinking		Process		Domestic		Industrial					
	year	day	year	day	year	day	year	day	year	day	year	day
Domestic and potable water consumption	255,997	746.37			244,278	709.27			11,719	37.1		
Production needs	77,794	220.34	67,719	1234.68			130,288	1158.45	15,225	296.57		
Total:	**333,791**	**966.71**	**67,719**	**1234.68**	**244,278**	**709.27**	**130,288**	**1158.45**	**26,944**	**333.67**	**246,313**	**11,895.8**
Total water demand, including	401,510 m^3/year; 2201.39 m^3/day											
Total wastewater disposal, including:	620,879 m^3/year; 13,763.5 m^3/day											
Discharge to waterbody	543,891.6 m^3/year; 4800 m^3/day*											
Injection into the absorbing strata	76,987.5 m^3/year; 1548.97 m^3/day											

*Daily flow of wastewater disposed into the waterbody is determined by the sewage treatment capacity (1200 m^3/day and 3600 m^3/day), considering the equalisation tanks

Source: NIPIGAZ JSC, 2019[73]

[73] Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Design documentation. Section 8. Part 5 "Assessment of impact on water resources". Book 1. Text part. Vol. 8.5.1. List of environmental protection measures – NIPIgaspererabotka JSC, 2019. 73 p.

Emergency Impacts

The main causes of potential accidents during operation of the Project facilities are disruptions of technological processes, erroneous actions of operating personnel, disregard of fire safety rules and work safety regulations, failure of power and water supply, disruption of wastewater disposal, natural disasters, mechanical damage of pipelines, extreme weather events, terrorist attacks, etc.

Transported products (hydrocarbons) may leak from damaged (gas) pipelines.

Failures and/or bursts of wastewater pipelines installed above ground may result in spillage of contaminated wastewater.

Pollution of waterbodies with untreated and/or inadequately treated wastewater in case of uncontrolled accidental discharge. Those may include sanitary wastewater from human life activities (with pollutants such as surfactants, phosphates, nitrogen compounds, suspended solids, etc.), and other contaminated wastewater streams from operation of the Salmanovskoye (Utrenneye) OGCF facilities.

Pollution concentrations in untreated wastewater are by dozens and hundreds times higher than in treated effluent, and significantly higher that the applicable limit levels (MACfish).

Therefore, accidental discharge/leak would result in short-term local contamination of the affected section of waterbody and contribute to the level of pollution.

In case of emergency, including accidental discharge of wastewater, response measures should include prompt closure of the pollution source and containment of affected section of waterbody in compliance with spill prevention and response plans.

Compliance with the safety rules, adhering to the work plan and technical design, and timely inspection of equipment will prevent potential accidents.

During normal operation of the Project facilities, and after adequate spill prevention and response measures, residual impact on surface water can be assessed as negligible.

More details of potential accidents and their impact on surface water are provided in Section 9.8. Risks of chemical spills at sea and preventive measures against surface water contamination are covered in Sub-section 9.3.3 – Impacts on the Ob Estuary marine environment.

9.3.3 Impacts on the Ob Estuary marine environment

9.3.3.1 Construction

Construction activities directly in the Ob Estuary water areas include construction of the sea port access channel and preparation of the inner port area, transportation and installation of GBS with topside process modules, connection of the process trains to the onshore infrastructure, and the final cycle of commissioning.

The internal water area of the Port is comprised of:

- Turning basin for vessels U-turn on the way to and from the jetties; and
- Operating basins at the jetties designated for berthing, re-berthing and maneuvering.

The access channel is meant for the safe Port entry/departure of vessels.

The following activities may be responsible for impact on the Ob Estuary water area during the construction phase:

- Dredging activity including soil extraction and dumping in the Ob Estuary;
- Construction activity in the Ob Estuary water protection zone;
- GBS commissioning;
- Ship traffic in the Port's water area; and
- Water abstraction for water supply needs, and discharge of insufficiently treated wastewater.

The marine environment during construction may be exposed to negative impacts such as emergency spills of petroleum products and other hazardous chemicals.

The impact assessment should recognise the fact that water area within the ice barriers is negligible compared to the total dimensions of the Ob Estuary[74]. The area protected by barriers is only 4 km in length and 2 km in width. The width of the concerned section of Ob Estuary in about 40-45 km, distance to the outlet to the open area of Kara Sea and to the crossing of the Ob Estuary and Taz Estuary is 200-250 km. Therefore, the protected area width makes up 4-4.5% of the width of the Estuary, and its length is about 1.5-2% of the characteristic distances along the Ob Estuary main channel.

<u>Dredging-associated risks</u>

The following impacts are possible in relation to the planned dredging activities:

- Impact of suspended bottom sediment on the water quality in the dredging and dumping area, and deposition on the seabed; and
- Impact on marine flora and fauna through disturbance to habitats at the dredging and dumping sites (direct impact), and nuisance factor.

Description of dredging operations and their potential impact on the marine environment is provided below.

Port water area and access channel construction

Construction of the Port provides for dredging to secure approach of ships carrying construction cargoes and oversize modules for the Plant construction, and of tankers for LNG and SGC offloading from the operational Plant.

Dredging will be carried out in two steps according to the Port construction schedule (GT Morstroy CJSC, 2017)[75] LENMORNIIPROEKT, 2019[76]:

- Startup Package 1 (PK 1) – early phase facilities (EPF); and
- Startup Package 2 (PK 2) – operating phase facilities (OPF).

PK 1 will include construction of the access channel to provide berthing approach/heading out for building cargo carriers.

The PK 1 (EPF) access channel parameters:

- Length – 2,600 m;
- Width – 225 m;
- Bottom level – minus 13.0 m (BSD).

PK 2 (OPF) will comprise expanding of the intra-port and access channel water areas, which is necessary for installation of the three Process Trains and giving space for a safe cargo turnover in accordance with the Plant construction schedule:

- Process Train 1 – Q III, 2023;
- Process Train 2 - 2024;
- Process Train 3 – 2026.

The PK 2 access channel parameters:

- Length – 5,700 m;
- Width – 495 m;
- Bottom level – minus 15.00 m (BSD).

The client for the dredging works in relation to construction of federal ownership facilities (access channel, port water area) is FSUE Hydrographic Enterprise (a part of Rosatom State Corporation). Dredging in the Investor's responsibility area include excavation of pit for GBS and seabed reinforcement.

The total volume of soil to be dredged for the EPF and OPF, including the access channel, maneuvering and operating basin of the Port, and GBS towage area, will roughly be 26.70 million m^3 (LENMORNIIPROEKT, 2019), including:

- For the Terminal (Port) construction, subject to subsequent maintenance in serviceable condition:

[74] Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas. Final Report. IEPI JSC. 2020. 287 p.
[75] Utrenniy Liquefied Natural Gas and Stabilised Gas Condensate Terminal. Main technical solutions. Document code 89.03.14.8.061-OTP. StPb. GT MORSTROY CJSC, 2017.
[76] Terminal of the liquefied natural gas and stabilized condensate "Utrenniy". Introducing updates and additions to the project documentation. Section 8. Part 1. Environmental impact assessment and environmental protection measures. Book 1. Narrative.

   - Stage 1 – 5,606,500 m^3;
   - Stage 2 - 11,849,145 m^3;
   - Stage 3 - 8,646,930 m^3;
- One-time dredging for GBS down to minus 17 m BSD
   - GBS1- 248,950 m^3
   - GBS2 and GBS3 - 347,990 m^3

Impact on bottom soil

Dredging will entail redistribution of bottom sediments and modification of the physicochemical properties of soils. At the soil excavation sites, dredging will slightly decrease the load on underlying soil, however without any notable consequences.

The excavated soil will be relocated to the Ob Estuary sections intended for soil dumping, which will result in increasing pressure on the bottom in the dumping area. Bottom soils have a uniform areal distribution without local points of excess pressure. Self-compaction of soil will occur on the bottom under the action of soil own weight and, as a result, there will be less soil stirring and hence turbidity.

In accordance with Part 2 of Article 37 of the Federal Law dated 31.07.1998 No. 155-FZ "On internal marine waters, the territorial sea and the adjacent zone of the Russian Federation", disposal of soil excavated in the course of dredging in inland sea and territorial sea of the Russian Federation is permissible provided that the content of regulated pollutants (mentioned in the list approved by the RF Government Instruction No. 2753-r of December 30 2015) in the soil does not exceed the background levels in soil in the dumping area prior to the impact of the soil dumping.

In 2017, Fertoing LLC conducted environmental surveys in the water area section tentatively allocated to dumping of the soil excavated during construction of the berth structures. Figure 9.3.2 shows the layout of soil dumping sites in the Ob Estuary. According to decision adopted at a later stage, one site (located in the north) will provide enough capacity for dumping of soil. Site in the south will not be used for dumping.

The surveys comprised soil sampling and analysis of concentrations of petroleum products, phenols, heavy metals, organochlorine pesticides (OCP), polychlorinated biphenyls (PCB), and other pollutants. Since quality assessment standards for bottom sediments are currently unavailable, bottom sediment contamination at the dumping site was assessed against MPC for soils.

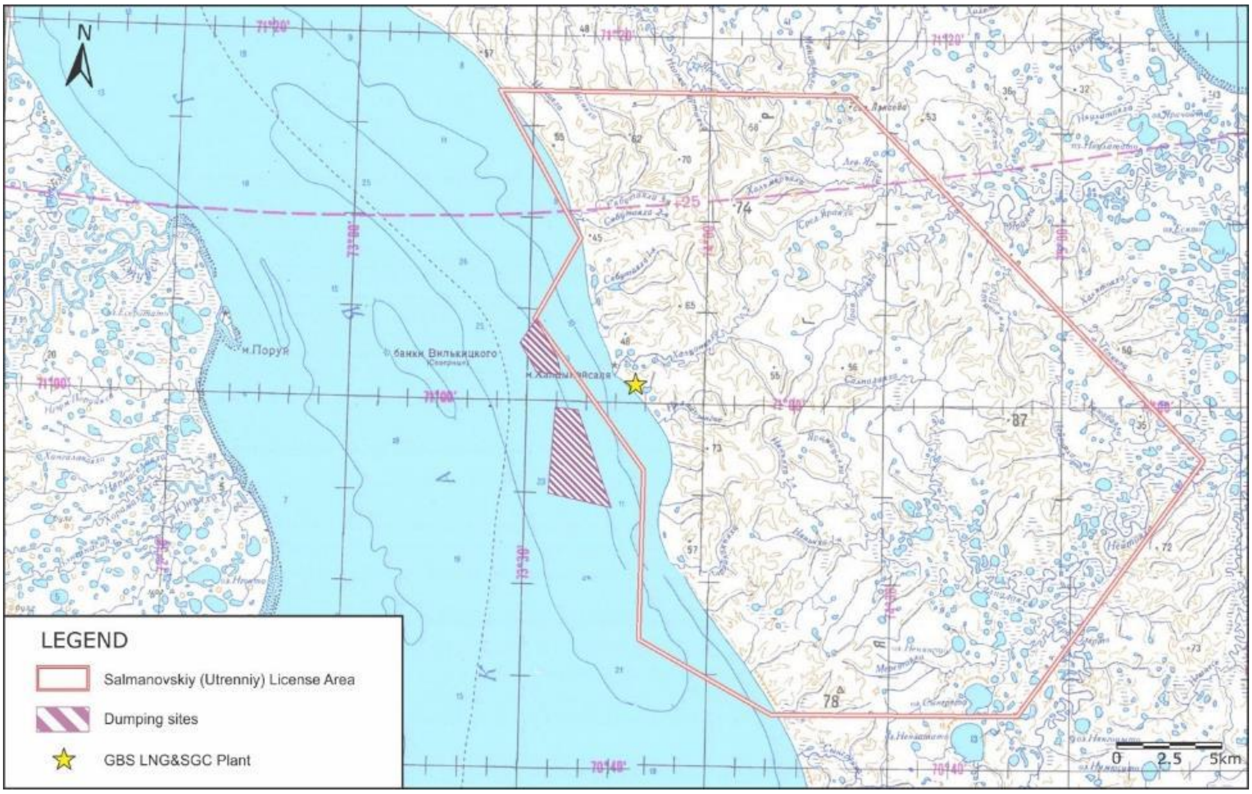

Figure 9.3.2: Location scheme of dredged soil dumping sites in the water area of the Port and access channel

Source: Fertoing LLC, 2017

The results indicated that concentrations of some microelements in bottom sediment at the designed dumping sites exceeded MPC for soils: by copper 4.6-fold, by zinc – 2-fold, by arsenic up to 5.5-fold, and by nickel from 2.4- to 6.5-fold. There are no sufficient grounds for evaluating chemical contamination of the tested samples: heavy metals and arsenic accumulation may be due to natural chemistry of the local substrate, or it may be explained by a long-term gradual accumulation of the elements from water flow by precipitating mechanisms (for suspended particulate matter) or sorption (for soluble substances). A comparison with the globally recognised Dutch lists[77] allows a conclusion on environmental safety of the tested bottom sediments against environmental standards of the European Union.

Chemical and radioactive contamination levels of sediments in the designed dredging areas has also been recognised as safe, no derivatives of oil, phenols, organochlorides and benzo[a]pyrene were found in the sediments (with the exception of one sample), while concentrations of heavy metals, arsenic and radioisotopes were similar to background levels.

The fact that chemical characteristics of soil to be disposed are comparable with the soil quality at the dumping site allows a conclusion on **negligible** impact of underwater soil dumping on bottom sediment, provided that proper dumping technology is observed.

Impact on the aquatic environment

The main impact of underwater technical operations on water environment is an increase in water turbidity caused by soil excavation/underwater dumping with subsequent suspended particulate matter precipitation and a higher rate of bottom sediment accumulation in the corresponding part of the water area. Also, there is a likelihood of secondary water pollution by pollutants migrating from bottom soil to water. Moreover, it is important to consider these impacts because of the sensitivity of their receptors – aquatic organisms inhabiting mid-waters, primarily fish, and seabed (benthos communities). The species composition, value and sensitivity of hydrobionts are detailed in Subsection 7.6.2.

Dredging produces a plume of resuspended bottom sediments. As the level of contamination of seabed sediments in the Ob Estuary is low, the risk of secondary chemical contamination of water during the underwater technical operations is low. Potential suspended sediment impact will be primarily related to the physical content of suspended solids in the plume and its subsequent precipitation on the bottom.

The plume from dredging activities will drift following the direction and velocity of currents which, in this part of the Ob Estuary, depend on a number of factors including tidal circulation, downsurge/upsurge effects, mixing of river effluent and sea intrusions in the setting of ice formations during a larger part of the year (refer to Section 7.3 for details).

In terms of temporal extent, the impact is expected to be long-term because suspended particulate matter and accompanying pollutants can migrate from bottom soil to seawater not only in the construction phase of the Plant and Port’s offshore engineering facilities but also during the whole period of their operation due to the regular maintenance dredging.

The following measures are designed to mitigate the impact of dredging on the marine environment in the Ob Estuary:

- Loading of self-propelled hopper barges through a floating dredge fill pipeline to avoid utility water spillage overboard;
- Unloading of material from hopper barges at the dump site only when the craft has fully stopped (adrift);
- During backhoe dredger operation, lowering the bucket as close as possible to the water surface in the hopper barge hold, to avoid spillage and splashing of slurry;
- Making sure that bucket is filled with ground by 75 % (with no neap), to prevent ground release back into water;
- Chemical analysis to control of water quality of the Ob Estuary before, during and after dredging;
- Continuous operational monitoring of compliance with the technology for underwater technical operations.

Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas (IEPI JSC, 2020) in 2019 included suspended solids dispersion modelling for the scope of dredging required for construction of the access channel and the Port water area, without

[77] Soil Remediation Circular. - Netherlands. Ministry of Infrastructure and Water Management (Rijkswaterstaat), 2013

excavation of pit for GBS. Simulations were run according to the dredged soil volumes at different stages of the works.

The following conclusions have been drawn from the simulation outputs.

Maximum levels of turbidity are identified for Phases 1-3, due to the largest volumes of soil to be extracted by dredging in the area of existing berths, and in the construction area of the quay and access channel. Activities at subsequent stages will cause a less significant increase in turbidity, due to the small volumes of soil dredging and dumping.

During Phase 1, maximum contribution to turbidity is expected in the immediate area of dredging - at the berths and access channel. The minimum threshold concentration of suspended solids when the first signs of adverse effects in the marine biota can be observed, is 10 mg/l[78]. The plume with suspended solids concentration over 10 mg/l is observed within a distance range of 5 km from the work site. Further to the north of the work site, at a distance of 15-20 km, turbidity levels are within 0.25 mg/l. Notably, turbidity plume extends to a significantly longer distance to the north than to the south. This is mainly due to the northward transport of water.

The longest distance of suspended solids transport is expected during Phase 2, due to the large volume and area of dredging for the access channel. However, the increase in turbidity plume area and concentration of suspended solids will be insignificant compared to those predicted during Phase 1. The distance of northbound transport of suspended solids will be slightly longer, with concentrations higher than 0.25 mg/l. Suspended solids concentrations up to 10 mg/l may be observed at a distance of 10-15 km from the protected water area (Figure 9.3.3). The ice barriers will partially block suspended solids transport from the protected area, with consequential decrease in turbidity influx into the estuary and its spread in the coastal zone.

During Phase 3, considering the ice barriers, the area with suspended solids concentrations above 0.25 mg/l will be minimal, as suspended solids will settle in the work area almost immediately due to the slow velocity of currents and the influence of ice barriers that obstruct water exchange.

[78] Plant on gravity-based structures for liquefied natural gas and stabilized gas condensate production, storage, and offloading. Design documentation. Section 8 «List of environmental protection measures». Book 4. Fisheries section. Annex A.

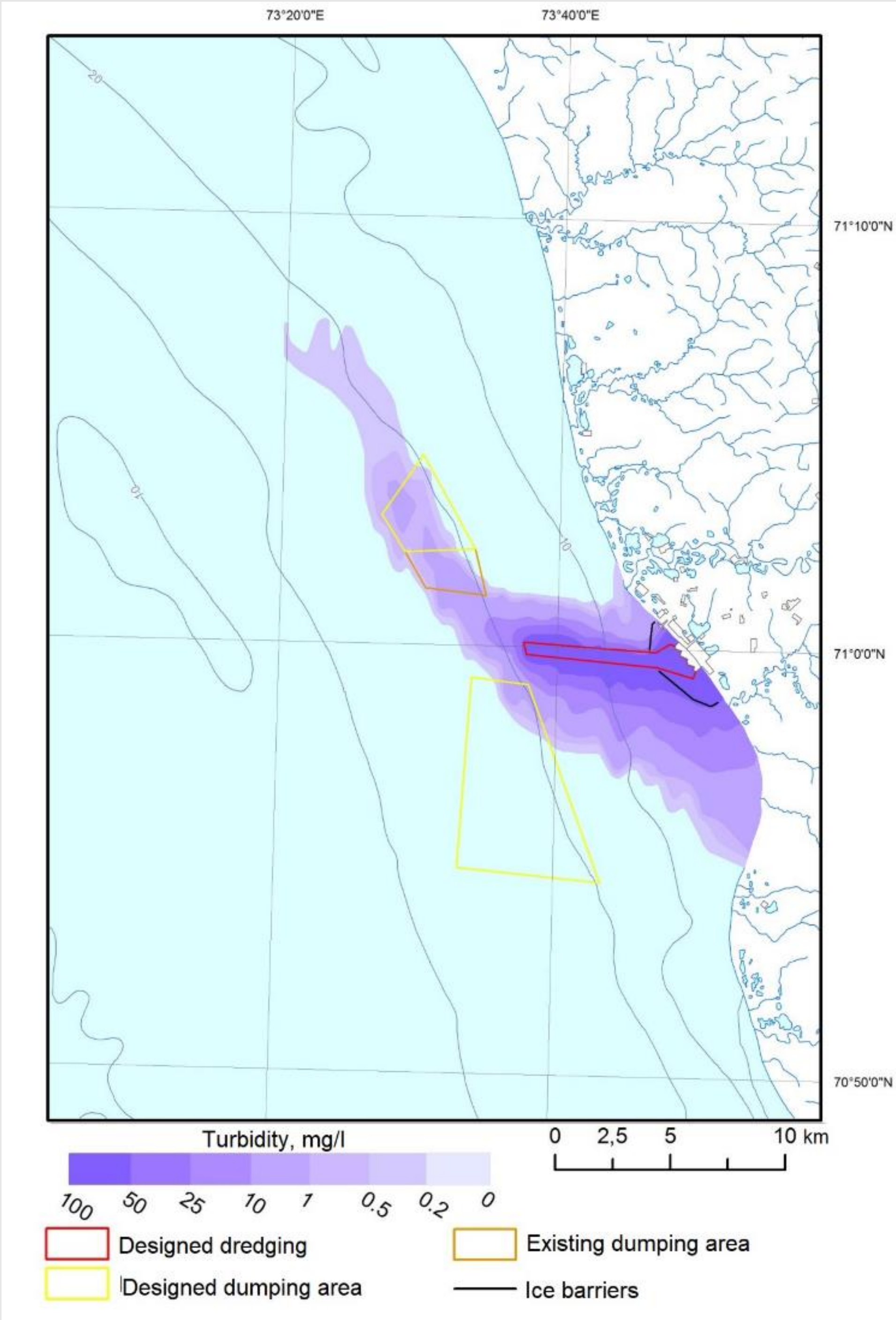

Figure 9.3.3: Turbidity zone (mg/l) during Phase 2 dredging activity

Source: Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas. Final Report. IEPI JSC, 2020.

Simulation results for the soil dumping activity indicate that suspended solids will be transported to a larger distance than due to dredging. The highest values were identified for the Phase 1 dumping. Calculation results show that turbidity plume with concentrations above 10 mg/l may extend 20 km to the north and 15km to the south. Suspended particles will be transported in the northern direction to a longer distance under the action of constant northward discharge current. Turbidity plumes resulting from Phase 1 soil dumping activities are shown in Figure 9.3.4.

Average time span of existence of the turbidity plumes is estimated by IEPI within the range from 13 days (Phase 3) to 72 days (Phase 2).

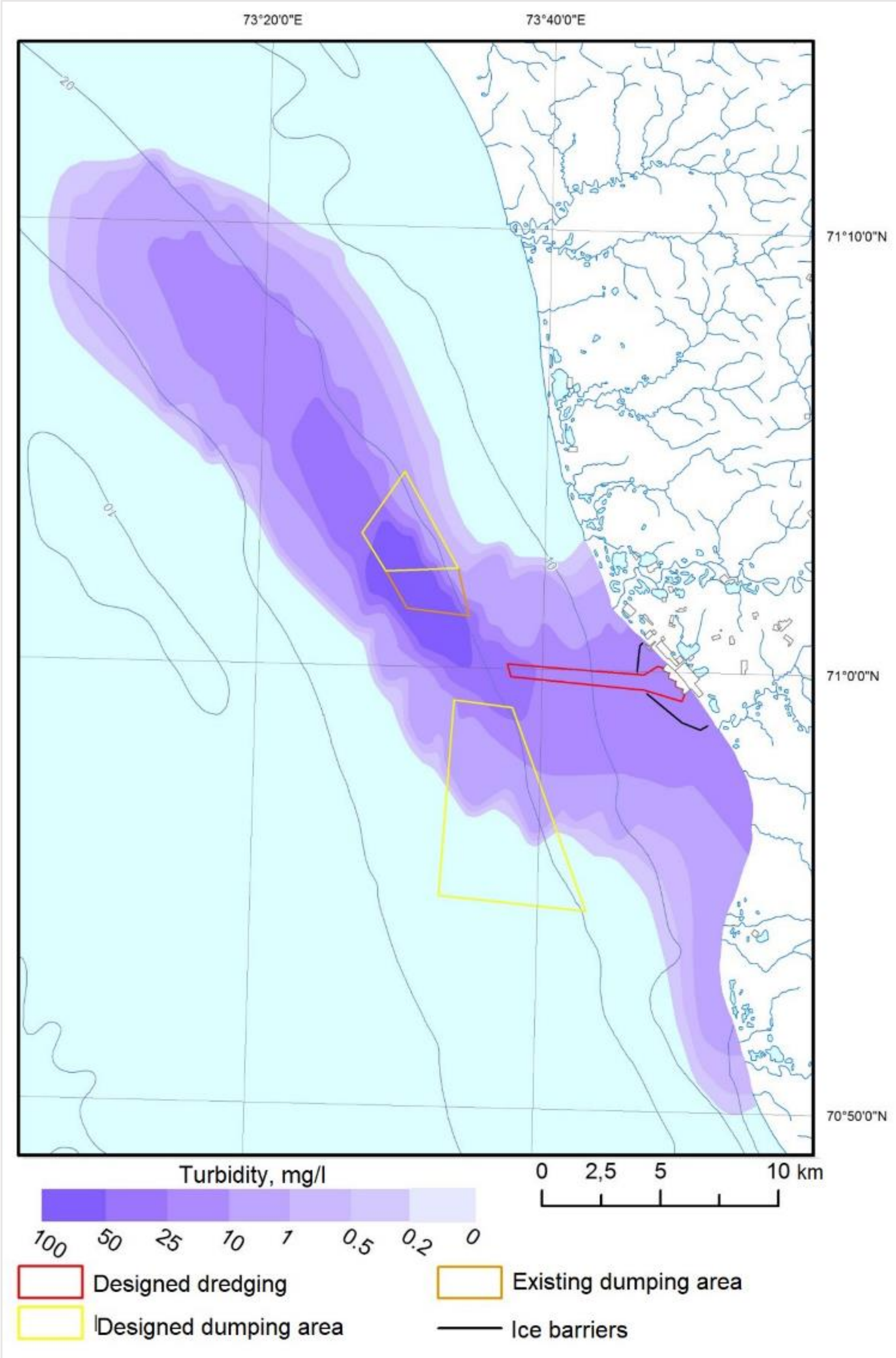

Figure 9.3.4: Turbidity zone (mg/l) during Phase 1 soil dumping activity

Source: Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas. Final Report. IEPI JSC, 2020.

Therefore, the calculated results indicate that turbidity plume with concentration 10 mg/l will travel as far as 20 km downstream of the Ob River with the main plume zone deviating from the coast, and as far as 10-15 km upstream moving mostly along the coastline. In terms of the contaminated plume size and dredging duration, and considering that the central part of the Ob Estuary is not used by other water users for domestic water supply, the impact of dredging operations on seawater is assessed as **moderate**.

Impact of the Port structures on the Ob Estuary hydrography and hydrochemistry

Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas (IEPI JSC, 2020) included an assessment of potential impact of the designed hydraulic structures of the Project on hydrodynamic conditions (velocity and direction of currents), water temperature and salinity in the Ob Estuary. Main findings of the study are summarised below.

Velocity and direction of currents

Currents structure analysis in presence of the Port hydraulic structures and in the natural settings, covering the northern and central sections of the Ob Estuary, produced similar structure of currents, in terms of directions and velocity. The hydraulic structures and access channel slightly modify currents structure in the Ob Estuary central section. The modifications are manifested at a local level by altering directions and velocities of local currents. The most prominent changes are observed immediately within the protected water area. As the area is confined, currents slow down, and their directions are shaped by the geometry of the ice barriers. In presence of hydraulic structures, average velocity of current within the protected water area is 73% of average current velocity in natural settings. The narrows to the north and south, between the ice barriers and the shore, induce higher velocity of currents - 180-200% of current velocities in natural conditions.

At longer distances from a hydraulic structure, its influence slackens down to negligible. Both seasonal and annual patterns of currents' directions and velocities are determined by three global processes: wind, tides and river flows.

Water temperature

Water temperature studies identified deviations of average monthly water temperature by more than 0.03°C only in the central section of the Ob Estuary, at the planned construction site of the hydraulic structures. In the northern and southern sectors, expected deviations are mush smaller and have been assessed as negligible.

Three main zones have been identified as a result of analysis of changes in temperature:

- Ob Estuary fairway zone with negative anomalies, i.e. surface layers of water in natural conditions are slightly warmer than in presence of the hydraulic structures;
- Central part of the protected water area and area to the west of the ice barriers with a positive anomaly, i.e. water is warmer in presence of the hydraulic structures than without them;
- Narrow coastal zone with a negative temperature anomaly.

The positive temperature anomalies result from a more intensive warming of the protected water area in summer, and in winter - from operation of the brash ice management system (BIMS) with injection of heated water into the protected water area.

In the bottom layer, a distinct influence of the channel is observed, with a negative temperature anomaly due to the increased depth and influx of cold water from the Kara Sea.

Overall temperature anomalies keep within 1-1.2°C, and their extent is local.

Salinity

Water salinity in the Ob Estuary is defined by the balance of influx of waters from the Kara Sea and major rivers discharging in the southern sectors of the Ob and Taz Estuaries, as well as precipitation and evaporation. Another contributing factor of salinity in the Ob Estuary is buildup and melting of ice. Seasonal and annual variations of salinity follow a natural pattern and are directly attributed to the seasonal and annual variations of river flows. In water-rich years, the boundary of saline water spread from the Kara Sea may stop in the northern sector of the Ob Bay, while in low-water years it may reach as far as Cape Kamenny.

Within the Comprehensive environmental studies (IEPI, 2020) the results of previous salinity studies in the Ob Estuary were analyzed, including the results of modeling saline water intrusions as a result of the construction of the sea channel in the northern part of the estuary. Since the planned construction of the hydraulic structures of the Project involves dredging and the construction of ice barriers, it was determined that the main influence of the Project may be related to saline water transport along the access channel into the central and southern sectors of the Ob Estuary, with potential development of stagnation zones and overall modification of salinity field. Key modelling results of the salinity transformation under the influence of the planned hydraulic structures are given below (IEPI, 2020).

Simulations show that maximum changes in salinity under the influence of the hydraulic structures of the Project are expected within the protected water area of the Port and to the west of it, in the accesses channel area. Within this area, a negative salinity anomaly is observed - 13-15% below the natural salinity level. This is due to the input of fresh water from the south and its retention in the stagnation zone within the Port area. In the bottom layer, on the contrary, there is a clear positive salinity anomaly: in presence of the hydraulic structures and access channel, salinity may increase by 30-35% above the level observed in natural settings. The positive anomaly is maximum in winter season with smaller river flows and a more intensive influx of saline water from the Kara Sea which is further boosted by the presence of the access channel.

In the coastal zone (southern and northern sectors), a positive anomaly is observed in both surface and bottom layers of water. At the bottom, it is directly attributed to the transport of water with increased level of salinity along the coast, under the action of tidal currents. In the surface layer, the positive anomaly is a function of increased average current velocity between the ice barriers and shore with excessive agitation and raising of saline water to the surface. Under the action of tidal motions and middle flow, the increased salinity band gradually spreads to 15-20 km along the coast line.

In winter, increased salinity zone may develop in both layers to the south of the Project hydraulic structures. This anomaly is due to the propagation of saline water from the Kara Sea in the bottom layer at the time of minimum river flows. In summer, when river flow increases, saline water is washed away, and salinity falls back to natural level.

Potential accumulation and gradual salinity increase have been examined in tree sectors of the water area (Figure 9.3.5). Analysis of annual fluctuations of salinity showed that maximum salinity anomalies may vary, however with no overall increase trend in salinity in the examined area. A characteristic increase in salinity was noted in winter period in the protected water area of the Port (Area No.5) and to the south of it (Area No.4). However, this does not develop to build up saline stagnation zones, due to the self-regulating processes in summer and autumn that bring salinity values back to natural. The increased salinity zones in winter will be limited to the aforementioned areas, and in Area No.1 they are hardly noticeable.

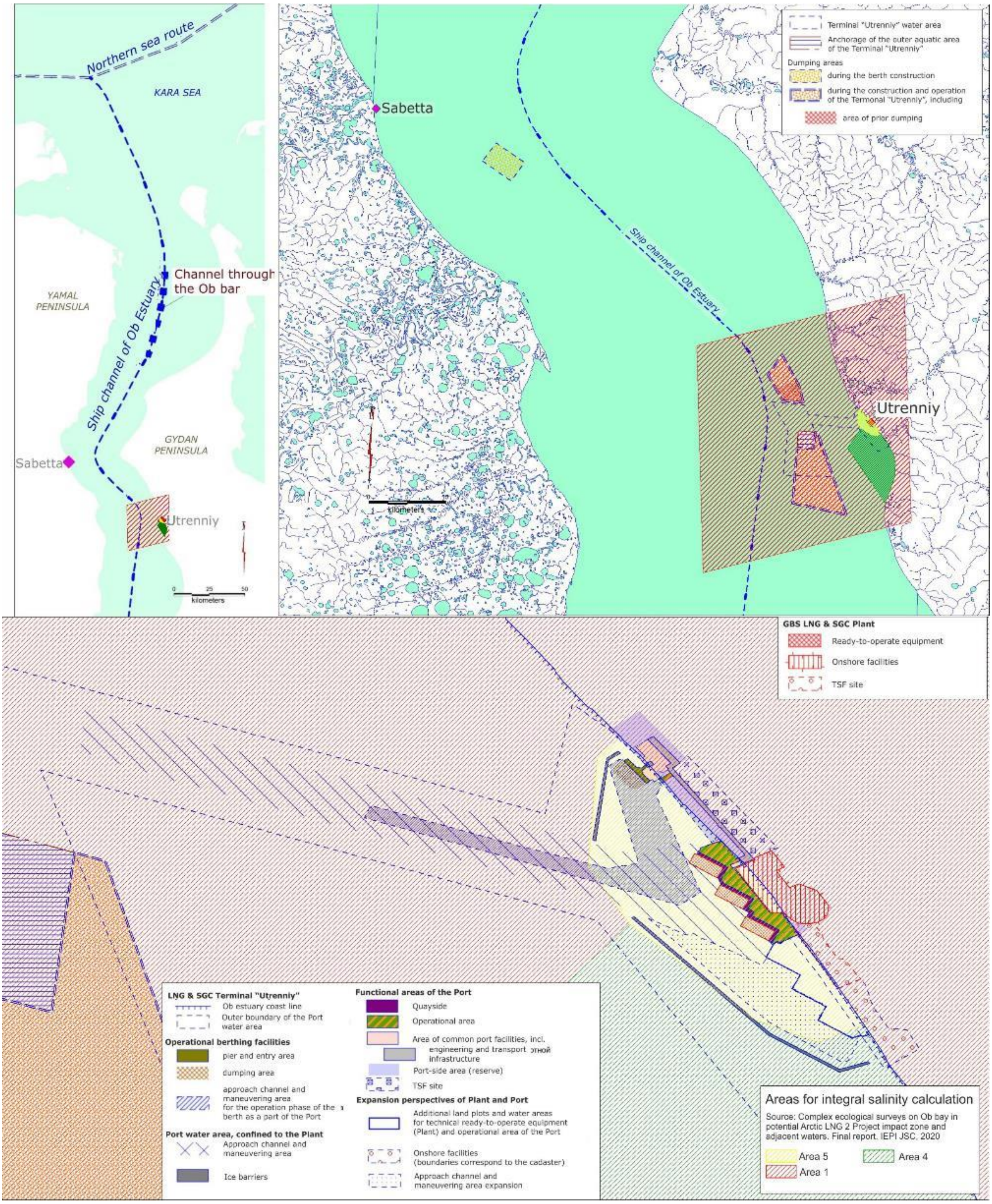

Figure 9.3.5: Integral salinity characteristics computation areas

Source: Comprehensive environmental studies of the Ob Estuary in the area of potential impact of the Arctic LNG 2 Project and adjacent water areas. Final Report. IEPI JSC, 2020.

Therefore, the following conclusions are drawn from the hydrodynamic modelling:

1) The influence of the Project hydraulic structures on velocity and directions of currents and on water temperature is expected to be local, and with distance it diminishes to negligible;
2) Local anomalies of salinity are identified in the protected water area of the Port and the access channel area;

3) In the increased salinity zone to the south of the protected area, the anomalies are seasonal and related to the period of low river flows in winter.

Considering that (1) the influence of the Project hydraulic structures on hydrodynamic conditions in the Ob Estuary will be long-term (throughout the Project service life), but local, and (2) salinity anomalies are local too, and will be balanced in the course of natural seasonal and annual variations of salinity, the impact of the Project hydraulic structures on hydrography and salinity of the Ob Estuary can be assessed as **low**.

<u>Navigation and GBS commissioning activities</u>

Wastewater and waste discharge from ships and GBS

The key factor of impact from navigation and installation operations with respect to the marine environment is unauthorised/accidental polluted wastewater discharge, including wastewater and bilge water from ships and domestic and storm water from process trains, which may involve chemical contamination of seawater and bottom sediment.

Since the Ob Estuary pertains to inland sea waters (Federal Law of 31.07.1998 No. 155-FZ "On internal marine waters, the territorial sea and the adjacent zone of the Russian Federation", Article 1), discharge of polluted effluents, including wastewater (sewage) and bilge water (including oily bilge waters from the engine room), is prohibited in the Ob Estuary.

Pursuant to the existing regulations, all bilge water will be delivered by vessels to receiving facilities in registry ports for further treatment. Exception is made for ships equipped with certified oily water separators which may discharge treated bilge water to the sea as set forth by the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). Maximum permissible oil concentration in discharge is 0.05 mg/l. Separators must be fitted with an automatic shutdown mechanism actuated where MPC of oily products in discharged water is exceeded. An alternative arrangement is to collect bilge water in on-board tanks, and when necessary transfer it to specialised collector vessels in the work area, on the commander's request.

With reference to MARPOL 73/78, four options are available to manage domestic wastewaters during the activities in the examined water area:

- Wastewater from holding tanks is treated in on-board treatment units, after which atomised and disinfected effluent is gradually discharged to water from vessel moving at a minimum speed of 4 knots, at a minimum distance of four nautical miles from the nearest shore;
- Wastewater is collected in holding tanks and, without treatment, gradually discharged to water from vessel moving at a minimum speed of 4 knots, at a minimum distance of 12 nautical miles from the nearest shore;
- Wastewater is collected in holding tanks and (on arrival at the port) transferred to specialised port services for disposal;
- Wastewater is collected in holding tanks, and when necessary, transferred to specialised collector vessels in the work area, on the commander's request.

The following solutions are proposed to prevent marine environment pollution by discharged ballast water:

- Using oil tankers with insulated ballast tanks;
- Prohibiting cleanups and repairs of ballast tanks in the sea port area;
- Prohibition of operation of construction vessels not equipped with tanks/containers for collection of bilge water and waste generated on these vessels;
- Carrying out watercraft maintenance at remote specialised enterprises (shipyards);
- Control of ships' ballast waters in compliance with the Guidelines for the control and management of ships' ballast water to minimize the transfer of harmful aquatic organisms and pathogens (IMO Resolution A.868(20) 2007);
- Reballasting operations will be conducted out in the Kara Sea in areas with a minimum water depth of 1000 m.

Wastewater generated at the Plant commissioning stage will be accumulated in sealed containers and removed offsite by specialised contractors. Waste discharge from process trains to the Ob Estuary at the commissioning stage is prohibited.

All types of solid waste generated on process trains will be accumulated in special tanks/containers and transferred to licensed contractors for disposal at remote landfills or recycling. Waste discharge to the sea is prohibited. Waste of hazard classes 3-5 in the future will be transferred to the solid municipal, construction and industrial waste disposal site in the territory of the Salmanovskiy (Utrenniy) LA. Information about the construction timeline and technical parameters of the solid municipal, construction and industrial waste disposal site is presented in Section 9.7.

Operational environmental control of potential pollution sources, and monitoring of components of the marine environment is provided during the construction activities.

Therefore, provided that Russian legal requirements and international regulations for activities in the internal sea are complied with, impact on the Ob Estuary water quality from ship traffic and GBS commissioning activities will be **negligible**.

Brash ice management system

A dedicated Brash Ice Management System (BIMS) will be implemented in the Port to ensure safe and efficient vessel maneuvering even in harsh winter conditions. The system will provide pumping, heating, injection and mixing of warm water to control brash ice thickness in the Port water area.

The design provides for injection of heated seawater in the water area of the Arctic LNG 2 Project Port. Heated water discharge has to meet water quality standards for fishery waterbodies, namely:

- Maximum exceedance of the suspended solids concentration vs. natural conditions has to be 0.25 mg/l in the regulated part relative to natural conditions;
- Water temperature in the waterbody may not increase by more than 5°C above natural temperature of the waterbody;
- pH 6.5 – 8.5;
- Mineral content - 1000 mg/l;
- Dissolved oxygen - >6.0 mg/l;
- BOD5 - <2.1 mg/l at 20°C;
- BODtot- <3.0 mg/l at 20°C;
- COD - <15 mg/l;
- Concentrations of all regulated chemical elements (heavy metals, chlorides, petroleum products, etc.) should comply with the standards for fishery sea waters.

Compliance with the discharge limits will be demonstrated by regular testing of sea water temperature and quality in the Port water area.

Provided the standards are observed and considering the local and intermittent nature of the BIMS operation (during the ice season), impact of heated water discharge in the Port can be assessed as **low**.

<u>Activity in the Ob Estuary water protection zone</u>

Key risks in the construction phase are associated with operations in the water protection zone and the coastal protection belt of the Ob Estuary.

In accordance with Part 8 of Article 65 of the RF Water Code, a width of the water protection zone of the Ob Estuary of the Kara Sea is defined at 500 m. Coastal protection belts are established within water protection zones where additional restrictions apply to economic or other activities (refer to Section 7.3 of Chapter 7).

It is suggested that the water protection zone of the Ob Estuary will accommodate the following facilities:

Process facilities of the Plant:

- Onshore Pipeline Rack;
- Flare unit;
- Operations control complex (OCC);

Onshore infrastructure of the Plant and Port:

- Boiler house with a standby diesel power plant (DPP);
- Reserve fuel stock for the boiler house and standby DPP;
- Transformer substations;
- Water intake and discharge facilities;
- Pumping stations (fire water pump station, surface runoff PS, domestic wastewater PS, and industrial wastewater PS);

- Port storm water treatment facilities;
- Logistics depot;
- Fire station;
- Mechanical repair shop,
- Port's vehicle fuelling station;
- Garage and parking space for motor vehicles;
- Offices and amenity buildings; and
- Accommodation module.

Potential negative impact sources during the Onshore Facilities construction:

- Operation of construction machinery and mechanisms;
- Storage and use of fuels, lubricants, and hazardous materials;
- Fuelling and repair of motor vehicles and construction machinery;
- Waste management.

Uncontrolled discharge of pollutants in the Ob Estuary water protection zone

The main risks of adverse impact are associated with pollution in the coastal protection belt and water protection zone caused by oil spills, accidental spills of toxic chemicals, improper storage of hazardous materials, and hazardous waste handling in breach of hygienic and environmental regulatory requirements. Polluted storm and melt water runoff from the construction site constitutes a risk of potential chemical contamination of the Ob Estuary.

To prevent seawater pollution, appropriate management and technical measures will be developed for the construction period with due regard to the following:

- Strict adherence to the works technology and timeframes;
- Keeping the works strictly within designated territories and water areas;
- Maintenance of motor vehicles and construction machinery at specialised service stations or contractor facilities;
- Compliance with the regulations for economic activities within the water protection zone and coastal protection belt, including:
  - the sites of temporary site facilities, including those intended for operational service needs, are hard paved with a slope and surface runoff collection system;
  - parking of vehicles, construction equipment and machinery, refuelling and maintenance of vehicles and construction machinery is conducted on dedicated sites, using fuelling vehicles, standard trays and other devices;
  - wheels air-cleaning facilities will be arranged for vehicles and wheeled machines leaving the construction site;
  - during the period of construction, domestic wastes will be collected in tight containers with trays installed on bunded sites paved with concrete road slabs.
  - snow will be removed from the construction site with motor grader blades, bulldozers and rotary snow ploughs.
  - for collection of potential spills, the Process Trains are fitted with drainage systems that prevent ingress of polluting substances to the Ob Estuary water.
- Monitoring of the impact of the activities on the Ob Estuary, within the scope of the operational environmental control (monitoring) programme.

After the proposed management and technical measures, residual impact of uncontrolled wastewater discharge from the Onshore Facilities on water of the Ob Estuary can be assessed as **low**.

<u>Water supply and wastewater disposal during construction</u>

Water Supply

During the construction, water for domestic and drinking needs at the onshore and near-shore sites in the Ob Estuary will be delivered by road.

Water abstraction from the Ob Estuary is foreseen for filling up ballast compartments of the Plant's three Process Trains. Subsequent recharge of the ballast compartments is expected, due to the use of water ballast water for testing of the Process Trains' fire safety systems.

The total volume of water abstraction from the Ob Estuary is 1,645,284m^3, of which 543,000m^3 for filling ballast compartments of each of the three Process Trains, and 678.5m^3 for testing of firefighting equipment at each of the Process Trains (once in five years).

Also, water from the Ob Estuary will be used in the system of outdoor firefighting automatic fire protective water system (water curtain) designed for the Terminal. The water curtain is intended to protect tanker from heat exposure in case of fire at the process facilities, and protect the process facilities from fire on tanker. Water supply to the external looped water network will be provided from pumping station with water storage tanks. The pipelines will be fitted with 20-mm mesh fish protection screens to prevent suction of young fish into the system.

Total water flow for firefighting is 31.1 l/s, of which 23.6 l/s is for the water curtain. For reference: mean water flow rate in the Ob River in the location of Salekhard is 12,500 m^3 per second and at the Ob Estuary outflow – from 5,000 to 35,000 m^3 per second, depending on season (Lapin, 2011).

Given that required volume of ballast and fire water is disproportionately smaller than the freshwater flow through the Ob Estuary to the Kara Sea, impact of the Plant's water intake facilities on the Ob Estuary marine environment at filling of the ballast system of the process trains can be assessed as **low**.

Wastewater disposal

Wastewater flows from the Terminal and Plant construction will include domestic wastewater (from the onshore sites and vessels), storm runoff, bilge (oily) water from vessels, and wastewater from hydraulic testing of the Plant equipment. Domestic wastewater from the Terminal onshore sites will be collected in impermeable holding vessels (mobile toilets, portable toilets) with 220 l receiving box and a washbasin (water consumption 30 l), and removed by a specialised contractor. Domestic wastewater from the Plant construction will be removed by vacuum trucks to the sewage treatment facilities (STF) at the construction camp for the onshore facilities. No wastewater discharge to the Ob Estuary is planned.

Storm water drainage will be provided in the areas of the construction camp, laydown areas, machinery parking sites and roads, in accordance with the following arrangements.

- Storm runoff from the construction sites will be collected by open gutters into holding tanks, and transported by road tankers to the Contractors' treatment facilities at the temporary site facilities (TSF) Nos. 4, 10 and 12 to be provided as part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup development.
- Storm runoff from road surfaces will be collected by a temporary drainage system – trenches 25-55cm in depth, to holding sumps lined with impervious film. When filled, sumps will be emptied and water transported by road tankers to the treatment facilities at TSF No.4, TSF No.10 and TSF No.12.

Maximum daily flows of melt and rain water at the Terminal construction stage:

- At the construction camp – 147.02 m^3;
- In the administrative and domestic facilities area – 71.71 m^3;
- On the temporary road – 15.83 m^3.

The impervious vessels and sumps is designed to provide effective holding capacity that will be used by 80% after collecting 100% the maximum volume of storm runoff water.

Melt water discharge

Melt water will be collected and delivered to treatment by the same drainage system as for the rain water. Contamination of snow must be prevented during the construction activity, in order to decrease the load of storm runoff on treatment facilities. The project provides for the following mitigation measures to prevent melt water contamination:

- Regular mechanical cleaning of the construction/operational site using motor grader blades, bulldozers and rotary snow ploughs;
- Mechanical sweeping shall start when the layer of loose snow mass on the site rises to the height of 2.5-3 cm, which corresponds to 5 cm of fresh-fallen compacted snow;
- In hard-to-reach areas, snow will be removed manually, by specialised personnel;
- In case of unceasing snowfall during a day, snow clearing equipment shall operate continuously, with short-time (maximum 1 hour) breaks for refuelling of machinery and meal for workforce;

- At the end of snow clearing activity, snow banks of a maximum width of 1 m shall be shaped to facilitate loading on dump trucks;
- The snow banks shall be arranged within a maximum period of 24 hours from cessation of snowfall;
- During the period of construction and operation, snow shall be removed by dump trucks to the snow accumulation site at the PGTP No.3 included in the Salmanovskoye (Utrenneye) OGCF Facilities Setup. Haulage distance is 2.5 km.

After the above measures, potential adverse impact of storm and melt water disposal during construction of the Terminal and the Plant Onshore Facilities cab be assessed as **negligible.**

9.3.3.2 Operation

Main potential sources of impact on the Ob Estuary in the Plant and Port operation phase are:

- Water supply and wastewater disposal from the Plant and Utrenniy Terminal;
- Navigation and vessels servicing;
- Activities in the water protection zone, such as:
  - Loading/unloading of fuels & lubricants, LNG and SGC, and chemicals;
  - Storage and use of hazardous materials;
  - Hazardous waste collection, accumulation, and transportation;
  - Motor vehicles and port machinery fueling;
- Accidental spills of oil and other hazardous chemicals.

<u>Water supply and wastewater disposal during operation</u>

Water Supply

No domestic and utility water abstraction from the Ob Estuary is planned because, for such water, it is planned to use the water supply network of the Salmanovskoye (Utrenneye) OGCF which will be constructed by the time of commissioning of the Plant Process Train No.1. The same network will supply water for indoor firefighting. Sea water abstraction from the Ob Estuary is merely foreseen for outdoor firefighting.

The firewater supply system for the Utrenniy Terminal will be used for outdoor firefighting. It will uptake water from the existing water supply network connected to the existing fire pump station with a seawater intake facility that will pump water to a 1,000 m^3 fire tank.

It is planned to provide a water curtain to protect tanker from heat exposure at fire in the methanol handling area, or for protection of the handling area in case of a fire on tanker. Similarly, water supply for the curtain and to pillar fire hydrants will be arranged from the existing fire water pump station with a seawater intake.

Water flow rate to put out a fire is estimated at 72.5 l/s, including 32.5 l/s for the water curtain 25 m in length and 40 l/s for the pillar fire hydrant to cool down metal structures, and for foam fire extinguishing. Water will be pumped into the fire system from two 81.4 l/s water intake facilities fitted with a fish protection screen and a pump station.

Sea water will be also used to recharge ballast compartments of the Process Trains, to make up for the water spent for testing of firefighting equipment (678.5m3 at each of the Process Trains, once in five years).

Given the freshwater flow through the Ob Estuary, impact of water abstraction for recharging the Process Trains' ballast compartments, and for the Terminal fire safety system during the operation period is assessed as **negligible**.

Wastewater disposal

During operation of the **Utrenniy Terminal**, separate systems will be provided for collection of all wastewater streams: domestic, industrial, and storm runoff.

Household and sanitary effluents collected in the domestic sewage system of the Utrenniy Terminal will be removed by road tankers to the sewage treatment facilities at the Salmanovskoye (Utrenneye) OGCF Facilities Setup. Domestic wastewater from buildings will be transported by internal gravity pipelines to the external wastewater network and further to the inlet tanks of sewage pump stations that will pump wastewater to the sewage treatment facilities at the Salmanovskoye (Utrenneye) OGCF.

Industrial wastewater is generated on the mobile process platform, process site of the pumping station, and during washing activity at the boom site (Company facilities), and at the indoor parking of the Port administration (Federal facility), in the total volume of 6.89 m^3/day, 311 ,^{3}/year, of which:

- Federal facility – 0.02 m^3/day, 5 m^3/year;
- Company facilities – 6.87 m^3/day, 306 m^3/year.

Industrial wastewater will be collected in the industrial wastewater disposal system and removed by road tankers to the sewage treatment facilities at the Salmanovskoye (Utrenneye) OGCF Facilities Setup.

Industrial wastewater from the boom site and process pumping station will be transferred by gravity sewers to the industrial wastewater holding tank, and then transported by road tankers to the sewage treatment facilities at the Salmanovskoye (Utrenneye) OGCF. The wastewater will be pumped out of the holding tanks by the truck-mounted pumps. Industrial wastewater from the mobile process platform will also be pumped by portable devices and transported to the sewage treatment facilities at the Salmanovskoye (Utrenneye) OGCF.

Surface runoff from the onshore area of the Utrenniy Terminal will be collected in storm sewers and transported to the balancing accumulation tanks. After preliminary precipitation and balancing the treated runoff will be pumped to the local stormwater treatment facilities at the Utrenniy Terminal site to be treated to the fishery standards before discharge to the Ob Estuary.

The estimated storm wastewater flow rate is 1326.45 m^3/day; 58. 11 m^3/year.

Thus, domestic and industrial wastewater, generated at the Utrenniy Terminal both at the construction and operation, will be discharged to the sewage treatment facilities at the Salmanovskoye (Utrenneye) OGCF. Storm water will be treated to fishery standards before the discharge. There will be no discharge of untreated effluents to the Ob Estuary.

Specific systems that will be provided for collection and disposal of all wastewaters (storm runoff, fire water, spills cleaning wastewater, industrial wastewater from heating, ventilation and air conditioning systems, and domestic wastewater) during operation of the **Plant** will manage the following streams:

- Domestic wastewater;
- Industrial wastewater and storm water;
- Stormwater;
- Industrial wastewater;
- Waste methanol-water.

Drainage systems of the Plant are designed in accordance with the "Zero Discharge" principle, which means that all effluents are transported by pipelines to the Sewage Treatment Facilities at the Salmanovskoye (Utrenneye) OGCF located at the site of STF-3, at a distance of 2 km from the Plant (Figure 5.5d in Chapter 5).

The industrial wastewater and storm runoff system is designed for collection of potentially contaminated rain water, water from firefighting operations, and from emergency spills. Accidental spills of cryogenic media will be collected by the same system. The system is open and has a connection to a holding tank. Open drainage system wastewater potentially contaminated with petroleum products and chemical agents will be accumulated in a 18,000 m^3 tank fitted with a petroleum/oils collector. The tank will be equipped with two pumps (one working and one standby) which will transfer wastewater from the open drainage system onshore to the contaminated storm water treatment facilities at STF-3 site.

Industrial wastewater and storm water runoff will be pumped to the onshore facilities and further to the site of STF-3. After treatment, industrial wastewater and storm runoff will be injected to formation.

The oil-contaminated water drainage system is designed to collect storm runoff potentially contaminated with small quantities of lubricants, diesel fuel, hazardous chemicals resulting from minor spillages and leaks. Oily rain and melt water from each Process Train will be collected into a 1960 m^3 tank and pumped through the onshore facilities to the oil-contaminated water treatment facilities at the site of STF-3. Water quality in the oil-contaminated water drainage system will be monitored, and pollution levels above the system's threshold will trigger manual discharge using portable equipment, and subsequent transportation to the STF-3 treatment facilities.

Domestic wastewater will be collected in 195 m^3 steel vessels in the interior of each Process Train, and regularly removed by road tankers to the biological treatment plant at the the STF-3 site.

Domestic and storm waters, including melt water and water from fire equipment tests, will be treated to the standard applicable to discharges to fishery waters, and will be discharged to Nyaday-Pynche River[79], or used to replenish fire water stock. Monitoring will apply not only to the direct wastewater recipient – the Nyaday-Pynche River, but also to the Ob Estuary that receives its flow.

Activity in the Ob Estuary water protection zone

Handling operations

Negative impacts associated with loading/unloading operations include leaks and spills of oil and chemicals. Marine environment exposure is possible during fuelling of vessels and operations of vessels collecting waste, wastewater and oil-containing bilge water from ships.

Measures to mitigate the Ob Estuary pollution risk are:

- Automation of handling operations in order to prevent leakages and spills;
- Equipping the fuel berth with automatic materials-handling system (cranes with emergency prevention system in case of uncontrolled gas carrier movement);
- Servicing of vessels by special ships for waste and wastewater collection and for bunkering assistance;
- Adhering to the "Rules of recording of operations with oil, oil products and other substances dangerous for human health or marine bioresources, as well as their mixtures produced on ships and other watercraft". RD 31.04.17-97;
- Compliance with all navigation-related safety regulations;
- Using of double-hulled vessels;
- Equipping seagoing ships in accordance with the requirements of the International Association of Lighthouse Authorities;
- Approval of navigation aids specifications by the RF MoD General Directorate of Navigation and Oceanography;
- Coordination of routes, navigating zones and anchoring berths in the Project area.

Hazardous materials and waste management

The likely sources of the pollutants ingress to the marine environment at the operation phase are uncontrolled surface runoff from operation sites, feedstock and POL storage and use sites, temporary waste storage sites, roads and parking spaces, and leakages from pipelines and equipment in the water protection zone of the Ob Estuary.

The following measures are designed to contain polluted storm water within the boundaries industrial sites:

- Waterproofing of fuel storage sites;
- Bunding of fuel storage tanks to accommodate not less than 110% capacity of the largest tank placed inside;
- Placing of chemicals and storage of bulk materials in shelters with waterproof paving;
- Temporary waste storage at sites with waterproof paving, in closed containers or under a shed;
- Surface runoff collection from roads and parking spaces via a drainage system to storm water treatment facilities;
- Routine cleanups of roads and operational sites;
- Polluted snow collection and removal to a dedicated site with waterproof paving and melt water drainage system connected to the industrial and storm water treatment facilities.

After the above measures, the risk of potential contamination of the marine environment is assessed to be low.

Wastewater discharge from vessels

Overboard wastewater discharge to the Ob Estuary is prohibited. All vessels must be equipped with sealed collection and accumulation tanks for sanitary wastewater, bilge water, wastes that will be removed by specialised contractors in registry ports, or transferred to collector vessels in the work area.

[79] Salmanovskoye (Utrenneye) OGCF Facilities Setup. Design documentation. Section 8. List of Environmental Protection Measures. Part 5. Assessment of impact on water resources. NIPIgazpererabotka JSC. 2019.

After the above measures for preventing pollution of the Port and Ob Estuary water areas, the operational-phase impact on the marine environment due to the water supply, wastewater disposal, handling, economic activities in the Ob Estuary water protection area and in the Plant and Port water area can be assessed as **low**.

Accidental oil spills in water area of the Port

Spills of oil at the Plant and Port facilities are possible during the construction and operation phases. Storage, handling and transportation of hydrocarbons, including LNG, condensate, diesel fuel and kerosene, at the Plant, in the Port and on ships are associated with the highest potential risk of oil spills at sea. Negative impact on the marine environment may appear significant unless oil spill response measures are taken. To provide effective response to spills of liquid hydrocarbons, special units shall be established and, if necessary, involved on a contractual basis (see also Section 9.8.5.1) to detect, control and clean up such spills in the Ob Estuary. The units must keep available the qualified personnel, equipment, reagents and other technical means for cleaning and protection of the port's water area and the coastlines, and be capable for time-sensitive monitoring of the spill's travel.

Specific actions to prevent pollution of the Port area in the event of a spill of chemicals will be defined in the Oil Spill Prevention and Response Plans (OSPRP) to be developed in conformity to the Russian legislation[80][81]. Design documentation for the Utrenniy Terminal of liquefied natural gas and stable gas condensate includes an OSPRP for the onshore[82] and offshore[83] emergencies.

The first document covers emergency situations involving onshore diesel spills. The assumed potential sources of spills are loss of pipeline containment, failure of equipment pumping petroleum products to tankers, loss of containment/failure of road tanker. Maximum possible volume of hazardous substance spill is assessed as 46 m^3 (38 tons), maximum area of exposure is 6898.5 m^2. In view of the above, potential emergency situations involving spills of petroleum products at the Terminal are considered as emergencies **of local significance**. The document proposes management and technical measures for prevention of and response to the emergency situation, which are designed to prevent transport of spilled petroleum products onshore and into the Ob Estuary water area.

The second document examines potential sources of oil spills in the Port water area, and includes calculation of potential volumes and areas of spills, and proposals for OSPRP. The following operations with petroleum products in the water area of the Sabetta Port (Section No.2) have been identified as potential sources of accidental spills:

- offloading of liquefied natural gas (LNG) and stabilised gas condensate (SGC) for sea transportation; assumed SGC volume is approximately 1.4 mtpa;
- reception of diesel fuel; planned maximum volume of 40,710 tpa;
- bunkering port fleet vessels with diesel fuel; planned cargo turnover is 10,200 tpa.

According to the design documentation for the Utrenniy Terminal, maximum spill of 7000 m^3 in the Terminal water area is possible in case of a failure of an SGC tank at the Plant.

For the Plant, the worst accident in terms of environmental impact is potential accident with spillage of condensate (ESIA[84] 2019). Loss of containment of SGC tank may result in spillage of maximum mass of petroleum products to sea:

- 1230 tons in case of complete destruction of pipeline offloading SGC to tankers;
- 6026 to 7342 tons in case of partial failure of SGC tank with a crack of 220 mm equivalent diameter.

Therefore, the maximum design spill is estimated at 7432 tons of condensate released from failed tank during 81 hours. Given the high rate of SGC evaporation, outputs of the model of spill on sea surface[85] showed that in case of uncontrolled spillage, maximum quantity of SGC on the sea surface would be

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[80] RF Government Decree of 14.11.2014 No. 1189 "Regulation on prevention and response measures in relation to spills of oil and petroleum products in the continental shelf of the Russian Federation, in the internal waters, territorial sea and contiguous zone of the Russian Federation"
[81] RF Government Decree of 21.08.2000 No.613 "Basic requirements for development of the Oil Spill Prevention and Response Plans"
[82] Utrenniy Liquefied Natural Gas and Stabilised Gas Condensate Terminal. DD. Section 12. Book 5. Oil Spill Prevention and Response Plan (OSPRP) Activities. Vol. 12.5. LENMORNIIPROEKT, 2019.
[83] Utrenniy Liquefied Natural Gas and Stabilised Gas Condensate Terminal. Amendments and additions to the design documentation. Section 12. Subsection 4. OSPRP activities, including estimation of forces and resources and specification of OSPR equipment for the Oil Spill Prevention and Response Plan. Part 1. Water area. Vol. 12.4.1. LENMORNIIPROEKT. 2019.
[84] GBS Plant for production, storage and offloading of liquefied natural gas and stabilized gas condensate. DD. Section 8. Book 1. Environmental Impact Assessment.
[85] Science and Technology Report by RGC Risk Informatics LLC. 2019. 88 p.

achieved in 81 hours - 600 tons under consistent no-wind conditions due to the spilled SGC evaporation. However, potential volumes of sea water pollution vary in a wide range, depending on weather conditions, height of waves, spill film thickness on surface, and it is possible that only 186 tons of SGC will remain on the surface by the end of SGC release. In this case, sea water column will be contaminated due to dispersion of oil film, i.e. oil film broken by action of waves and currents, and oil emulsion will spread in water. Dispersion may be a complex process, depending on the spill thickness on surface, wave height, depth to which detached droplets pass in water, and size distribution of the droplets. Larger droplets are fast to rise to the surface and re-join the spill. Potential pollution of sea water depends on the proportion and mass of smaller droplets that remain in water and are transported by currents. A MAC-level pollution of surface water layer of 1.4 m is possible if oil film is about 70 μm thick. The oil plume development and sea water pollution simulations have been conducted for oil film thickness greater than 0.01 mm. Application of special oil film collection equipment for collection of thin films is unreasonable, as such films naturally degrade under the impact of waves (LENMORNIIPROEKT, 2019).

Potential impact on the Ob Estuary water is characterised by the following estimated levels of pollution:

- About 5.0 km^3 of sea water can be exposed to contamination at 0.05 mg/l (hydrocarbons MAC for fishery water bodies);
- 0.1 mg/l (2 MAC) or higher - 2.72 km^3;
- 0.5 mg/l (5 MAC) or higher – 0.54 km^3;
- 5.0 mg/l (10 MAC) or higher – 0.05 km^3;
- 10.4 mg/l (maximum) – 0.026 km^3.

The model outputs show that spilled SGC will extensively evaporate at the initial stage of spill, and up 50% of spilled condensate will evaporate within 2-4 hours. The rapid evaporation will continue during 1-1.5 days from the time of spillage, after which about 10% of spilled SGC will remain on the surface. During that time, the lighter fractions (benzene and kerosene) of SGC will dissipate, resulting in elevated concentrations of hydrocarbon fumes in air beyond the maximum allowable explosive concentration, which preclude safe OSPR operations. Collection of spilled gas condensate can be started only when hydrocarbon fumes concentrations fall down to safe level (LENMORNIIPROEKT, 2019).

The oil spill prevention and response strategy for the Port water area provides for several tiers of protection:

- Barrier 0 – Prevention of oil spills - a system of industrial and environmental safety measures in compliance with the applicable law of the RF and project-specific requirements.
- Barrier 1 – Containment of spills at source:
    - Duty cycle Accident Rescue Group in the area of petroleum products handling operations;
    - Making a boom barrier around tanker before start of SGC offloading, and around port fleet vessels before bunkering;
    - Making a boom barrier around GBS if the gravity-based structure is damaged.
- Barrier 2 – Spill response in sea:
    - Closing water area with booms to prevent transport of oil plume beyond the boundaries of the Port water area;
    - If oil plume spreads beyond the Port water area, oil gathering vessels, skimmers, booms and holding tanks for collected petroleum products will be used.
- Barrier 3 – Shore protection from contamination with oil:
    - Installation of protective boom barriers across or around sensitive areas. Booms change direction of movement of the oil plume, or hold it and direct to the place of collection;
    - Installation of diverting booms. This is intended to protect sensitive zones from oil plume drifting with current or wind. Booms are installed at an angle to the plume drifting trajectory, so that spilled product is directed to areas with slower currents where the film can be collected;
    - Protection of mammals and birds by scaring them away from the areas of contamination and spread of oil plume.
- Barrier 4 – Shore cleaning from contamination with oil:
    - Washing petroleum product off the shore or watercraft into coastal area, followed by collection of film from water surface;
    - Reduced-impact cleaning technology – manual collection.
- Barrier 5 - Involvement and deployment of additional forces and resources (delivery of assistance), if the volume of spill of oil or petroleum product is larger than maximum volume covered by the Company's OSPRP and cannot be eliminated by the forces and resources provided for in OSPRP.

In this case, the Company will seek support of the unified state system of emergency prevention and response via the Federal Agency of Sea and River Transport (Rosmorrechflot).

The SGC spill response strategy defines:

- Spill containment measures;
- Cleaning of spills in the port area;
- Composition of resources and equipment for containment and cleaning of spills, including required number of personnel.

Depending on direction of currents (including tidal currents), directions and speed of winds, boom installation configurations are proposed as follows:

- Obstructing containment to prevent transport of spilled material along the coastline;
- Preventive containment intended to keep spill within the port area;
- Operating containment to provide conditions for cleaning of spill.

It is proposed to provide the following main resources for containment of spills:

1. Complete set of inflatable booms of a minimum height of 1200 mm and length up to 1500 m, for preventive containment of spill in the port area.
2. Anchor sets to keep booms in position, in sufficient quantity to install a barrier with a minimum length of 1000 m.
3. Permanent flotation booms of a minimum height of 900 mm and length up to 1500 m, as a backup for the main boom barriers to be used for the preventive containment operations.
4. Inflatable booms of a minimum height of 900 m and length of 750 m, for arrangement of sectional and floating oil traps and sweeping residues of condensate in the port area.
5. Minimum 2 units of boom-laying boats with adequate capacity for towing, installation and state control of boom containment for spill localization.
6. 500 m of boom socks with replaceable sorbent fillers for cleaning of water area, particularly cleaning of minor spills or hydrocarbon residues on water after washing of contaminated port structures.

Minimum requirements to composition of spill response equipment are defined as follows:

1. Oil gathering vessel of adequate class, with a minimum 300 m^3 tank for collection of collected mixture and oily mixture pumps with a minimum capacity of 75 m^3/h.
2. Boom-laying boat for joint operation in order with oil gathering vessel during sweeping of water area and collection of spilled material.
3. At least 2 units of complete skimming system with a minimum capacity of 50 m3/h, for backup and simultaneous collection of petroleum products in different locations.
4. Up to 500 m of boom sock lines with exchangeable sorption media, for cleaning SGC residues from water area.
5. 2 sets of hydrojet units with drives and hand-held fire nozzles, minimum capacity 200 l/m, for washing SGC residues off the ice barriers and other port structures, and washing of contaminated booms, vessels and oil gathering equipment.

Staffing requirements:

- OSR Manager – 1 person, certified salvor;
- Spill containment activity – 8 persons (2 persons at each of the three boom-laying boats + 2 persons – backup at the boat inspecting the state of boom containment), of which at least 4 persons shall be certified salvors;
- Spill cleaning activity – 6 persons (2 persons at each of the two boom-laying boats + 2 persons on oil gathering vessel), or which at least 4 persons shall be certified salvors.

The results of modelling and suggested response activities will be used at development of the Oil Spill Prevention and Response Plans for the Utrenniy Terminal and the GBS LNG&SGC Plant of the Arctic LNG 2 Project.

Provided that legal requirements for organisation and management of spill response activities are respected, and that timely containment and cleaning of spill is ensured, residual impact on the marine environment may be **moderate**.

9.3.4 Summary

The Ob Estuary and inland surface waterbodies are vulnerable components of the natural environment which, where impacted, may be exposed to negative changes. The Project design envisages a number of environmental measures for prevention (where possible), minimisation and mitigation of negative impacts from construction and production activities.

Impacts at the construction phase

The main impact of construction of the Project and associated facilities on surface water is related to potential transport of suspended matter and pollutants by surface runoff, and with construction activities in the water protection areas of rivers, streams and lakes, which may disturb the hydrology and morphological structure of riverbed. Subject to the implementation of the proposed environmental protection measures, and given that the impacts will mostly be short-term and local, the residual impact of construction on inland water bodies is assessed as **low**.

Among the main impacts on the Ob Estuary at the construction phase will be dredging and soil dumping underwater. According to the results of the dumping-related suspended solids diffusion model, and considering the works duration and phasing, the impact on the marine environment in the dredging and soil dumping areas is assessed as **moderate**.

Impacts at the operation phase

The main impacts of the Project and associated facilities operation on inland waters include water abstraction from surface water sources, discharge of domestic and industrial wastewater and stormwater, pollution of natural water at operation of linear facilities and in case of emergency.

The volume of water abstraction from surface sources for the Project water supply will make up only a small portion of the permitted abstraction volume in the water management section, according to the Integrated Water Management Scheme (IWMS) for the Taz River basin.

All wastewater streams from operation of the Project and associated facilities will be treated at the Sewage Treatment Facilities at the Salmanovskoye (Utrenneye) OGCF and either injected to formation (industrial wastewater and storm runoff from industrial sites) or discharged into Nyaday-Pynche River (domestic and stormwater). After the planned management and technical mitigation measures, and provided that wastewater is treated to fishery quality standard before discharge to waterbody, residual impact of the Project operation on surface water can be assessed as **negligible** or **low**.

Storage, handling and transportation of hydrocarbons, including condensate, diesel fuel and kerosene, at the Plant, in the Port and on ships are associated with the highest potential risk of oil spills at sea. To provide effective response to spills of liquid hydrocarbons, special units shall be established and, if necessary, involved on a contractual basis (see also Section 9.8.5.1) to detect, control and clean up such spills in the Ob Estuary. The units must keep available the qualified personnel, equipment, reagents and other technical means for cleaning and protection of the port's water area and the coastlines, and be capable for time-sensitive monitoring of the spill's travel. Provided that legal requirements for organisation and management of spill response activities are respected, and that timely containment and cleaning of spill is ensured, residual impact on the marine environment cab be assessed as **moderate**.

The main environmental measures for preventing and mitigating negative impact on surface waters during construction and operation of the Project and associated facilities are tabulated in the summary Table 9.3.8.

Table 9.3.8: Surface water impact and mitigation summary

Impact	Sign	Receptor	Receptor sensitivity	Stage	Impact significance	Risk	Mitigation	Residual impact
Operations in the Ob Estuary								
Increase in water turbidity from dredging operations in the water area of the Port and access channel	N	Marine environment, marine flora and fauna	H	Construction / repair works in the operation phase	M	M	The following measures are envisaged to minimise the suspended solids migration to the marine environment: • Prevention of technical water overflow when filling suction hopper dredges; • Unloading of material from hopper barges and suction hopper dredges at the dump site only when the craft fully stopped (adrift); • During backhoe dredger operation, lowering the bucket as close as possible to the water surface in the hopper barge hold, to avoid spillage and splashing of slurry; • Making sure that bucket is filled with ground by 75 % (with no neap), to prevent ground release back into water; • Chemical analysis to control of water quality of the Ob Estuary before, during and after dredging; • Continuous operational monitoring of compliance with the technology for underwater technical operations.	M
Seawater pollution with wastewater discharge from ships	N	Marine environment, fish fauna	H	Construction Operation	M	I	Overboard wastewater discharge is prohibited. Each vessel must be equipped with accumulation tanks for polluted liquid wastes (wastewater, oily bilge water) for the period of its presence in the Ob Estuary. The following requirements are set MARPOL 73/78 for discharge of treated bilge water: • Provision of certified oily water separators on-board; • Maximum permissible oil concentration in a discharge is 0.05 mg/l; • Separators must be fitted with an automatic shutdown mechanism actuated where MPC of oily products in discharged water is exceeded	N
Seawater pollution from waste discharge from ships and GBS	N	Marine environment, fish fauna	H	Construct ion, operation	M	I	All wastes generated on vessels and GBS will be accumulated in dedicated tanks/containers and passed over to licensed contractors for disposal at remote sites or for recycling. Waste of hazard classes 3-5 in the future will be transferred to the solid municipal, construction and industrial waste disposal site in the territory of the Salmanovskiy (Utrenniy) LA.	N
Marine environment pollution from wastewater discharge from GBS	N	Marine environment in the Port water area	H	GBS commi ssi-	M	I	All wastewater and polluted storm water will be accumulated in sealed tanks/containers and delivered to wastewater treatment facilities at the Salmanovskoye (Utrenneye) OGCF.	N
Marine environment pollution from uncontrolled discharge of	N	Marine environment, fish fauna	H	Constr uction, commi	H	M/ Mr	• Stringent compliance with the Russian law on the prevention of pollution of waterbodies from ships; • Strictly compliance with approved process technologies;	M/ L

Impact	Sign	Receptor	Receptor sensitivity	Stage	Impact significance	Risk	Mitigation	Residual impact
polluted effluents and oil spills in the water area							• Ensuring trouble-free operation and routine inspection of all process equipment in order to prevent spillovers, leaks and spills of process liquids; • Prohibition of operation of construction vessels not equipped with tanks/containers for collection of bilge water and waste generated on these vessels; • Carrying out watercraft maintenance at remote specialised enterprises (shipyards); • Adhering to the procedures of GBS-generated domestic wastewater and waste collection, accumulation and frequency of removal; • Operational and environmental control/monitoring of potential pollution sources; • Monitoring of the state of marine environment components.	
Seawater quality change from discharge of heated seawater for ice thickness control	N	Marine environment in the Port water area	M	Construction, operation	M	Mr	Heated discharged water falls under the limitations, namely: • Maximum allowable increase of the suspended solids concentration vs. natural conditions is 0.25 mg/l in the regulated part relative to natural conditions; • Water temperature in the waterbody may not increase by more than 5°C above natural temperature of the waterbody; • BOD, COD and pH parameters must be consistent with same parameters for fishery waterbodies; • Concentrations of all regulated chemical elements (heavy metals, chlorides, petroleum products, etc.) should comply with the standards for fishery sea waters.	L

Seawater pollution from uncontrolled polluted runoff from the Ob Estuary water protection zone	N	Marine environment in the Port water area	H	Construction	H	M/ Mr	• Strict adherence to the works technology and timeframes;
							• Keeping the works strictly within designated territories and water areas;
							• Maintenance of motor vehicles and construction machinery at specialised service stations or contractor facilities;
							• Compliance with the regulations for economic activities within the water protection zone and coastal protection belt, including:
							  ○ Movement of construction and other machinery strictly on the existing and designed roads;
							  ○ Temporary storage of materials and structures at dedicated sites with waterproof paving;
							  ○ Temporary waste accumulation at dedicated sites with waterproof paving;
							  ○ Collection and timely removal of building and domestic wastes to a remote disposal facility under contract with a specialised company, or to the waste disposal site at the Salmanovskoye (Utrenneye) OGCF (when commissioned);
							  ○ POL storage at dedicated sites with hard paving fitted with an oily effluents drainage and capture system;
							  ○ Fuelling of machinery at dedicated sites with waterproof paving and a storm water drainage system;
								L

Impact	Sign	Receptor	Receptor sensitivity	Stage	Impact significance	Risk	Mitigation	Residual impact
							• Monitoring of the impact of the activities on the Ob Estuary, within the scope of the operational environmental control (monitoring) programme.	
Firewater intake	N	Fish fauna (juvenile fish)	M	Con	L	I	Water intake facilities will be equipped with fish protection screens	N

Seawater pollution by domestic wastewater discharged from the Onshore Facilities	N	Marine environment and fish fauna in the Port water area	H	Construction	L	I	• Collecting domestic wastewater in impermeable holding tanks;
							• Removal as appropriate by sewage (vacuum) trucks by a specialised contractor for treatment and recovery;
							• Collection of storm runoff from the construction sites in holding tanks and their subsequent removal by specialised contractors for treatment to fishery standards:
							  ○ Suspended solids – 3 mg/l
							  ○ Petroleum products – 0.05 mg/l
							  ○ BOD – 1.66 mg/l
							Treated stormwater will be transported to the wastewater treatment facilities at the Salmanovskoye (Utrenneye) OGCF.
								N

Seawater pollution by polluted melt water runoff from the Onshore Facilities	N	Marine environment in the Port water area	H	Construction	M	Mr	Measures recommended for the snow / melt water pollution prevention: • Regular mechanical cleaning of the construction/operational site using motor grader blades, bulldozers and rotary snow ploughs; • Mechanical sweeping shall start when the layer of loose snow mass on the site rises to the height of 2.5-3 cm, which corresponds to 5 cm of fresh-fallen compacted snow; • In hard-to-reach areas, snow will be removed manually, by specialised personnel; • In case of unceasing snowfall during a day, snow clearing equipment shall operate continuously, with short-time (maximum 1 hour) breaks for refuelling of machinery and meal for workforce; • At the end of snow clearing activity, snow banks of a maximum width of 1 m shall be shaped to facilitate loading on dump trucks; • The snow banks shall be arranged within a maximum period of 24 hours from cessation of snowfall; • During the period of construction and operation, snow shall be removed by dump trucks to the snow accumulation site at the PGTP No.3 included in the Salmanovskoye (Utrenneye) OGCF Facilities Setup. Haulage distance is 2.5 km.	L
Seawater pollution by domestic wastewater discharged from the Plant, Port and Onshore Facilities	N	Marine environment, fish fauna	H	Operation	M	I	• Provision of domestic sewer system connected to the OGCF domestic sewage collection system; • Three-step wastewater treatment on the OGCT treatment facilities; • Designing permissible discharge standards; • Payment of the fee for pollutants discharge to the natural environment; • Control of treated wastewater outlet quality, and monitoring of the recipient waterbody (Nyaday-Pynche River);	L

Impact	Sign	Receptor	Receptor sensitivity	Stage	Impact significance	Risk	Mitigation	Residual impact
							• Monitoring water quality in the Ob Estuary at the place of discharge of Nyaday-Pynche River	
Seawater pollution by storm and melt water runoff from the territory of the Utrenniy Terminal	N	Marine environment, fish fauna	H	Operation	M	I	• Collection of rain water in holding tanks; • Equalising and pre-settling of wastewater in equalisation tanks; • Removal of clarified water to the sewage treatment facilities at the Salmanovskoye (Utrenneye) OGCF Facilities Setup. No discharge to the Ob Estuary is anticipated.	L
Seawater pollution by industrial wastewater and storm water discharged from the Plant	N	Marine environment, fish fauna	H	Operation	H	I	• Disposal to the industrial wastewater system of the Salmanovskoye (Utrenneye) OGCF; • Treatment at the STF-3 site of the Salmanovskoye (Utrenneye) OGCF; • Injection into absorbing stratum	N
Seawater pollution from emergency spills of petroleum products, chemicals and POL within the water area and water protection zone	N	Marine environment, fish fauna	H	Construction, operation	H	M	• Developing Oil Spill Prevention and Response Plans; • Establishing oil spill prevention, control and response teams equipped with aids for hydrocarbon film collection from water, shoreline protection, spill containment within the water area, etc. • Prompt response (within 2-4 hours) to oil spills in the Port water area, to ensure containment of spill within the protected water area	M/L
Activities in the License Area								
Modification of hydrological conditions	N	Surface water	M	Construction	L	Mr	• compliance with environmental requirements for earthworks in the floodplains and onshore sections of crossings specified in the construction regulations for earthwork structures; • keeping the works strictly within designated territories; • site preparation and main civil and installation works are conducted during winter construction season; • strict compliance with the design during the grading and civil and installation works; • advance filling of access roads; • reinforcement of slopes against water erosion, managing the surface runoff to prevent stagnation of surface water; • according to the design, works to be conducted first at the site preparation stage are surface filling and grading, including arrangements for removal of surface runoff; • collection of all wastewater generated on site and their transfer to treatment; • riverbed erosion will be prevented by reinforcement of shores and provision of overflow troughs;	N

Impact	Sign	Receptor	Receptor sensitivity	Stage	Impact significance	Risk	Mitigation	Residual impact
							• implementation of systems for separate collection and treatment of domestic wastewater, industrial wastewater, and surface runoff; • operations resulting in suspension of solids are not conducted during the subglacial period; • waterproofing of all pipelines.	

Violation of water protection regulations during operations near waterbodies	N	Surface water	H	Construction	M	Mr	• Compliance with rules and restrictions for works in water protection zones, including:
							  ○ Prohibition of off-road traffic (except for specialised vehicles); traffic is only permitted on temporary and permanent access roads;
							  ○ Prohibition of fuel and lubricants storage, operation of vehicle maintenance and washing facilities;
							• Routine area cleaning and removal of all waste;
							• Collecting spent POL in dedicated tanks;
							• Fuelling vehicles and mechanisms outside of river and lake floodplains in adequately equipped sites, and from filling tanks or cisterns;
							• Using adequate filling guns for gas and oil fuelling of special vehicles to prevent spillover
								L

Disturbance of the morphological structure of river channels, of terrain and moss vegetation cover on river floodplains and valley slopes during construction of water crossings	N	Waterbodies affected by crossings for linear facilities	M	Construction	M	Mr	• compliance with rules and restrictions for works in water protection zones; • respecting restrictions applicable in the coastal protection belts; • river sections for construction of crossings are selected in areas with highest resilience to deformations, on the basis of maps and field surveys; • to avoid release of additional quantity of loose material from eroding channel and denudating banks and valley slopes, which results in a sharp increase of water turbidity, construction of underwater crossings is conducted during winter season; • riverbed erosion will be prevented by reinforcement of shores and provision of overflow troughs; • strengthening river channels with in-situ concrete; • to prevent waterlogging and bogging of adjacent areas during construction of access motor roads, metal tubes will be installed in the relief lows for passage of surface (flood) water; • gas flow-line across rivers will be constructed above surface, on pile supports. No piers or trenches in channels are designed; • to prevent damage of gas flow-line during ice drift on rivers, the crossing beam structures will be installed on piles with ice guards.	L
Disturbance of the morphology of lacustrine shelves and higher turbidity	N	Waterbodies used for jet quarrying	M	Constr uction	M	Mr	• subsoil conservation by strict observance of the boundaries and complete development of the quarry, surveying control of compliance with the designed geometry of the exploited sections of the field, including staking-out and fixation of the latter on the surface with floating marks, to ensure continuous monitoring of compliance with the	L

Impact	Sign	Receptor	Receptor sensitivity	Stage	Impact significance	Risk	Mitigation	Residual impact
of water resulting from construction of quarries for building material production							development boundaries, location of the mining equipment, adequacy of the production volumes in relation to the recoverable reserves of ground (sand, clayey loam) in the exploited sections; • strict observance of the measures to prevent pollution of waterbody with wastewater and oily water, dry rubbish and food wastes; • to prevent deterioration of sanitary and hygienic quality of waterbody, the detailed design requires that watercraft engaged in soil production are equipped with suitable holding tanks for collection of domestic wastewater, and also for domestic and industrial wastes; • pollution of river with petroleum products and oily water is prevented by providing leakproof connections and closed systems for vessels bunkering with fuel and lubricants; • the design provides for reclamation of disturbed land at the end of production activity.	

Water quality change in surface waterbodies (from wastewater discharge)	N	Surface water	H	Construction	M	Mr	Providing separate sewage systems for domestic, industrial wastewater and storm water in the OGCF territory;
							Disposing the entire domestic wastewater volume to the sewage treatment facility (STF) of the Salmanovskoye (Utrenneye) OGCF. A part of treated wastewater will be disposed in surface water bodies - lakes (during hydraulic production of sand), and to Nyaday-Pynche River, not far from the river mouth.
							Injecting associated formation water, building brines and a large portion of industrial wastewater not subject to treatment into absorbing geological formations.
							• Compliance with rules and restrictions for works in water protection zones, including:
							  ○ Prohibition of off-road traffic (except for specialised vehicles); traffic is only permitted on temporary and permanent access roads;
							  ○ Prohibition of fuel and lubricants storage, operation of vehicle maintenance and washing facilities.
							• collection, accumulation and treatment of domestic wastewater for subsequent discharge to nearby waterbodies or into geological horizons;
							• prevention of discharge of untreated and/or insufficiently treated wastewater;
							• keeping activities within the boundaries of the areas allocated for the construction;
							• provision of vessels for collection of spent POL and wastewater at the construction sites;
							• arranging facilities, such as POL storage sites, machinery refuelling and washing facilities, etc. outside the water protection zones of waterbodies, on bunded sites with impermeable paving;
							• technical washing facilities are equipped with closed-cycle water supply systems;
							• surface runoff from polluted areas of the construction sites will be collected by grade elevation open gutters at site perimeters, to holding tanks. The holding tanks capacities are designed for peak (maximum daily) surface water flows - in waterlogged areas, pipelines construction will be conducted after sufficient freezing of soils;
							• temporary waste accumulation at dedicated sites with waterproof paving;
							• collection and timely removal of the building and domestic wastes by specialised contractors;
							• grading industrial sites areas to provide a slope toward a drainage ditch, to prevent spillage of rain, snowmelt water and wastewater outside the site territory;
							• monitoring the technical state of process equipment (integrity of pipelines and vessels, operation of the control and measuring instruments and automatic process control systems);
							• monitoring of the technical state of the waste accumulation facilities (integrity of containers, vessels, bunding of the process site and drilling wastes holding basin, etc.);
							• immediate cleaning of areas affected by spills of oil and other toxic liquids; reclamation of disturbed land;
							• monitoring of the status of surface and ground water through a system of monitoring stations.
								N

Acquisition of land for the Plant in floodplains and channels of streams	N	Sections of waterbodies subject to acquisition	M	Construction	M	Mr	• Maintaining and supporting the natural direction of surface runoff; • Mandatory observance of boundaries of construction and operation sites; • Observing work regulations for water protection zones and coastal protection belts;	L

Impact	Sign	Receptor	Receptor sensitivity	Stage	Impact significance	Risk	Mitigation	Residual impact
							• Conducting construction activities during cold season, as far as possible, considering the local climate; • Strict control of adequate technical state of machinery.	
Water abstraction for the water supply	N		M	Construction, operation	M	M	• Compliance with the Water Use Agreements; • Keeping records of water intake volumes; • Providing to interested agencies of information on the results of measured accounting of water intake (abstraction) from water body, and on wastewater and/or drainage water discharge volumes and quality; • Filtration ditch with a bottom gradient toward the main drainage channel along the header, will be excavated at the site perimeter, to stop spillage of spent water to ground and collect filtration water, under stock piles. The drainage channel will recycle the water back into the lake	L
Water quality change in surface waterbodies (from wastewater discharge)	N	Surface water	H	Operation	M	Mr	• All types of wastewater generated at the Project facilities and the associated facilities will be transferred to the treatment facilities of the Salmanovskoye (Utrenneye) OGCF; • Domestic wastewater and stormwater will be treated to meet MPC for fishery waterbodies and discharged to the Nyaday-Pynche River; • The Project provides for monitoring of the effluents discharged to the river • Associated formation water, construction brine solutions and major part of industrial wastewater will be injected into intake formations.	N
Surface water pollution from accidents	N	Surface water	H	Accidents	H	M/Mr	• Developing Oil Spill Prevention and Response Plans • Establishing and contracting special units for prevention, monitoring, localization and elimination of spills of condensate, petroleum products and other technical liquids, equipped for skimming hydrocarbons, protection of coastlines, localization of spills in the water area, which are also capable to organize monitoring of spills. Emergency response actions: • In case of pipe rupture during strength tests of the gas pipeline, making arrangements for water drain to the sump and containing water released through rupture points within the construction site; • In case of fuels or lubricants spillage to ground, mechanical removal of the spilled liquids, soil burning-out or polluted soil mixing with sorbent and removal of the mixture to a dedicated waste disposal site; • Immediate shutdown of operation of the damaged network section or facility at the time of the beginning of emergency response actions; • In case of an accident at the sewage system, diversion of incoming wastewater to bypass the damaged network section or facility through an emergency discharge outlet	M/ L

9.4 Impact on Soils and Subsoil

One physiographic feature of the subject area is the spatial and temporal correlation of the soil formation and exogenesis processes, and therefore the impacts of the planned activity on soil, terrain and exogenous processes, as well as on the geological environment require that a joint forecast process, a single set of response measures, and a common monitoring program be developed.

9.4.1 Sources of impacts

The majority of the impacts of the proposed activity on soils and the subsoil as well will be limited to the construction phase and will be due to:

- Construction of temporary and permanent buildings and installations, including earth embankments, bases and foundations;
- Works that create static and dynamic loads on soil foundations and geological environment (pile driving and other similar works relating to the construction of foundations for buildings and installations, operation of construction machinery and other special equipment, operation of vehicles);
- Direct physical and mechanical disturbance of the integrity of the soil strata and water-bearing horizons with the transformation of the natural terrain into a man-made one and the replacement of some of the local soils with imported (transposed) ones.

Impacts on soils and subsoil during the Project construction and operation will also originate from:

- Extraction of hydrocarbons and soil-based building materials and injection of treated wastewater into deep geological horizons;
- Sources of air emissions of pollutants; air pollutants will come into contact with the soil and topmost horizons of the geological environment that are devoid of soil, and a wide range of such pollutants will be deposited therein;
- Heat radiation sources – buildings and structures with temperatures higher than those of the surrounding geological strata, or those creating heated intermediary medium (e.g. warm air at flare or ventilation systems sites).

Furthermore, the construction activity will activate dangerous exogenous geological processes and hydrological phenomena (DEGP&HP), and buildings and structures of the Field, Plant and Port will stay as a destabilizing factor for soils and the subsoil also during the operation phase. In particular, such effects will include colmatation (clogging of pore space) and compaction of soils under the weight of construction machinery, buildings and structures, and redistribution of surface and subsoil runoff, including barrage and drainage effects along filled embankments – particularly along the linear facilities.

In the onshore conditions, among secondary DEGP&HP, the most dangerous are various cryogenic processes (frost cracking, frost heaving, thermokarst, thermal erosion, solifluction), underflooding, wind and water erosion and accumulation. Local downcutting and lateral erosion, gravitational processes are expected. The risk of outbursts of intrapermafrost brines and gas hydrates is small and local.– In the water area and on the shores of the Ob Estuary, under the influence of the hydraulic structures, the course of ice-exaration processes will change (gouging by ice, ice piles and thrusts within the foreshore area); temporary flooding of land areas may be accompanied by icing, erosion, and water accumulation.

In addition to long-term impacts from the sources mentioned above, accidental impacts may also occur, associated with the failure to comply with design solutions or a variety of external factors. The most likely sources of such impacts are as follows:

- Hydrocarbon supply and storage facilities (including feed and treated condensate, hot oil);
- Process liquids storage and handling facilities (including fuels, lubricants and paints, glycol solution, solvents, methanol, water-mineral solution);
- Waste collection facilities;
- Water supply and wastewater disposal facilities.

Emergencies associated with these sources, which may impact the soil and the geological environment, include:

- spills and leaks of fuels, lubricants and paints and other process liquids, as well as wastewater, leading to their entry into the soil and the geological environment and causing the formation of infiltration bodies in soils and groundwater pollution;

- Uncontrolled disposal of construction waste and wastewater in the geological environment;
- Use of contaminated soils in the development of technogenic topography;
- Infiltration of polluted surface runoff (storm and melt snow water) into the soil;
- Replenishment of water-bearing horizons with leaks from water pipelines;
- Groundwater pollution due to rises in groundwater levels (flooding), and contact with building materials and structures and construction waste on the surface.

9.4.2 *Impact systematization*

The systematization of impacts of the planned activity on soil and subsoil proposed by the Consultant (Table 9.4.1) takes into account the phasing of the planned activity and the results of the pre-FEED engineering surveys.

Table 9.4.1: Impact of the Planned Activity on Soils and Subsoil

Grouping of impacts by genesis	Types of impacts to be assessed
1. Impacts on land, conditions of land and subsurface use	1.1. Acquisition of land for the construction of the designed facilities
	1.2. Restrictions on land use (including environmental restrictions)
	1.3. Changes in the conditions of subsoil use
	1.4. Changes in availability of geological baseline information about the concerned area
2. Direct physical impacts on soil and subsoil	2.1. Destruction of the soil or topmost soil horizons
	2.2. Transformation of the soil strata as a result of earthworks or related work: cutting, excavation and movement of soils, construction of embankments (including the use of imported soils), technical reclamation
	2.3. Vertical transformation of the soil strata as a result of drilling and piling operations
	2.4. Static loads on the soil from buildings and installations
	2.5. Dynamic loads on the soil (caused by traffic, piling and other works associated with impacts on the geological environment)
3. Thermal impact on soils and subsoil	3.1. Temperature of soil, ground and ground water increase due to direct contact with surfaces of above-ground and underground buildings and structures which are warmer than containing geological environment, or are exposed to influence of a heated intermediate medium (e.g. warm air at the sites of flaring and ventilation systems)
	3.2. Secondary transformation of the thermal regime of soils and rocks in the areas of snow clearing, excavation and related works, placement of buildings and installations, and reclamation, i.e. as a result of changes in the natural combination of hydrothermal regime factors
4. Secondary impacts of dangerous exogenous geological processes and hydrological phenomena (DEGP&HP)	4.1. Ice exaration impact (gouging by ice) - Weakening by ice-protective structures and strengthening of ice-protective structures from the outside
	4.2. Physical and mechanical impact of ice masses on the installations and the natural relief of the Ob Estuary coast (e.g. due to ice piles and thrusts within the foreshore area)
	4.3. Flooding and related processes (icing, erosion, water accumulation)
	4.4. Bottom and lateral erosion, sediment redistribution. 4.4.1. Change in sediment balance due to the redistribution of water flows and ice masses caused by the hydraulic structures. 4.4.2. Complete or partial blocking of sediment movements 4.4.3. Local transformation of river channels in places where they are crossed by linear structures or where culverts are built
	4.5. Permafrost degradation and related processes (thermokarst and thermal erosion; an increase in the influx of organic matter decomposition products from the soil into the atmosphere; local releases of gases previously accumulated in the permafrost)
	4.6. Frost cracking
	4.7. Frost heave
	4.8. Groundwater impact: 4.8.1. Impact (discharge) of supra-permafrost groundwater (flooding) and related processes (icing, suffusion and subsidence, waterlogging, gleying of soil and ground). 4.8.2. Impact (discharge) of inter-permafrost supercooled highly mineralized groundwater - cryopegs
	4.9. Aeolian processes: 4.9.1. Deflation (wind erosion) and aeolian accumulation (thermogenic weathering is an accompanying process). 4.9.2. Aeolian accumulation

Grouping of impacts by genesis	Types of impacts to be assessed
	4.10. Suffusion and subsidence (unrelated to flooding)
	4.11. Gravitational processes (solifluction, sinking of slopes, etc.)
	4.12. Planar erosion and accumulation
5. Chemical and biological pollution of soil and geological environment	5.1. Contamination of the soil or topmost soil horizons of the vadose zone that are in contact with the soil or devoid of soil accompanied by the formation of secondary foci and/or infiltration bodies
	5.2. Secondary mobilization and addition of pathogens of dangerous diseases to the food chain
	5.3. Secondary mobilization and distribution of pollutants in the soil and geological environment
	54. Groundwater pollution
6. **Impact of minerals extraction**	6.1. Reduction of hydrocarbons deposits
	6.2. Reduction of commonly occurring mineral resources
	6.3. Deformation processes
	6.4. Technogenically induced seismicity
7. **Impacts of treated wastewater injection into geological horizons**	7.1. Chemical and biological pollution
	7.2. Chemical and biological contamination of groundwater in other horizons
	7.3. Transformation of subsoil natural hydrodynamic conditions

All impacts listed in Table 9.4.1, will be caused by the planned activity in one form or another and to one degree or another, and the significance of their consequences will be determined by the sensitivity of the receptors and the effectiveness of the countermeasures.

9.4.3 Impact receptors and their sensitivity

The primary receptors of the impacts listed in Section 9.4.2 are the components of the natural environment of the area of influence of the planned activity: the soils, the geological environment, including soils and groundwater, surface water bodies, vegetation, and animals.

Indirectly, the impacts will affect the natural resources of the Tazovskiy Municipal District of the YNAO (land, soil, water, subsoil resources) and the quality of the corresponding ecosystem services (ecosystem functions) used by members of the local nomadic population engaged in traditional forms of land use. In addition, response reactions in the soil and the geological environment will affect the buildings and installations of the Project.

The receptors listed above vary in their sensitivity to impacts from the planned activity. The most sensitive receptors are *soil and the topmost horizons of the geological environment* – the seasonally thawed layer, the roof of permafrost rocks, the topmost groundwater horizon: as shown in Chapter 7, these landscape components are highly vulnerable to physical, mechanical and thermal impacts, exposed to the penetration and accumulation of pollutants falling with precipitation on the soil surface or entering with spills and leaks of process fluids or wastewater, or during solid waste handling.

The main ecological functions of *soil* in the area are maintaining the fragile status of local ecosystems, including productive lichen pastures, conserving permafrost through thermal insulation, regulating the water regime of the seasonally thawed layer, and stability of the terrain. Soil is also a natural depositing medium for pollutants and microorganisms, including pathogens of dangerous diseases, and, therefore, responses of soil to the impacts can significantly expand the area of influence of the planned activity and the range of impact receptors.

The upper horizons of the geological environment actually include the soil strata involved in soil formation, which generally correspond to the thickness of the seasonally thawed layer within the area in question (with the exception of hydrogenic taliks under lakes and marshes) and the upper part of the permafrost layer affected by the Project construction work. The high sensitivity of this landscape component is primarily due to the permafrost nature of the temperature and water regimes of the soils that are prone to transformation triggered by a local damage to vegetation or the removal of snow cover, with consequential outbreak of a wide range of exogenous geological processes across a much larger area.

Ground waters within the Salmanovskiy (Utrenniy) License Area are not used in economic activities and are not highly sensitive to technogenesis. The shallow groundwater horizon is generally represented by fresh, free-flowing, supra-permafrost waters of the seasonally thawed layer which undergo phase changes on the annual basis. Along with waters of hydrogenous non-through taliks, which are confined to modern alluvial, marine and biogenic sediments and hydrologically associated with surface water bodies that caused their presence, those horizons are not protected from the ingress of pollutants with surface runoff and act as a carrier medium.

In this case, the sensitivity of the two above-mentioned groundwater horizons should be assessed as medium, as, on the one hand they lack protection from penetration of pollutants, but on the other hand these waters have no practical value. It is predicted that the impact of the planned activity on the permafrost waters will be significant, but local and most pronounced during the construction period. On the contrary, intra-permafrost brines are characterized by low sensitivity, but they themselves may pose a danger to the proposed buildings and installations if they break through to the surface or come into contact with underground parts of buildings and installations.

In the context of *soil, subsoil and other resource availability*, vulnerability of the area is defined by the boundaries of its examination: for the purposes of this assessment, the Consultant considers the area of Tazovskiy Municipal District and the previously established elements of its territorial division – the Antipayuta and Gydan tundras, and due to the relatively low Project needs for soil resource, their vulnerability in this case is low.

Receptors of soils and subsoil response impacts are considered as highly vulnerable for the following reasons:

- *ISPN communities* rely heavily on the reindeer pasture resources that depend, among other things, on stability and specific properties of soils and geological top strata;
- *Buildings and installations of the Project* are located in complicated geological and geomorphological conditions with high engineering risks.

9.4.4 Responses from soils and the geological environment to impacts if the planned activity

The ultimate result of the analysis presented in Chapter 7 and Section 9.4.3 consists in the integrated assessment of soils in the designed location area of the Field, Plant and Port Facilities as highly sensitive to physical, mechanical and chemical impacts. Due to the high intensity of exogenous geological processes within the area of the planned activity, young primitive soils that have no ecological or economic value are widespread, and their loss will be followed by their rapid restoration – within a few years or decades – in areas free from buildings and hard surfaces. On the other hand, soils with a well-formed profile (podburs, gleysols) and thick organogenic horizons (peat-gleysols, peat oligotrophic, peat-cryosols) have been forming for hundreds and thousands of years, and no restoration of their profile will be possible after its physical-mechanical destruction.

The soil conditions in the area under review, with its notable complexity and heterogeneity, do not play a decisive role in choosing the land plots most suitable for constructing the designed buildings and installations. At the same time, soil responses to physical and mechanical disturbances accompanying the construction work, and the ability of soils to accumulate pollutants and dangerous microorganisms should be taken into account when designing environmental protection measures accompanying the implementation of the planned activities and operational environmental monitoring.

The combination of chemical and mechanical impacts on the soil leads to the development of specific trends in their technogenically provoked evolution. At the same time, soils may lose a number of their ecologically important qualities and functions forever (that is, for a very long time, of the order of hundreds or thousands of years), become “aggressive” in relation to the geotechnical systems being created; such trends need to be monitored and recorded in the course of reclamation and operational environmental monitoring during the Project construction and operation.

Preliminary systematization of responses of soils and exogenous geological processes to anthropogenic impacts (Table 9.4.2) makes it possible to develop recommendations for the restoration of soil that may be disturbed by the planned activity. The most common scenario of technogenic transformation of soils and conditions of relief formation within the area under review is shown in Figure 9.4.1: physical and mechanical disturbance of soil and vegetation leads to changes in the thermal conditions of soil and intensification of dangerous exogenous processes, and may provoke build-up of critical conditions in the buildings and installations.

Table 9.4.2: The most likely scenarios of technogenic transformation of soils and exogenous geological processes within the Project construction area

Driving factors		Driving processes	Transformation of soil	Change of land use conditions
Physical and mechanical disturbances of the vegetation and soils, including organogenic horizons	Changes in the hydrothermal conditions of soils and ground within the construction area. Changes in the structure of surface and underground runoff	Secondary cryogenesis	Loss of natural horizontal profile stratification by soils, pedoturbation, and other scenarios of physical and mechanical transformation of soil bodies and soil structures	Increased seasonal mobility of soils leading to a deterioration of the engineering-geological conditions within the area. Epizootics caused by mobilization of spores and their addition to the food chains
		Secondary hydromorphism	Change in hydrophysical and morphological properties, hydrothermal conditions of soils Alternating mobilization/ immobilization of iron and manganese compounds and associated metals and organic substances, their joint deposition on geochemical barriers	Increased seasonal mobility of soils leading to deterioration of the engineering-geological conditions within the area Increased aggressiveness of soils to construction materials. Local iron accumulation at the boundary between the building structures and the soil
	Physical and mechanical loads on the soil surface	Compaction (for peat - shrinkage)	Distribution of soils with shorter organic horizons, peatlands degradation	Increased seasonal mobility of soils leading to deterioration of the engineering-geological conditions within the area
	Formation of soil bases for buildings and installations	Burial under technogenic soils	Distribution of reduced soils with shortened profiles, sand arenas, buried soils, primitive fill-up soils	Replacement of natural soils with technogenic fill-up and alluvial soils
	Formation of technogenic terrain	Water erosion and deflation, concentrated accumulation, solifluction		Formation of sand arenas, exposure of pipelines and other underground structures Destruction of soil, development of planar and linear erosion. Increased risk of pipe exposure, sagging and deformation
Entry of pollutants	with precipitation (directly or through snow cover)	Accumulation, migration and transformation of pollutants	Increased soil toxicity	Gradual degradation of the vegetation cover accompanied by the loss of productivity of ecosystems, including deer pastures
	during spills of process fluids, wastewaters, distribution of polluted surface runoff		Changes associated with secondary hydromorphism (see above) Increased soil toxicity	Same changes as above, but of greater intensity

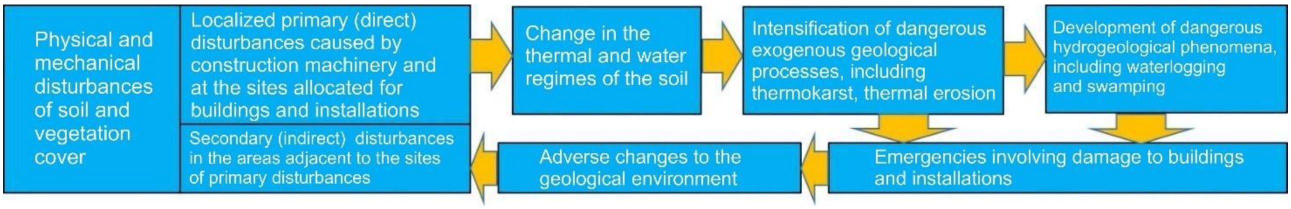


Figure 9.4.1: Flow chart of the distribution of primary and secondary disturbances of the soil and the geological environment in the cryolithic zone caused by construction work

Secondary intensification of dangerous exogenous processes will be the most significant response of the geological environment to the impact of the planned activity, which may also cause local manifestations of other processes due to the local features and the use of subsoil, including explosion gas occurrences, conditions of which are described in Chapter 7.

In particular, one hydrogeological feature of the Plant onshore structures is cryohaline water (cryopegs) found in this area – these are intra-permafrost supercooled brines, occurring at a depth of 10-20 m, which occurrences on the surface are an accident factor due to the pressure levels, high corrosivity and negative temperature of these waters. Manifestations of cryopegs (as well as gas hydrates[86]) are most likely during the construction period and may result from disruption of the natural impermeability of the corresponding strata by drilling operations and, in the long run – from degradation of overlying permafrost.

In addition, the extraction of hydrocarbons and earth-based building materials provided for by the Arctic LNG 2 Project may lead to the intensification of local geodynamic processes – the most likely scenario being a slow and steady subsidence of the land surface and the sea floor above the subsurface area in question. Due to the fact that the deformation of the earth's surface within the bounds of the field caused the land users' concern at the stage of preliminary discussions in March 2018, the forecast of geodynamic impacts of the planned activity has been presented in as much detail as possible with a review of similar facilities (Appendix 8).

9.4.5 Quantitative parameters of the Project impacts on soil and exogenous geological processes

In the whole territory of the license area (340,900 ha), about 4000 ha (just more than 1%) will be occupied by the permanent facilities and temporary site facilities (TSF). Most of this area will be used for the Field facilities (Table 9.4.3), however, it should be noted that more than a half of the land areas acquired for the Project is subject to reclamation and will be returned to the lessor after completion of the construction phase (Figure 9.4.2).

[86] No surface gas hydrates or significant accumulations of gasous products of their dissociation have been detected by engineering geological surveys within the license area, but this phenomenon is generally characteristic of the part of the cryolithic zone under review, and therefore it can be assumed that gas hydrates occur in deeper unexplored geological horizons. A spontaneous gas occurrence was registered during engineering-geological drilling in the coastal area (refer to Chapter 7 for details).

Table 9.4.3: Acquisition and reclamation of soils in relation to the Project

<table>
<tr><th rowspan="2">Project facilities</th><th colspan="3">Acquisition of soils, ha**</th><th colspan="3">Extent of restrictions</th></tr>
<tr><th>Long-term acquisition (for the whole Project period)</th><th>Short-term acquisition (for construction)</th><th>Total land acquisition</th><th>Established land plots*</th><th>SPZ (including overlapping and excluding land allocation)</th><th>Other URZ</th></tr>
<tr><td colspan="7">Arctic LNG 2 Project</td></tr>
<tr><td>GBS LNG & SGC Plant</td><td>42</td><td>14</td><td>56</td><td rowspan="8">The process of establishing land plots for the Project and their cadastral registration has not been completed, therefore, Project land acquisition parameters are subject to updating. Some of the established land plots are immediately used for the Project facilities, while other (with the total area estimated by the Consultant as 40% of the values stated in the table) can be considered as a reserve, or territory subject to land use restrictions around the designed facilities</td><td rowspan="2">1500</td><td rowspan="8">Project facilities being constructed or designed, as well as the airport are coupled with regulated zones where restrictions are applied on development and certain forms of nature use, as well as protective sanitary zones, and areas with other conservation and monitoring status</td></tr>
<tr><td>Terminal (Port)</td><td>31</td><td>39</td><td>70</td></tr>
<tr><td>Field facilities, including</td><td>1613</td><td>1888</td><td>3501</td><td rowspan="4">9300</td></tr>
<tr><td>Early development facilities</td><td>434</td><td>88</td><td>522</td></tr>
<tr><td>PIR-1</td><td>65</td><td>145</td><td>210</td></tr>
<tr><td>PIR-5</td><td>1114</td><td>1655</td><td>2769</td></tr>
<tr><td colspan="4">Associated Facilities</td><td></td></tr>
<tr><td>Airport</td><td>256</td><td>190</td><td>446</td><td>320</td></tr>
</table>

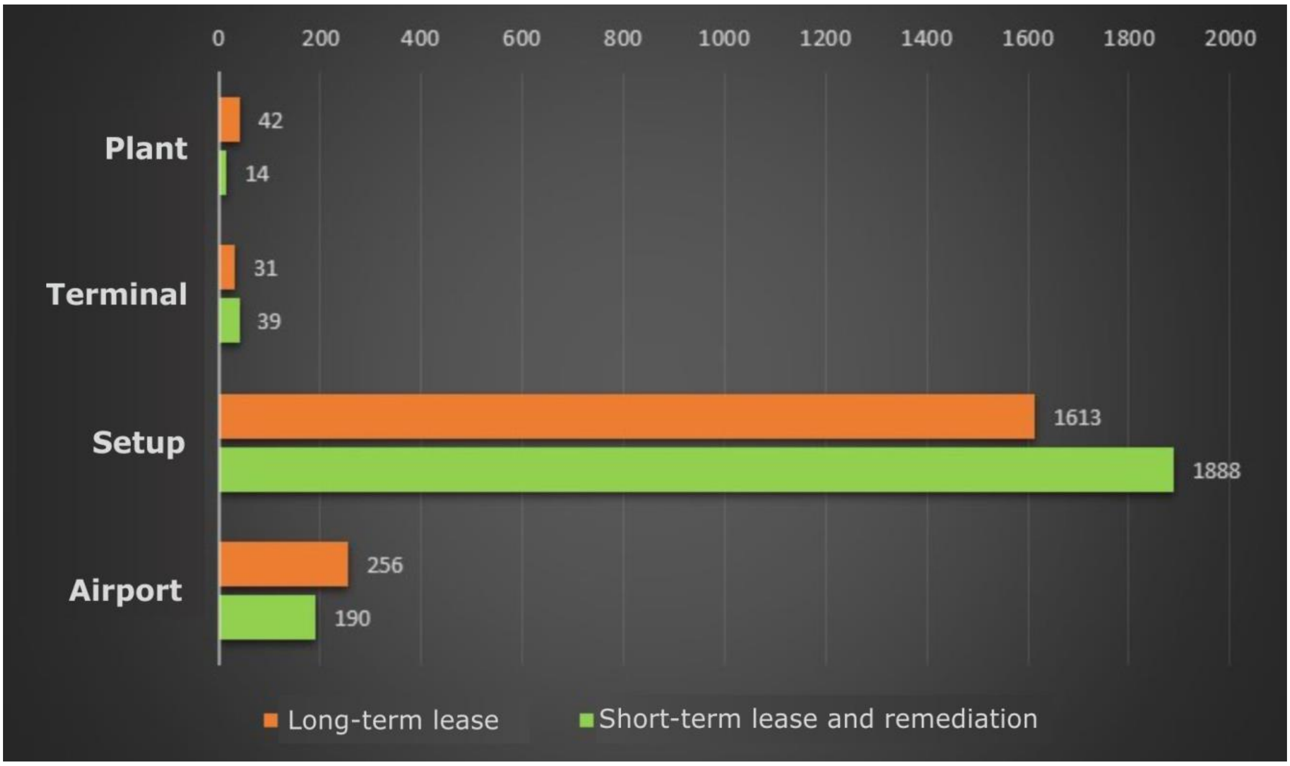


Figure 9.4.2: Estimation of the scale of reclamation of land acquired under short-term lease for the Project construction, compared to the permanent land acquisition

The Utrenniy Airport is the second largest facility in terms of required land acquisition, as significant land allocation is planned in relation to its construction.

Land plots acquired under short-term lease make up about 50% (about 2000 ha) of the total land acquisition. These areas will be used during 3-5 years for the temporary site facilities during the construction, after which they will be reclaimed and returned to lessor. Summary of the designed reclamation of such land plots is provided in Annex 10.

Disturbed areas are unevenly distributed in the territory of the Salmanovskiy (Utrenniy) LA (Figure 9.4.3): most of them are associated with the onshore sites of the Plant and Port, as well Field facilities nearest to them. The largest territories with land use restrictions will be located in the same areas, due to operation of the Project facilities. The largest sanitary protection zones will be those established with reference to the level of chemical pollution of air, therefore, specific restrictions on agricultural activity will be applied in such SPZ (in the given circumstances, prohibition of deer grazing, picking wild crops and medicinal plants and mushrooms will be applied).

Sanitary protection zones of the Plant, Port and main Field facilities (well pads, gas treatment units, power supply complex, waste disposal site) will extend beyond the respective boundaries of land acquisition. Total area of soils not physically occupied by the Project but falling within regulated SPZs of the Project facilities is tentatively estimated by the Consultant (Table 9.4.4) as 12,000 ha, i.e. about 5% of the LA territory.

Table 9.4.4: Estimated size of territory beyond the Project land acquisition where soils will fall within sanitary protection zones

№	Soils		Replacing natural vegetation with bare soil, or with young soils in reclaimed areas						Impact on soils through atmospheric precipitation (within SPZs of the Field, Plant and Port, considering overlapping and less facilities' sites areas)		Acquisition of vegetation during construction of the Utrenniy Airport						Impact on vegetation through atmospheric precipitation (SPZ of the ground-based facilities of the Utrenniy Airport)		Respective vegetation and value of pasture lands			
	Soils and soil structures as per ESRSR-2014, occurrence rate in the YNAO (%)	Soils and soil structures as per WRB-2015	Long-term replacement with the Project buildings and installations		Short-term replacement for the period of construction, with subsequent biological reclamation		Total Project land acquisition				Long-term replacement with the Project buildings and installations		Short-term replacement for the period of construction, with subsequent biological reclamation		Total land acquisition				Vegetation	Green forage reserves	Lichen forage reserves	Relative pasture land value score (5-point scale)
			ha	share, %	ha	share, %	ha	share, %	ha	share, %	ha	share, %	ha	share, %	ha	share, %	ha	share, %		3-point scale		
1	Low-center polygonal complexes of peaty and peaty-gley bog (ID 170), tundra gley peaty and peaty soils (ID 8), soils of cryogenic fissures (ID 308) and barren patches (ID 16) - 6.5%	**Codominants:** Histic Reductaquic Turbic Cryosols (Dystric, Arenic). **Associated:** Dystric Cryic Histosols (Turbic), Protic Arenosols (Aeolic), Dystric Arenosols, Turbic Leptic Cryosols	194	11,5	203	10,5	397	11,0	1387	11,6	54	21,1	30	15,9	84	18,9	36	11,3	Polygonal and patterned ground dwarf-shrub tundra	1	2	3
2	Fissure-polygonal complexes of tundra surface-gley differentiated, tundra gley peaty and humus soils, soils of cryogenic fissures and barren patches (ID 239) - 2.2%	**Codominants:** Histic Reductaquic Turbic Cryosols (Dystric, Arenic), Dystric Cryic Histosols (Fluvic, Turbic), Dystric Histic Reductic Gleysols (Turbic). **Associated:** Histic Turbic Cryosols (Dystric)	534	31,6	681	35,1	1215	33,5	2551	21,3	114	44,8	85	44,8	200	44,8	103	32,0	Forb-subshrub-moss tundra	2	2	4
3	Hillocky hummocky complexes of tundra gley peaty and peat/ peat and peaty tundra gleysols (ID 8), peaty and peat-gley paludal soils (ID 170), soils of cryogenic fissures and barren patches (ID 308 and 16) - 15.3%	**Codominants:** Dystric Histic Reductic Gleysols (Turbic), Dystric Cryic Histosols (Turbic). **Associated:** Histic Reductaquic Turbic Cryosols (Dystric, Arenic)	502	29,7	521	26,9	1023	28,2	2845	23,7	26	10,0	19	10,0	45	10,0	81	25,4	Willow sedge and cottongrass tundra	2	1	3
4	Hillocky hummocky complexes of tundra podburs (ID 11), tundra gley peaty and peat soils (ID 8), soils of cryogenic fissures and barren patches (ID 308 and 16) - 0.3%	**Codominants:** Dystric Fluvic Gleyic Arenosols (Turbic), Spodic Cryosols (Dystric, Arenic). **Associated:** Protic Arenosols (Aeolic), Dystric Arenosols	38	2,3	52	2,7	90	2,5	245	2,0	10	3,9	7	3,9	17	3,9	12	3,8	Hillocky tundras and chionophilous communities	1	1	2
5	Combinations and complexes of tundra podburs (ID 11), tundra gley peaty and peat soils (ID 8), soils of cryogenic fissures (ID 308) - appr. 3%	**Codominants:** Spodic Histic Reductaquic Cryosols (Dystric), Dystric Fluvic Spodic Histic Gleysols. **Associated:** Spodic Histic Turbic Cryosols (Arenic)	73	4,3	102	5,3	175	4,8	634	5,3	1	0,2	0	0,2	1	0,2	3	0,9	Subshrub willow tundra	3	1	5
6	Combinations of waterlogged floodvalley (ID 192), peaty and peaty-gley bog soils (gley peaty and peaty bog) soils (ID 170), peaty bog and transitional soils (ID 165) and peat bog lowland soils (ID 166), sands (ID 305) - appr. 2 %	**Dominant:** Dystric Gleyic Histic Fluvisols (Turbic). **Associated:** Subaquic Fluvisols (Arenic), Spodic Histic Reductaquic Turbic Cryosols (Dystric, Arenic, Fluvic), Haplic Arenosols, Dystric Arenosols	119	7,1	177	9,1	296	8,1	1076	9,0	10	3,9	17	9,1	27	6,1	29	9,0	Vegetation complexes of small river valleys; meadows, subshrub tundras, sedge bogs	3	1	4
7	Combinations of tundra podburs (ID 11), tundra gley peaty and peat soils (ID 8), peaty and peaty-gley bog soils (gley peaty and peaty bog soils, ID 170) - около 2 %	**Codominants:** Spodic Histic Reductaquic Cryosols (Dystric), Dystric Fluvic Spodic Histic Gleysols. **Associated:** Dystric Cryic Histosols	49	2,9	49	2,5	98	2,7	246	2,1	8	3,1	4	2,2	12	2,7	14	4,4	Dwarf-shrub lichen tundra	1	3	5
8	Peaty and peaty-gley bog soils (gley peaty and peaty bog soils, ID 170) in combination with peat bog transitional soils (ID 165) and peat bog lowland soils (ID 166) - appr. 0.5 %	**Codominants:** Dystric Histic Reductic Gleysols (Turbic), Dystric Cryic Histosols (Turbic). **Associated:** Histic Reductaquic Turbic Cryosols (Dystric, Arenic), Dystric Cryic Histosols (Fluvic)	115	6,8	74	3,8	188	5,2	674	5,6	33	12,8	26	13,7	59	13,2	35	10,8	Sedge and cottongrass wetlands	3	0	4
9	Peat bog upland (ID 164) and peat bog transitional soils (ID 165) in combination with Ppeaty and peaty-gley bog soils (gley peaty and peaty bog soils, ID 170) - appr. 2.5 %	**Dominant:** Histic Gleysols (Dystric). **Associated:** Eutric Cryic Histosols, Eutric Gleysols	42	2,5	55	2,8	97	2,7	309	2,6	1	0,3	1	0,3	1	0,3	5	1,5	Sphagnum and sedge-sphagnum bogs	1	0	3
10	ID 305: Sands - 0.1%	*Речные пески* **Codominants:** Subaquic Protic Arenosols, Protic Arenosols. **Associated:** Haplic Arenosols, Dystric Fluvic Gleyic Arenosols (Turbic) *Приморские пляжи* **Codominants:** Subaquic Protic Arenosols, Tidalic Protic Arenosols. **Associated:** Haplic Arenosols, Dystric Arenosols *Пески междуречий природные* **Codominants:** Haplic Arenosols, Dystric Arenosols. **Associated:** Protic Arenosols (Aeolic), Spodic Cryosols (Dystric, Arenic) *Песчаные насыпи техногенные* Codominants: Leptic Technosols (Arenic, Relocatic, Transportic), Protic Arenosols (Aeolic)	17	1,0	22	1,1	38	1,1	566	4,7	0	0,0	0	0,0	0	0,0	3	0,9	Sands on foreshores, deflated areas, fills with pioneer vegetation	0	0	0
11	ID 307: Water - 0.5%	None	4	0,3	5	0,3	9	0,3	1466	12,2	0	0,0	0	0,0	0	0,0	0	0,0	Waterbodies with aquatic and wetland vegetation	1	1	1
		Total:	**1686**	100,0	**1941**	100,0	**3627**	100,0	**12000**	100,0	**256**	100,0	**190**	100,0	**446**	100,0	**320**	100,0				

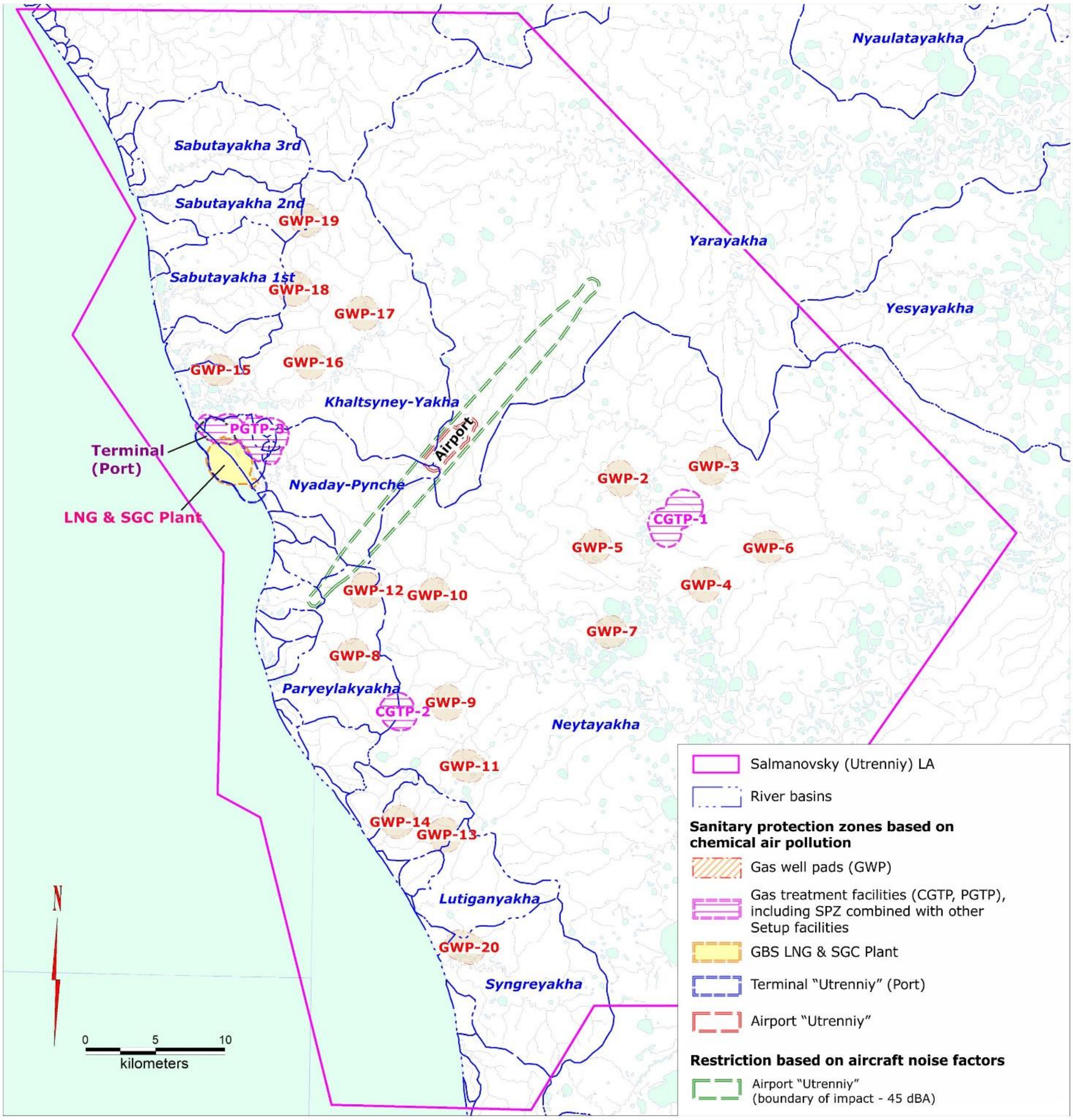


Figure 9.4.3: Sanitary protection zones of the Project facilities

(also refer to Table 9.4.4)

The Consultant has estimated the areas of soils that will be acquired:

- For the period of construction of specific components of the Project (3 to 5 years, in most cases), with subsequent technical and biological reclamation in accordance with the approved design;
- For the whole Project period or its significant part, for construction of permanent buildings and installations, where reclamation design will most likely be developed as part of the dismantling design documentation using the environmental monitoring results and new survey data.

Similar calculations (Table 9.4.4) have been made for the Utrenniy Airport being the only associated facility of the Project that will occupy dedicated land plots.

Also, soil areas falling within the sanitary protection zones based on levels one or more air pollutants above the MPC limit have been estimated. Restrictions on agricultural activity will apply within the SPZ, including prohibition of deer grazing, as well as picking wild crops for which soils function as substrate.

Given that a part of air pollutants emitted by the Project sources will precipitate on soils surface and be deposited in soils, cancellation of the sanitary protection zones after decommissioning of the Project facilities is subject to verification with environmental monitoring data and special surveys to confirm safe levels of pollutants accumulated in soils.

The following conclusions can be drawn from analysis of the above areas.

1. Most of the permanent and permanent land acquisition areas of the Project (about 60% of the allocated land plots) represent three most common structures of the regions' soils:

- Fissure-polygonal complexes of tundra surface-gley differentiated, tundra gley peaty and humus soils, soils of cryogenic fissures and barren patches;
- Low-center polygonal complexes of peaty and peaty-gley bog (ID 170), tundra gley peaty and peaty soils (ID 8), soils of cryogenic fissures (ID 308) and barren patches (ID 16) - 6.5%
- Hillocky hummocky complexes of tundra gley peaty and peat soils (peaty tundra gleysols), peaty and peat-gley paludal soils , soils of cryogenic fissures and barren patches[87].

2. Most part of soils to be acquired are not associated with the most productive (5 points, refer to Table 9.4.4) reindeer pastures. The share of tundra podburs and soil associations where podburs are included that function as substrate for subshrub-lichen and subshrub willow tundras (being the most valuable pasture resources) is estimated at 7 percent of the permanent land acquisition and 11-12 percent of the temporary land take (subject ot reclamation at the end of construction). Within the sanitary protection zones, these soils account for approximately 7.5% of unbuilt surfaces.

3. Sands exposed to rapid destruction due to deflation and associated exogenous processes account for approximately 1% of the Project land acquisition; the share of soil-barren inland waterbodies is 0.3%. Exposure of soils of floodvalley complexes in river valleys is also relatively small - 7% and 9%, respectively. As that sites for immediate construction of buildings and installations have been selected in least waterlogged areas, the share of waterbodies falling within the sanitary protection zones increased to 12%.

9.4.6 Impact prevention and mitigation measures

The impacts on the geological environment and the DEGP&HP listed above are taken into account when designing environmental protection measures, most of which are indirectly related to the geological environment, directly affecting the adjacent media – the soil and vegetation cover, surface waterbodies, buildings and installations.

In particular, in order to avoid the adverse impacts on the geological environment listed above, the project design documentation provides for:

- Preserving the soils of the land acquisition area in an undisturbed state as much as possible; in areas where soil conservation in its natural state is impossible – provide for preliminary removal of organogenic horizons (if they exist and have thickness in excess of 0.3 m) and preservation of their material for subsequent use in reclamation;
- Conducting earth works in the period when soil and ground is frozen to the excavation depth;
- Using soils without ice inclusions and with low susceptibility to cryodeformations while building embankments;
- Using special equipment and methods of protection against congelifraction when laying underground pipelines;
- Reclamation of land leased for short-term periods and disturbed by construction work, and subsequently transferring the same to the lessor;
- Preparation of sites intended for construction of permanent facilities, to prevent accumulation of rain and melt water at the edges of soil foundations, and the rise of the groundwater level (waterlogging), with a drainage system for interception of streams and redirection of flow to the Ob Estuary, scour protection and other methods of shoreline mechanical and thermal stabilization of slopes;
- Protecting soil foundations from damage;
- Providing thermal insulation of buildings, installations and the surfaces of free soils to prevent permafrost degradation (including with the use of thermal stabilizers).

[87] Table 9.4.4 lists the names of all soils acquired for the Project with reference to the RF Unified State Register of Soil Resources and the international classification of soils WRB-2015

Besides the above technical arrangements, the design documentation for the Field, Plant and Port also provides for a system of management measures to minimise the Project impact on soil and subsoil:

- Minimizing land acquisition and organizing construction work in a way to avoid any damage to the soil by construction equipment and vehicles outside the technical sites and roads;
- Complying with the construction schedule, taking into account the seasonal patterns of certain types of work;
- Developing a traffic management plan taking into account the need to minimize technogenic loads on soils and installations;
- Planning snow clearing, excavation and reclamation works with due account of congelifraction conditions (cold snaps at the beginning of the cold season) when ;
- Creation of conditions to minimize soil contamination by atmospheric precipitation, spills of process liquids, contact with contaminated surface runoff and other types of wastewater: Measures to minimize and control emissions from fixed and mobile sources; keeping all work (including storage of materials and wastes, parking and maintenance of machinery) strictly within designated sites;
- Organizational measures to prevent littering of the territory with solid industrial and domestic wastes, spills of sewage, fuels and lubricants, paints and varnishes and other technical liquids, including regular inspections of site areas for prompt detection and elimination of such violations.

Development and implementation of response for the following situations:

- Detection of epizootics and dangerous diseases among members of the staff and local residents;
- Detection of animal burial sites in the soil and geological environment;
- Sudden occurrences of cryopegs, gas hydrates or other hazardous factors of the geological environment;
- Detection of legacy pollution (which is extremely unlikely);
- Accidental contamination of soil and ground as a result of spills and leaks of process fluids.

Among the measures that can be professionally developed by the Consultant to prevent and minimize the negative impact of the proposed activities on soils and subsoil, the most significant is reclamation of disturbed lands; the proposed technical solutions are discussed in Appendix 9 in maximum possible detail. These solutions are common for the entire Arctic LNG 2 Project and can be used for the reclamation of the TSF sites of the Plant, Port and Field, as well as other land plots disturbed by the construction of the Project and Utrenniy Airport.

9.4.7 Residual impact

Summary Table 9.4.5 puts the abovementioned and other measures proposed by the Consultant alongside the predicted impacts, some of which, however, cannot be fully or partially prevented and are considered as residual impacts[88]. In particular, the operation of the Field, Plant and Port will give rise to certain continuous inevitable changes and trends in the geological environment due to:

- Permanent re-distribution of surface and underground runoff (in the seasonally thawed layer) by buildings, installations and paving;
- Long-term barrage and filtering effects of technogenic earth structures and other installations, particularly linear facilities, as well as wells drilled for various functions;
- Long-term thermal impacts on topmost permafrost horizons and seasonal freezing and thawing conditions, both primary (heating through contact with buildings and installations, or under influence of heated intermediate medium) and secondary (effects of re-distribution of snow, stripping of soil and vegetation, etc.).

[88] As in other sections of Chapter 9, the following symbols of the project's lifecycle stages are used for illustrations: construction - *C*, commissioning - *Cm*, operation - *O*, decommissioning and subsequent period - *DCm*)

Table 9.4.5: Assessment of impacts on soils, subsoil and land resources

Impact		Receptor		Stage	Impact characteristics		Mitigation	Residual impact	Operational environmental monitoring and control
Description	Sign	Description	Sensitivity		Magnitude	Significance			
1. Impacts on land, conditions of land and subsurface use									
1.1. Land acquisition	N	Land and soil resources of the Tazovskiy District	L	C+Cm	M	M	Minimisation of land acquisition for buildings and installations, including temporary ones Reclamation of land disturbed by construction work, and subsequent transfer to the lessors	Adverse, of low significance due to the inevitable increase in the proportion of the developed area	Monitoring compliance with the borders of the land acquisition area Identifying and registering sites actually used by construction contractors outside the land acquisition area and monitoring the state of these sites Monitor implementation of design solutions for reclamation of disturbed lands
				O	L	L	Not required		Monitoring the state of lands after reclamation
				DCm	L	L	Reclamation of land after the dismantling of buildings and installations, and its transfer to the lessor	Adverse, of low significance due to the impossibility of fully restoring the initial state of the sites of the Project buildings and installations	
1.2. Restrictions on land use (including environmental restrictions)	N	Onshore infrastructure of the Plant and Port	L	C+Cm+O	H	M	Compliance with the requirements of land management, urban planning and design documentation as to the conditions of land use		Industrial environmental monitoring and control (the IEMC program as a whole)
				DCm	L	N	Not required		Monitoring the state of lands after reclamation
		Land acquisition for the Field facilities	M	C+Cm+O	H	M	Compliance with the requirements of land management, urban planning and design documentation as to the conditions of land use		Industrial environmental monitoring and control (the IEMC program as a whole)
				DCm	L	L	Not required		Monitoring the state of lands after reclamation
		URZ areas associated with the designed buildings and installations of the Plant and its associated facilities	M	C+Cm+O	M	L	Compliance with the URZ restrictions	None expected	Monitoring compliance with the respective URZ restrictions
				DCm	N	N	Not required		Not required
		Land resources of the Tazovskiy District	L	C+Cm+O	L	L		Adverse, of low significance due to the impossibility of fully restoring the initial state of the sites of the Project buildings and installations	
				DCm	N	N			
1.3. Changes in the conditions of subsoil use	N	Mineral and groundwater deposits at the sites of the proposed installations of the Plant and its associated facilities	N	C+Cm+O	L	M	Measures provided for by the subsoil license and design documentation for the subsoil management operations. Additional actions may be required during the Field operations	Adverse, of low significance due to the impossibility of fully restoring the initial state of the subsoil areas used, appearance of technical objects in the geological environment and overall complication of further use of subsoil resources in the developed area	Monitoring the state of subsoil in accordance with the terms of the subsoil license and design documentation for the subsoil management operations (field development technical design, etc.). No additional environmental monitoring and control measures are required
				DCm	L	L	Not required		
2. Direct physical impacts on soils and subsoil									
2.1. Destruction of the soil or topmost soil horizons	N	Soils within the land acquisition area of the Plant and its associated facilities	H	C	H	H	Minimisation of land acquisition for buildings and installations, including temporary ones Preserving the soils of the land acquisition area in an undisturbed state as much as possible In areas where soil conservation in its natural state is impossible – provide for preliminary removal of organogenic horizons (if they exist and have thickness in excess of 0.3 m) and preservation of their material for subsequent use in reclamation Restoration (through reclamation) of topsoil on lands disturbed by construction	Adverse, of low significance due to the inevitable loss of soils within the developed area	Monitoring the soils within the land acquisition area, URZ (SPZ, WPZ), and at reclaimed sites as part of the IEMC program
				Cm+O	L	N			
				DCm	M	L			

Impact: Description	Impact: Sign	Receptor: Description	Receptor: Sensitivity	Stage	Impact characteristics: Magnitude	Impact characteristics: Significance	Mitigation	Residual impact	Operational environmental monitoring and control
2.2. Transformation of the soil strata as a result of earthworks or related work: cutting, excavation and movement of soils, construction of embankments (including the use of imported soils), technical reclamation	N	Topmost horizons of the geological environment (at or above the depth of works) within the land acquisition area of the Plant and its associated facilities	M	C	H	H	Conducting earth works in the period when soil and ground is frozen to the excavation depth Technical reclamation of areas disturbed by construction	Adverse, of low significance due to loss of material and irreversible transformation of the physical and mechanical properties of local soils and their partial replacement with imported soils	Monitoring topmost ground horizons in areas with stripped soil, within the land acquisition area and at reclaimed sites as part of the IEMC program
				Cm+O	L	N			
				DCm	M	M			
	N	Geological environment below the work depth, within the Plant, Port and Field sites	L	C	M	L	Compliance with the requirements of the design documentation as to earthworks and related works. No additional environmental measures are required.	Adverse, of low significance, due to the unavoidable increase of technogenic loads on geological environment, re-distribution and stress accumulation in geological environment, loss of the bearing capacity of soils under buildings and installations, irreversible local loss of subsoil integrity due to drilling and pile-driving activity	Geotechnical monitoring of operated buildings and installations and their sites. No special environmental monitoring and control measures are required
				Cm+O	L	N			
				DCm	M	L			
2.3. Vertical transformation of the soil strata as a result of drilling and piling operations	N	Geological environment at the well clusters and pile fields within the land acquisition area of the Plant, Port and Field	L	C	M	L			
				Cm+O+DCm	N	N			
2.4. Static loads on soils	N	Geological environment at the sites of buildings and installations within the land acquisition area of the Plant, Port and Field	L	C+Cm+O	M	L			
				DCm	L	N			
2.5. Dynamic loads on soils	N	Geological environment at the sites of access roads within the land acquisition area of the Plant, Port and Field	L	C	M	M	Development of the Project's traffic management plan taking into account the need to minimize technogenic loads on soils and installations		Monitoring compliance with the Project's traffic management plan
				Cm+O	M	L			
				DCm	L	N			
3. Thermal impacts on soils and subsoil									
3.1. Temperature of soil, ground and ground water increase due to direct contact with surfaces of above-ground and underground buildings and structures which are warmer than containing geological environment, or are exposed to influence of a heated intermediate medium (e.g. warm air at the sites of flaring and ventilation systems)	N	The soil and geological environment at the sites of buildings and installations within the land acquisition area of the Plant, Port and Field	H	C	M	L	Minimization of land acquisition area for buildings and installations, including temporary ones Preserving the soils of the land acquisition area in an undisturbed state as much as possible Conducting earth works in the period when soil and ground is frozen to the excavation depth Compliance with the requirements of the design documentation as to thermal insulation of buildings and installations, snow clearing Reclamation of land disturbed by construction	Adverse, of low significance due to irreversible adverse changes in geocryological properties of the geological environment (including the loss of the bearing capacity of the soil), increase in its chemical and biochemical corrosion potential with respect to building structures, higher groundwater pollution risks	Geotechnical monitoring of operated buildings and installations and their sites Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
				Cm+O	H	M			
				DCm	N	N			
3.2. Secondary transformation of the thermal regime of soils and rocks in the areas of snow clearing, excavation and related works, placement of buildings and installations, and reclamation, i.e. as a result of changes in the natural combination of hydrothermal regime factors	N			C	H	M			
				Cm+O	M	M			
				DCm	L	L			
4. Secondary impacts of dangerous exogenous geological processes and hydrological phenomena (DEGP&HP)									
4.1. Ice exaration impact (gouging by ice): Weakening by ice barrier structures	P	Ob Estuary: maneuvering water area and section of the approach channel within the active area of the ice barriers	H	C+Cm+O+DCm89	M	H	Compliance with the requirements of the design documentation as to construction works and structures in the water area and coastal areas of the Ob Estuary No additional environmental measures are required.	Beneficial due to stabilization of the seabed relief in the protected water area	Monitoring the safety of hydraulic structures Geotechnical monitoring Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
4.1. Ice exaration impact (gouging by ice): Exterior strengthening of the ice barriers	N	Ob Estuary: section of the approach channel outside the active zone of the ice barriers		C+Cm+O+DCm	H	H		Adverse, of moderate significance due to higher ice loads and the transformation of the seabed relief in the area outside of the ice barriers	
4.2. Physical and mechanical impact of ice masses on the installations and the natural relief of the Ob Estuary coast (e.g. due to ice piles and thrusts within the foreshore area)	N	Soil base of the artificial land plot, the Plant's berthing facilities and GBS, the Port's berth structures	H	C+Cm+O+DCm	H	H		Adverse, of moderate significance due to accumulated effects of loads	
	N	Coastal areas immediately adjacent to the onshore facilities of the Plant and Port	H	C+Cm+O+DCm	M	L		Adverse, negligible, or beneficial due to redistribution of ice and the corresponding loads of ice-protective and other structures, intensification of the protective function of fast ice with regard to the coastal relief	
4.3. Flooding and related processes (icing, erosion, water accumulation)	N	Soil foundations of buildings and installations within the Plant's and Port's land acquisition area	L	C+Cm+O+DCm	M	L	Compliance with the design documentation requirements for site preparation (including protection of the site from being flooded by the waters of the Ob Estuary, lakes, watercourses, snowmelt runoff),	No flooding is expected if the design solutions are complied with, i.e. flooding is considered as an emergency situation requiring special response measures (dewatering,	Monitoring the safety of hydraulic structures Geotechnical monitoring Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
		Soils and open ground surfaces within the land allocation area of the Plant and the Port	H	C+Cm+O+DCm	M	M			

89 The Consultant assumes it will not be necessary to dismantle the ice barriers and remove the artificial land plot accommodating the Plant after dismantling the GBS and the onshore facilities

Impact			Receptor		Stage	Impact characteristics		Mitigation	Residual impact	Operational environmental monitoring and control
Description		Sign	Description	Sensitivity		Magnitude	Significance			
			Soils and open ground surfaces at the sites adjacent to the land acquisition area of the Plant and Port	H	C+Cm+O+DCm	M	M	earthworks and related activities, installation of culverts and water pipelines No additional environmental measures are required.	elimination of ice, restoration of the project relief, installation of additional elements of drainage systems and culverts)	Monitoring the state of water supply pipelines and drainage systems
			Soils and open ground surfaces at the sites adjacent to the pipeline corridors (linear facilities) of the Field	H	C+Cm+O+DCm	H	H			
4.4. Bottom and lateral erosion, sediment redistribution	Change in sediment balance due to the redistribution of water flows and ice masses caused by the hydraulic structures	N	Ob Estuary: maneuvering water area and section of the approach channel within the active area of the ice barriers	H	C+Cm+O+DCm	M	M	Compliance with the requirements of the design documentation as to construction works and structures in the water area and coastal areas of the Ob Estuary. No additional environmental measures are required.	Adverse, of moderate significance due to the formation of new areas of erosion and accumulation in the water area of the Ob Estuary, displacement of areas of accumulation of sediments carried by rivers into the Ob Estuary	Monitoring the morpholithodynamical conditions along the coastline and at the borders of artificial installations (as part of the IEMC program)
		N	Estuarine zones of rivers draining the proposed site of the Plant and the Port (Khaltsyney-Yakha, Nyaday-Pynche)	H	C+Cm+O+DCm	M	L	Meeting the requirements of the design documentation as to installation of culverts and pipeline river crossings. No additional environmental measures are required.		Monitoring bottom and lateral erosion processes in the lower reaches of the Khaltsyney-Yakha and Nyaday-Pynche rivers (as part of the IEMC program)
	Complete or partial blocking of sediment movements	N	Streams draining lakes Nos. 4 and 690 into the Ob Estuary across the proposed Plant site	H	C+Cm+O+DCm	H	M	Site preparation for the Plant's onshore facilities, including provision of a drainage system for intercepting and redirecting stream flows into the Ob Estuary	Adverse, of low significance due to changes in the sediment balances of small watercourses	Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
	Local transformation of river channels in places where they are crossed by linear structures or where culverts are built	N	Other watercourses (rivers, streams) in the Gydan peninsula	M	C+Cm+O+DCm	M	L	Meeting the requirements of the design documentation as to installation of culverts and pipeline river crossings. No additional environmental measures are required.	Adverse, of low or moderate significance, mainly local, due to changes in the sediment balances of watercourses	Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
4.5. Permafrost degradation and related processes (thermokarst and thermal erosion)		N	Soil foundations of buildings and installations within the land acquisition area of the Plant, Port and Field	M	C+Cm+O+DCm	M	M	Meeting the requirements of the design documentation as to earthworks and related works, protection of soil base from damage (including the requirement for excavating frozen soil) Using soils without ice inclusions for building embankments Meeting the requirements of the design documentation as to thermal insulation of buildings and installations Site preparation to avoid accumulation of rain and melt waters along the boundaries of soil bases and the rise of the groundwater level (waterlogging)	Adverse, of moderate significance due to inevitable degradation of permafrost and partial loss of bearing capacity of soil bases, gradual erosion of icy frozen soils by flowing water	Geotechnical monitoring Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
			Soils and ground within the land acquisition area of the Plant, Port and Field	H	C+Cm+O+DCm	M	M	Preserving the soils of the land acquisition area in an undisturbed state as much as possible Site preparation to avoid accumulation of rain and melt waters along the boundaries of soil bases and the rise of the groundwater level (waterlogging) Reclamation of land disturbed by construction	Adverse, of low significance due to the inevitable degradation of permafrost within the area of influence of the buildings and installations (including the direct warming effect of gas pipelines, flare stacks, power and heat generators)	Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program

[90] The lakes are numbered according to the TsGEI survey materials (2017) and Figure 9.4.3

Impact		Receptor		Stage	Impact characteristics		Mitigation	Residual impact	Operational environmental monitoring and control
Description	Sign	Description	Sensitivity		Magnitude	Significance			
		Soils in areas adjacent to the land acquisition area of the Plant, Port and Field, with permafrost rocks (cryosols gleysols, peat bog soils, podburs) lying close to the surface	L	C+Cm+O+DCm	L	L	Managing construction work to avoid any damage to soils by construction equipment and vehicles outside the technical sites and roads	Adverse, of low significance due to inevitable degradation of permafrost in areas with altered water and thermal conditions of soils and rocks under the influence of exogenous processes (waterlogging, etc.)	
4.6. Frost cracking	N	Soil bases of buildings and installations, soil backfilling of trenches, pits and other excavations within the land acquisition area of the Plant, Port and Field: Linear facilities	H	C+Cm+O+DCm	M	H	Meeting the requirements of the design documentation as to earthworks and related work, protection of soil bases from damage The use of soils with low susceptibility to cryogenic deformations for the formation of embankments (coarse sand, sand and gravel, crushed stone, etc.), underground laying of pipelines - use of special equipment and methods of protection against cracking Site preparation to avoid accumulation of rain and melt waters along the boundaries of soil bases and the rise of the groundwater level (waterlogging) Meeting the the design documentation requirements as to heat insulation and waterproofing of buildings and installations When planning snow clearing operations, excavation and reclamation work, take into account the most favorable conditions for frost cracking (cold snaps at the beginning of the winter period with minimum snow cover to protect the surface; snow cover, peat, artificial materials, dewatering, higher embankments serve as heat insulation that helps prevent congelifraction)	Adverse, of low significance due to gradual buildup of deformations in the soil and weakening of its bearing capacity, increased susceptibility to other exogenous processes - water erosion, subsidence, slope sinking, etc., irreversible mass transfer along cracks in freeze-thaw cycles	Geotechnical monitoring
		Site facilities	M		L	M			
		Soils and open ground surfaces within the land acquisition area of the Plant, Port and Field	M	C+Cm+O+DCm	M	M	No special measures are required	Intensification of congelifraction is anticipated in the conditions of higher soil and substrate moisture content along areas of secondary flooding (see section 4.8) and higher thickness of the seasonally thawed layer (4.5). In the rest of the area, the process will remain dependent on climatic conditions.	Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
		Topsoil and free soils outside the land acquisition area of the Plant, Port and Field, prone to congelifraction (areas with cryosols gleysols, peat bog soils shown on the maps in section 7.5)	H	C+Cm+O+DCm	M	L			
4.7. Frost heave	N	Soil bases of buildings and installations, soil backfilling of trenches, pits and other excavations within the land acquisition area of the Plant, Port and Field	L	C+Cm+O+DCm	L	M	Meeting the requirements of the design documentation as to earthworks and related work, protection of soil bases from damage Use of soils with low susceptibility to frost heave for the formation of embankments (coarse sand, sand and gravel, crushed stone, etc.) Site preparation to avoid accumulation of rain and melt waters along the boundaries of soil bases and the rise of the groundwater level (waterlogging)	No frost heave is anticipated if the design solutions are complied with; it is regarded as an emergency situation requiring special response measures	Geotechnical monitoring
		Soils and open ground surfaces within the land acquisition area of the Plant, Port and Field	H	C+Cm+O+DCm	M	M		Adverse, of low significance due to gradual intensification of cryogenic processes in the conditions of unavoidable increase in surface or subsoil moisture levels and changes in the thermal regime of the soil	Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program

Impact			Receptor		Stage	Impact characteristics		Mitigation	Residual impact	Operational environmental monitoring and control
Description		Sign	Description	Sensitivity		Magnitude	Significance			
			Topsoil and free soils outside the land acquisition area of the Plant, Port and Field, prone to frost heave (areas with cryosols gleysols, peat bog soils shown on the maps in section 7.5)	M	C+Cm+O+DCm	M	L	Preventing the existing frost heave mounds from being scraped off during the leveling of the terrain Meeting the the design documentation requirements as to heat insulation and waterproofing of buildings and installations	No impact (natural dynamics of cryogenic processes) or adverse impact of low significance associated with higher surface or soil moisture levels, changes in the thermal regime of the soil	
4.8. Groundwater impact	Impact (discharge) of permafrost groundwater (waterlogging) and related processes (icing, suffusion and subsidence, waterlogging, gleying of soils and rocks)	N	Soil bases of buildings and installations, soil backfilling of trenches, pits and other excavations within the land acquisition area of the Plant, Port and Field: Linear facilities; Site facilities	H	C+Cm+O+DCm	L	M	Meeting the requirements of the design documentation as to earthworks and related work, protection of soil bases from damage Site preparation to avoid accumulation of rain and melt waters along the boundaries of soil bases and the rise of the groundwater level (waterlogging) Site preparation for the Plant's onshore facilities, including provision of a drainage system for intercepting and redirecting stream flows into the Ob Estuary Meeting the the design documentation requirements as to heat insulation and waterproofing of buildings and installations	Adverse, of moderate significance, consisting in long-term trends in the transformation of the water regime of soil embankments, partial loss of their bearing capacity, an increase in the corrosive potential of the geological environment with regard to the building structures, and a decrease in the level of groundwater protection from pollution	Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
			Soils and open ground surfaces within the land acquisition area of the Plant, Port and Field	H	C+Cm+O+DCm	M	H		Adverse, of moderate significance, consisting in the long-term trend towards the spreading of wetlands, intensification of waterlogging, gleying and cryogenesis High intensity waterlogging is not anticipated if the design solutions are complied with, i.e. it is regarded as an emergency situation requiring special response measures	Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
			Topsoil and free soils outside the land acquisition area of the Plant, Port and Field prone to waterlogging (confined to relief depressions or embankments of linear facilities)	M	C+Cm+O+DCm	H	H			
	Impact (discharge) of inter-permafrost supercooled highly mineralized groundwater - cryopegs	N	Soil foundations of buildings and installations within the land acquisition area of the Plant, Port and Field Building structures Soils and open ground surfaces within the land acquisition area of the Plant, Port and Field	M	C	L	M	Compliance with the requirements of the design documentation as to earthworks and related works	Manifestations of cryopegs associated with a local increase in the mineralization and corrosivity of surface and subterranean supra-permafrost runoff and icing processes is not anticipated if the design solutions are complied with, i.e. it is treated as an emergency situation requiring special response measures	Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
					Cm+O	L	L	Development and implementation of response action plan for sudden discharges of cryopegs		
				L	DCm	N	N	Not required	Not considered	
4.9. Aeolian processes	Deflation (wind erosion) and aeolian accumulation (thermogenic weathering is an accompanying process)	N	Surface horizons of soil bases of buildings and installations, soil backfilling of trenches, pits and other excavations within the land acquisition area of the Plant, Port and Field	H	C	H	H	Meeting the requirements of the design documentation as to earthworks and related work, protection of soil bases from damage	Adverse, of low significance due to the loss of material from the earth embankments and its partial redeposition outside the land acquisition area	Geotechnical monitoring Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
					Cm+O	M	M			
					DCm	M	L			
			Soils and open ground surfaces within the land acquisition area of the Plant, Port and Field	H	C	M	M	Minimization of land acquisition area for buildings and installations, including temporary ones Preserving the soils of the land acquisition area in an undisturbed state as much as possible Conducting earth works in the period when soil and ground is frozen to the excavation depth Managing construction work to avoid any damage to soils by construction equipment and vehicles outside the	Adverse, of low significance due to the redistribution of topsoil material, the slowing down of soil formation processes, the growing instability of the relief	Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
					Cm+O	L	L			
					DCm	L	L			
			Topsoil and free soils outside the land acquisition area of the Plant, Port and Field, prone to deflation (areas marked on the maps in Section 7.5)	H	C+Cm+O+DCm	M	M			

Impact: Description	Impact: Sign	Receptor: Description	Receptor: Sensitivity	Stage	Impact characteristics: Magnitude	Impact characteristics: Significance	Mitigation	Residual impact	Operational environmental monitoring and control
Aeolian accumulation	N	Soil and vegetation cover of land plots used as pastures	H	C	M	M	technical sites and roads Reclamation of land disturbed by construction	Adverse, of moderate or low significance (depending on the distance of pastures from deflation foci)	Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
				Cm+O	L	L			
				DCm	M	M			
4.10. Suffusion and subsidence (unrelated to flooding)	N	Soil foundations of buildings and installations within the land acquisition area of the Plant, Port and Field	H	C+Cm+O	H	H	Meeting the requirements of the design documentation as to earthworks and related works, protection of soil bases from damage (including the requirement for excavating frozen soil) and use of anti-erosion measures (geogrids, geonets, geomats to strengthen slopes)	Adverse, of moderate significance due to accumulation and realization of stress conditions in embankments due to instability of underlying soils, excavation of frozen soils, inherent heterogeneity of embankments, presence of multiple engineering networks and other factors, gradual erosion of artificial embankments and redistribution of their material by water flows	Geotechnical monitoring Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
4.11. Gravitational processes (solifluction, sinking of slopes, etc.) 4.12. Planar erosion and accumulation	N			C	H	H			
				Cm+O	L	M			
				DCm	M	L			
		Soil and ground in erosion-prone areas within the land acquisition area of the Plant, Port and Field (primarily, erosion slopes of the 2nd marine terrace within the Plant's land acquisition area, including the TSF site)	H	C	M	M	Minimization of activities within the boundaries of erosion slopes of the marine terraces (in particular, making sure that the slopes are not dissected or cut by gutters) Reclamation of land disturbed by construction Preserving the soils of the land acquisition area in an undisturbed state as much as possible Site preparation to prevent accumulation of rain and melt water along the boundary of soil bases Compliance with the requirements of the design documentation as to site preparation, including shore protection and other forms of slope stabilization (slope degradation is prevented by maintaining the soil and vegetation cover and by intercepting surface runoff and groundwater flows using trenches or mounds)	No impacts (natural dynamics of the slopes) or adverse impacts of low significance associated with the gradual loss of slope stability under the influence of a combination of factors	Monitoring the development of dangerous exogenous geological processes and hydrological phenomena as part of the IEMC program
				Cm+O	L	L			
				DCm	M	M			
		Soils in erosion-prone areas adjacent to the land acquisition area of the Plant, Port and Field	M	C+Cm+O+DCm	L	L	Managing construction work to avoid any damage to soils by construction equipment and vehicles outside the technical sites and roads	Keeping the rate of erosion-accumulation processes close to natural in areas not exposed to physical-mechanical and thermal impacts	
5. Chemical and biological pollution of soil and geological environment									
5.1. Contamination of the soil or surface ground horizons within the vadose zone that are in contact with soil or devoid of soil, and development of secondary foci and/or infiltration bodies	N	Soil and topmost horizons of the geological environment within the land allocation area	M	C+Cm	H	M	Creation of conditions to minimize soil contamination by atmospheric precipitation, spills of process liquids, contact with contaminated surface runoff and other types of wastewater: Measures to minimize and control emissions from fixed and mobile sources; keeping all work (including storage of materials and wastes, parking and maintenance of machinery) strictly within designated sites;	Adverse, of low significance due to the ingress of pollutants and deposition of some of them into the soil and the geological environment, and an increase in soil toxicity levels	Monitoring the soil (particularly in reclaimed areas) as well as surface ground in areas devoid of soil
				O	L	L			
				DCm	M	M			

Impact		Receptor		Stage	Impact characteristics		Mitigation	Residual impact	Operational environmental monitoring and control
Description	Sign	Description	Sensitivity		Magnitude	Significance			
5.2. Secondary mobilization and addition of pathogens of dangerous diseases to the food chain	N	Land users leading a traditional way of life Terrestrial vertebrates (primarily, reindeer)	H	C	M	M	Minimization of land acquisition and physical and mechanical disturbances of the soil Development and implementation of response for the following situations: Detection of epizootics and dangerous diseases among members of the staff and local residents; Detection of animal burials in the soil and the geological environment; Regular medical examination (at least once a year) and targeted personnel orientation briefing	Adverse, of moderate significance due to permanent changes in the structure of land use (including the location of pastures, deer herds migration routes), disruption of the physical and mechanical integrity of the soil and ground, an increase in the thickness of the seasonally thawed layer and the biochemical activity of the soils	Collection and analysis of information on the sanitary-epidemiological situation in the Tazovskiy District (as part of the IEMC program) Regular medical examinations of personnel with the highest frequency during the construction phase - at least twice during the warm season
				Cm+O	L	L			
				DCm	M	M			
5.3. Secondary mobilization and distribution of pollutants in the soil and geological environment	N	The soil and the geological environment (soils of the vadose zone, groundwater) within the land acquisition area and in adjacent areas	L	C+Cm	L	L	No special measures are required	Due to the local extent and low significance of legacy pollution within the project sites, the risk of secondary mobilization of pollutants during the implementation of the Project is negligible	Monitoring supra-permafrost groundwaters in areas of accidental pollution (spills, leaks) registered in the course of IEMC
				O	N	N			
				DCm	L	L	Inclusion in the documentation for the dismantling of buildings and installations of a response plan in case of sudden detection of contamination of soils and the geological environment with oil products and solid waste at the construction sites	In areas of earthworks and other types of work associated with the physical and mechanical disturbance of the soil and the geological environment, and in places of infiltration of surface and snowmelt runoff, the impact will be inevitable, but presumably of low significance	
54. Groundwater pollution	N	Supra-permafrost waters	H	C+Cm	M	M	Measures listed in items 4.3, 4.5, 4.8	Adverse, of low or moderate significance due to the downward and lateral (downslope) movement of pollutants in a low-thickness vadose zone and water-saturated horizons of the poorly protected seasonally thawed layer	
				O	L	L			
				DCm	M	M			
		Inter-permafrost waters	L	C+Cm	L	L			
				O	L	N			
				DCm	L	L			
		Exploited aquifers	N	C+Cm+O+DCm	N	N			
6. Impact of hydrocarbons extraction									
6.1. Reduction of hydrocarbons deposits	N	Field production levels	H	O, DCm	M	L	Measures provided for by the subsoil license and design documentation for the subsoil management operations. Additional actions may be required during the Field operations	Adverse, of low significance: the field to be developed is originally considered as a finite hydrocarbons resource, and is also one of the 18 fields of the Gydan petroleum region	Monitoring the state of subsoil in accordance with the terms of the subsoil license and design documentation for the subsoil management operations (field development technical design, etc.). No additional environmental monitoring and control measures are required
	N	Hydrocarbon deposits of the Gydan petroleum region	L	O, DCm	L	L	Not required. In the future, also other fields within the Gydan petroleum region may be used as a resource base for the GBS LNG & SGC Plant		
6.2. Deformation processes	N	Subsoil	L	O	M	L	Measures provided for by the subsoil license and design documentation for the subsoil management	Adverse, of low significance: compaction of reservoirs and deformation of their enclosing rock are considered as acceptable consequences of the field development	
				DCm	L*	L			
	N	Earth surface	N	O	L	L		Adverse, of low significance, as expected amplitudes of terrain deformations are small	Geotechnical monitoring of terrain in the areas of most probable development of deformations. Geodynamic monitoring in a specially established polygon No special environmental monitoring and control measures are required
				DCm	L*	L			
6.3. Technogenically induced seismicity	N	Buildings and installations	N	O	L	L		Adverse, of low significance, due to small amplitudes and low repeatability of induced seismic effects	Geotechnical monitoring of operated buildings and installations. No special environmental monitoring and control measures are required
				DCm	M*	L	Required measures will depend on future use of the land plots after dismantling of buildings and installations		Not required (further seismic effects will be registered by the monitoring network related to futur use of the land plots, and by the state monitoring network)

Impact		Receptor		Stage	Impact characteristics		Mitigation	Residual impact	Operational environmental monitoring and control
Description	Sign	Description	Sensitivity		Magnitude	Significance			
7. Impacts of treated wastewater injection into geological horizons									
7.1. Chemical and biological pollution	N	Groundwater in the absorbing stratum and ground directly contacting with it	L	O	L	M	Not required	Adverse, of moderate significance, due to injection and potential accumulation of residuql quantities of pollutants and microorganisms (within the applicable technical limits) in the absorbing stratum	Monitoring the state of subsoil resources in accordance with the terms of the subsoil license and design documentation for the subsoil management operations. No additional environmental monitoring and control measures are required
				DCm	M**	L	Required measures will depend on future use of the subsoil resources		
7.2. Chemical and biological contamination of groundwater in other horizons	N	Groundwater in exploited aquifers	N	O	N	N	Not required	None expected, due to the absence of exploited aquifers within the Project area of influence	
				DCm			Required measures will depend on future use of the subsoil resources		
7.3. Transformation of subsoil natural hydrodynamic conditions	N	Groundwater resources of Tazovskiy Municipal District	L	O	L	L	Not required	Adverse, of low significance, due to the local extent of expected hydrodynamic changes	

A common trend for the entire license area will also consist in the extraction of hydrocarbons from containing reservoirs and the accompanying changes in the geological environment. Preliminary consultations conducted by NOVATEK with the stakeholders in March-April 2018 with the participation of Ramboll CIS revealed the concern of members of the indigenous population in the Tazovskiy District about possible changes in the field terrain - sinks, subsidence, etc. The issue of potential geodynamic consequences of the implementation of the Arctic LNG 2 Project is discussed in more detail in Appendix 8.

As regards the Field, Plant and Port, the residual impacts on the geological environment and the soil during the construction and operation phases will be mostly local, i.e. confined directly to the technical sites and pipeline routes. The majority of identified impacts, as well as soil and geological environment responses, will be characterized by a distinct seasonality, irreversibility and accumulative nature, due to the one-way transport of material by exogenous processes.

At the onshore sites, the soil foundations of buildings and installations will become the arena of gravitational, cryogenic, erosion-accumulative and aeolian processes. On their periphery, secondary intensification of dangerous exogenous processes and hydrological phenomena will become most significant, especially cryogenesis, waterlogging and flooding, erosion-accumulative processes, deflation and aeolian accumulation.

Seasonal manifestations of these processes are most likely to affect the areas immediately adjacent to the sites of the designed facilities. With the greatest lateral development of secondary exogenous processes, their outward expansion on land from the construction sites of the onshore facilities of the Plant and Port (area of the highest concentration of engineering risks and sources of impacts on relief and soil) to the north, north, eastn and south is limited by the river valleys (Khaltsyney-Yakha, Nyaday-Pynche) and lake basins.

The gas condensate production Field facilities and their interconnecting utility corridors spread from the Plant and Port onshore facilities in three directions - to the north, east and south – and affect catchment areas of two medium-sized rivers discharging to the Gydan Estuary – Neitayakha and Yarayakha. Unlike the western macroslope of the Gydan Peninsula, these territories are more prone to waterlogging and underflooding (with degradation of permafrost in underflooded sections); secondary activation of these processes will shape the landscape response to the technogenic intervention. Erosion-accumulative, aeolian, slope scouring and cryo-deformation processes in this area will be relatively less pronounced and more controllable by the designed measures.

Aeolian accumulation engaging the earthfill materials are also possible at longer distances from the natural deflation foci - specific parameters of this process will be determined by IEMC, however it is clear already at present that technogenic sand arenas will be by multiple times larger than natural foci of wind erosion of sandy and pulverous material, most of which is associated with beaches (foreshore and laida), river floodplains and slopes of marine terraces. Production and transformation of sand, placing them in embankments and long-term exploitation will inevitably result in aeolian losses of certain quantity of technogenic soil and its accumulation, both dispersed and concentrated, on adjacent terrain and in bottom sediments of waterbodies.

The lateral component of pollutant migration flows in the geological environment will be mainly associated with the supra-permafrost waters of the seasonally thawed layer, which are discharged into the local valley network. The deeper groundwater horizons are fairly well protected against the ingress of pollutants from the surface, and at the same time have no practical value; therefore, their sensitivity is assessed as low.

In the Ob Estuary, the inevitable impacts of the planned construction of the Plant and Port facilities will consist in redistribution of ice loads by hydraulic structures and a disruption of lithodynamic equilibrium within the area of their influence, which will lead to the formation of new accumulation, erosion and ice gouging zones. No abrasion outbreaks due to the deficit of sediments are expected along the coast due to the compensatory role of accumulation associated with tidal and wind-induced currents, residual ice and wave activity or inflow of sediment via river valleys or with distributed surface runoff. At the same time, in some parts of the coastal zone, the development of thermoabrasion processes is possible, due to the melting of icy soils and ice interlayers inside them.

Expect with the greatest spatial extent – up to several dozens of kilometers – is expected in relation to increased turbidity during the hydrotechnical works. Modeling the turbidity zones confined to the dredging and dumping sites near the port of Sabetta led to a conclusion that the significance of this type of physical impact on the water area is higher than that of a localized one, but due to its expected brevity the integral significance of the impact is stated as moderate[91]. According to the calculations, the dispersion fields of suspended matter in the water area of the Ob Estuary spread not only downstream, but also upstream of the main flow of the Ob River and approach the sections in the Salmanovskiy (Utrenniy) license area (refer to Section 9.3 and Chapter 15).

9.4.8 Proposals for the monitoring of subsoil and soils

Industrial environmental monitoring is the main tool for assessing the state of the geological environment and monitoring its changes and the implementation and assessment of the adequacy of design solutions for the protection of subsoil resources and the soil during the construction and operation phases of the Field, Plant and Terminal.

The monitoring of the geological environment and DEGP&HP within the Salmanovskiy (Utrenniy) license area will be based on:

- Monitoring the state of subsoil resources in accordance with the terms of the subsoil license and design documentation for the subsoil management operations (field development technical design);
- Geotechnical monitoring of existing buildings and installations of the Plant, Terminal and Field as well as the sites of those buildings and installations to be carried out during the construction and early stages of operation of the facilities in accordance with the requirements of SP 22.13330.2016 and other applicable national standards;
- Monitoring the safety of hydraulic structures throughout their operation in accordance with the requirements of RD 03-259-98;
- Monitoring of geodynamic processes over the undermined area of the field and areas of wastewater injection into deep absorbing horizons.

In addition, monitoring the geological environment, DEGP&HP and the soil is an essential part of the industrial environmental monitoring and control (IEMC) program which accompanies the construction and operation of all the proposed buildings and installations. The Consultant’s proposals set forth in this Section refer specifically to this monitoring component and are structured as follows (Table 9.4.6).

Table 9.4.6: Monitoring of subsoil and soils: scope and timing

Scope of work	Observations timeline		
	Monitoring	Operational	Special
DEGP&HP monitoring	Remote sensing Route surveys	Observations are intended to assess the environmental consequences of potential accidents associated with the intensification of DEGP&HP, pollution of soils and the geological environment	Observations are intended to address specific issues not covered by the monitoring observations program (in particular, monitoring the chemical composition of groundwater into which treated wastewaters are injected)
Monitoring chemical contamination of the soil	At sampling sites and within reclaimed areas according to the standard list of indicators in Section 6.4 of SanPiN 2.1.7.1287-03 for the undisturbed soils (0.0-0.2 m)		
Groundwater monitoring	n/a		

Due to the Russia’s typical lack of unity integration of the geological monitoring activities listed above, the Consultant recommends to make them mutually complimentarity and establish a unified information space within the Project, in order to improve efficiency and reduce the costs. In particular, it is recommended to establish a common geo-information system (GIS) where results of geodynamic, geotechnical (geo-cryological) monitoring, and monitoring of hazardous processes and phanomena would be kept in a common data base.

The initial stage of work of IEMC contractor should involve the development of an appropriate program (procedure) based on the design solutions and the requirements of the regulatory/technical documentation: GOST R 56063-2014 and, as regards DEGP&HP observations, SP 115.3330.2016 (updated edition of SNIP 22-01-95 “Geophysics of dangerous environmental impacts”), SP 47.13330.2012/2016 “Engineering surveys for construction. Main provisions", SP 11-105-97 "Engineering and geological surveys for construction" (Part I "General rules for the work", Part II "Rules for working in areas of development of

[91] South Tambey Gas Condensate Field Development. Construction of sea Port’s facilities in the area of the village of Sabetta on the Yamal Peninsula, including the establishment of a navigable approach channel in the Ob Estuary. Amendments and additions to the design documentation. Design documentation. Section 8. List of Environmental Protection Measures. Part 6. Assessment of impact on aquatic biological resources. Book 1. Simulation analysis for determination of geometric parameters of the turbidity plume in the water area during underwater operations. Vol. 8.6.1. - StPb: Eco-Express-Service LLC, 2015

dangerous geological and engineering-geological processes"), SP 116.13330.2012. "Code of practice. Engineering protection of sites, buildings and installations from dangerous geological processes. Main provisions. Updated version of SNiP 22-02-2003", GOST R 22.1.06-99 "Monitoring and forecasting dangerous geological phenomena and processes", RF MNR Order No. 74 dated February 28, 2018.

The main objectives of monitoring the geological environment and soils at the sites of the Field, Plant and Terminal are:

- Assessing the effectiveness of environmental engineering measures and overall level of environmental safety;
- Assessing the development and occurrence of dangerous geological processes;
- Obtaining information needed for timely decision-making on environmental engineering and environmental protection measures.

The tasks of local monitoring of the geological environment will include:

- Monitoring the state of the soil and the geological environment, the development of dangerous geological processes, both already identified and provoked by the construction process in the contact zone between the facility and the geological environment;
- Analyzing, processing and storing collected information;
- Developing recommendations for the protection and sustainable management of soils and the geological environment, protection of buildings and installations from adverse impacts of DEGP&HP;
- Optimizing the observational network.

Monitoring dangerous exogenous processes and hydrological phenomena simultaneously solves the problem of keeping track of the physical integrity of the soil. In connection with the need to make observations across a vast inaccessible area, it is advisable to use the materials of *remote sensing*, the most useful of which are ultra-high-resolution satellite images.

The area's location in high latitudes and frequent periods of cloudy weather reduce the possibilities of remote sensing. The Consultant's analysis of the availability of 2017-2019 space imagery showed that sub-meter satellite images made by WorldView-1 and WorldView-2 satellites covering the eastern coast of Gydan are available for the period between June 1 and October 1, which is the most promising in terms of diagnosing exogenous geological processes and hydrological phenomena: a selection of images taken in cloudless periods (cloudiness below 3%) and at an angle of less than 30% provides 8 scenes, dated June 16-17 and July 12-14.

By adjusting the imagery search parameters to 6 m/pix for multispectral channel and to 1.5 m/pix for panchromatic channel makes it possible to use Spot 6 and Spot 7 imagery. Those materials can be effectively used as a basis for monitoring future impacts, which can be monitored remotely by pre-ordering images of a particular area for almost any day and, as regards certain systems, for any particular time of day.

Also, an acceptable is using PlanetScope satellite images by Planet (https://www.planet.com/). Resolution of these images is not very high (3.0-3.7 m), but, due to the abundant orbital constellation, the whole Earth's surface is pictured on a daily basis (this facilitates finding cloudless images). Furthermore, this imaging system allows building time series of pictures and fairly accurate definitionof starting dates of various process.

To monitor dispersion of suspended matter in water areas, the optimum approach is to use multi- and hyper-spectral imaging systems that enable selection of suitable combinations of spectral band channels for diagnostics of processes and phenomena. The well proven solutions provide for using the data from Aqua MODIS imaging system that covers vast areas with 250/500 m resolution in different bands, and also high-resolution images from Landsat-8 and Sentinel-2A, 2B systems.

Reportedly, suitable spectral regions for the purpose are 390-410 nm (absorption of nonliving organic matter), 420-460 nm (chlorophyll a concentrations) and 460-650 nm (dispersion of suspended solids)[92]. Application of this method of assessment of turbidity concentrations in sea water is covered by many

[92] Korchemkina E.N., Shybanov E.B. Special minimization technique for analytical algorithms of chlorophyll retrieval //Proc. V International Conf., Current problems in optics of natural waters, Saint-Petersburg. 2009. P. 73-77

published studies [93] [94] [95] [96]. The methods of assessing phytoplankton concentrations and estimating primary production in marine water areas are considered in detail in a number of publications[97] [98].

Table 9.4.7: Availability of remote sensing data applicable for geosystems monitoring within the area of influence of the Arctic LNG 2 Project

Remote sensing data	Spatial resolution (visible and near-IR band, m)	Size of scene / image swath width (km)	Taking frequency	Possibility of working with spectral channels	Applicability
Aqua MODIS	250–1000	2000	2 times a day	Yes (upon order of input data)	Monitoring of suspended matter and chlorophyll-a concentrations in sea
Landsat-8	30	185	16 days	Yes	Monitoring of suspended matter, vegetation monitoring, assessment of extent of disasters, monitoring of technogenic thermal impacts
Sentinel-2A, 2B	10, 20	600	5 дней		
PlanetScope	3, 3.7	24	Once a day	No	Monitoring of disturbed soils and vegetation, DEGP&HP, extent of technogenic impact
Spot 6/7*	1.5, 6	60	3 days	No	
WorldView1, 2*	0.50–1	16.4	1.1-3.7 days	Yes	

* Operational imaging service is available on request

As an illustration, a series of photographs has been provided of the location of the Yamal LNG Project facilities in the South Tambey License Area in the Yamal Municipal District of YNAO (Figure 9.4.4) – the closest analogues of the designed Plant, Terminal and Field facilities. The clearly discernible ice barrier structures can be used as a reference point.

93 M. K. Tarasov, O. V. Tutubalina. Water turbidity determination methodology for Selenge river and adjacent water area of Baikal lake using remote sensing data // Researching Earth from cosmos. 2018. No. 1. P. 60-71.
94 L. Kh. Tchin, M. K. Tarasov. Methodology for defining suspended matter concentrations in surface waters of Tchi An reservoir (Vietnam) using remote sensing data // Moscow University Newsletter. Series 5. Geography. 2016. No. 2. P. 38-43.
95 Miller R.L., McKee B.A. Using MODIS Terra 250 m imagery to map concentrations of total suspended matter in coastal waters //Remote sensing of Environment. 2004. Vol. 93. No.1-2 P. 259-266.
96 Zhou Z. et al. Quantitative assessment on multiple timescale features and dynamics of sea surface suspended sediment concentration using remote sensing data //Journal of Geophysical Research: Oceans. 2017. Vol. 122. N 11. P. 8739-8752
97 T. V. Arkhipenko, B. P. Vlasov, A. Yu. Sivenkov. Interpretation of hydroecological status of quarry waterbodies using the methods of remote sounding of the Earth // Geography: development of science and education. 2017. C. 297-301
98 Pitarch J. et al. Remote sensing of chlorophyll in the Baltic Sea at basin scale from 1997 to 2012 using merged multi-sensor data //Ocean Science. 2016. Vol. 12. N. 2. P. 379-389

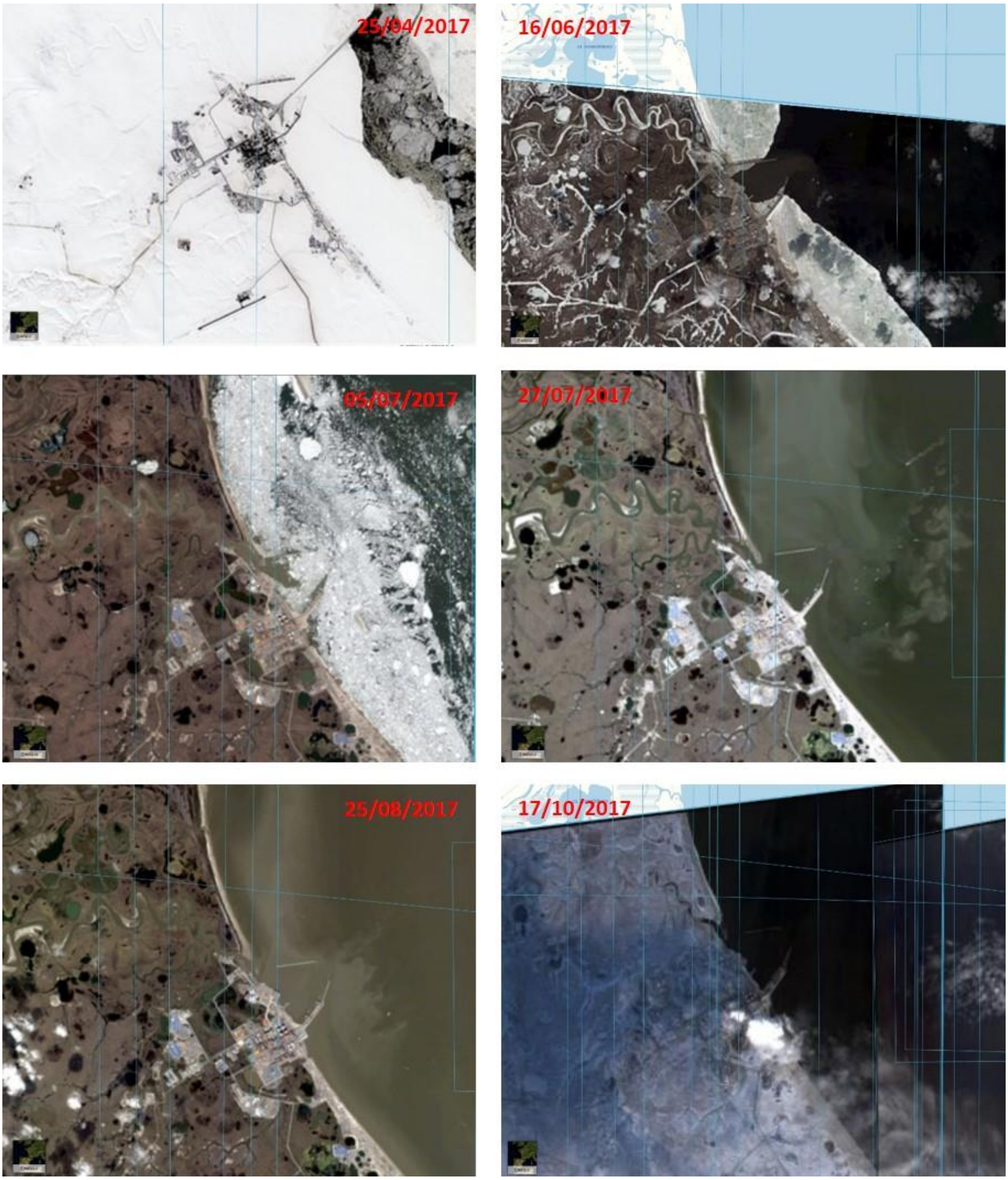


Figure 9.4.4: Indicating potential of satellite imagery in different seasons exemplified by WorldView (October 17, 2017) and Pleiades (the rest of the scenes) images of the Yamal LNG Plant location

Source: Sovzond and ScanEx official websites at http:// catalog.sovzond.ru/ and https://search.kosmosnimki.ru/

Obviously, the April images are well suited for diagnosing technical facilities in the absence of visible manifestations of DEGP&HP; The mid-June image reflects the situation where fast ice persists after the Ob's main channel has been freed from ice, and most of the snow on land is gone while ice remains on rivers and lakes; the July and August images consistently record various aspects of the tundra vegetation cover and the distribution of suspended matter across the Ob Estuary water area; finally, the mid-October image demonstrates the absence of ice phenomena but at the same time shows that the land is covered by a thin layer of snow – which is good for diagnosing thermal technogenic impacts on the soil and the geological environment.

Thus, the use of optical range imagery is an effective tool for monitoring impacts on the soil and the geological environment. Taking into account the natural conditions of the territory in question, the Consultant proposes the following procedure for the use of remote sensing data:

- As regards monitoring during the construction phase, commissioning and first year of operation, three chronological series of images will be collected and analysed – for the first decade of June (with a possible shift of the shooting date to no later than June 15), the third decade of July (the first decade of August is also permissible), and the third decade of September (no later than October 15); the second decade of August is most suitable for en route survey and environmental sampling, and therefore fieldwork will be preceded by the interpretation of 2 sets of images related to late spring and summer, which will optimize the fieldwork program by linking it to the areas of DEGP&HP manifestations to be interpreted;
- As regards the operation phase, starting from year two (in the absence of active DEGP&HP manifestations reported during the first year), it will be possible to reduce the interpretation volumes to two chronological series with the obligatory summer shooting (the second set of images may be taken in late spring or early autumn depending on the results of the previous stages of interpretation);
- At the stage of decommissioning, dismantling of buildings and installations, and land reclamation it will be necessary to revert to the version of the procedure intended for the construction phase.

The use of images will require the availability of automated workstations which will use GIS applications for receiving, transforming, and interpreting scenes and for preparing thematic maps based thereon.

The purpose of *route surveys* at the initial field stage of the IEMC program is ground-based identification of satellite image interpretation techniques and subsequent selective verification of remote sensing data at sites with previously identified development of DEGP&HP. For areal facilities, route surveys are conducted throughout the site area except for 50-100 m band from the site’s borders, along parallel routes with a 100 m observation corridor for each route. For linear facilities (roads, gas pipelines, power transmission lines, cable lines, aqueducts) observations are conducted along the entire length of each route within a corridor at least 50 or 100 m wide (the specific width of the observation corridor is determined by the IEMC program based on the available data relating to DEGP&HP manifestations at the corresponding site). In the course of route surveys, all DEGP&HP manifestations are recorded by field navigation equipment, photographed and registered in the field log according to the following indicators:

- Extent and rate of process development (DEGP&HP area and nature);
- Areal exposure rate,%; exposed area, km²;
- Plan view outlines and dimensions of the processes development foci;
- Distances from DEGP&HP manifestation sites to buildings and installations;
- Visual interpretation signs of the processes.

It is recommended to establish a unified format for description of DEGP&HP to be used by all entities conducting monitoring activity in the territory of the Salmanovskoye (Utrenneye) OGCF.

Based on the information on the existing manifestations of exogenous processes, the Consultant has proposed a preliminary situational layout for monitoring DEGP&HP (Figure 9.4.5, exemplified by the are with the highest concentration of impact sources – Plant, Terminal and nearest Field facilities), which also shows the sampling sites (those outside the Project sites) for soils and the topmost groundwater stratum at the stage of engineering surveys.

The results of the assessment of the sensitivity of various types of soil presented in Chapter 7 determined the areas and methods of monitoring suggested by the Consultant (Table 9.4.8): area-wide monitoring of the physical integrity of soils should be supplemented by monitoring of chemical pollution where subject environment is prone to accumulation of pollutants.

Table 9.4.8: Prospective areas for monitoring the soils in the area of influence of the planned activity

Contour index in Fig. 7.5.3b	Soil structures and non-soil formations	Soil sensitivity according to Ramboll terminology[99]	Priority areas of monitoring
1	Beach sediments, devoid of soil	Not assessed	Monitoring dangerous exogenous geological processes
	Sand blowoffs on hilltops devoid of soil		
2	Variants of humus and typical psammozems	Medium	Monitoring physical integrity of soil and development of dangerous exogenous geological processes
3	Variations of typical and illuvial-iron water-saturated psammozems		
4	Combinations of illuvial-iron psammozems and podburs		
5	Combinations of peat gleysols and peat oligotrophic soils	High to medium	Monitoring chemical pollution, the physical integrity of soil, development of dangerous exogenous geological processes and hydrological phenomena
6	Peat cryosols		
7	Variants of peat-podburs and peaty water-saturated podburs		
8	Combinations of water-saturated peat-podburs, gley podburs and peaty oligotrophic soils		
9	Underdeveloped water-saturated podburs	High	Monitoring physical integrity of soil and development of dangerous exogenous geological processes
10	Variants of podburs and gleyic fine-peaty podburs		
11	Combinations of podburs and cryometamorphic gleysols		
12	Combinations of alluvial humus permafrost soils and water-saturated peat podburs	High to medium	Monitoring chemical pollution, the physical integrity of soil, development of dangerous exogenous geological processes and hydrological phenomena

In the area of influence of the Plant, Terminal and main Field facilities (sites of GWP, CGTP and PGTP, Power Supply Complex No.2, solid municipal, construction and industrial waste disposal site), it is proposed to arrange soil testing in a series of sampling sites located within their respective sanitary protection zones (in Figure 9.4.5, four of them are located in the occurrence areas soils that were tested during the previous surveys, for the sake of continuity of monitoring data).

Generally, when choosing the final location of the sampling sites it is necessary to take into account the location of emission sources of air pollutants, the character of local circulation of near-ground air, the local conditions for the entry of pollutants into the soil (topography, vegetation, snow accumulation conditions), and the location of reclaimed land areas. If there is a single dominant source of emissions or a concentration of such sources in a relatively small area, sampling sites may be arranged according to a 4 or 8-rhumb system or along the lines of maximum expected distribution of pollutants with a certain pitch. With respect to the designed sites of the Plant and the Port it should be taken into account that the areas of influence of those facilities and the adjacent Field facilities will overlap, and therefore it would be advisable to develop a common soil quality observation program for the entire license area with the highest number of sampling sites located specifically in the vicinity of the Plant and the Terminal.

The general requirement for the sampling sites is that their soil should not have any signs of physical or mechanical disturbance (except for remediated soils), and the sampling procedure should allow for keeping track of possible accumulation of pollutants entering the soil with precipitation.

[99] As amended by the Consultant - refer to the text of this section for details

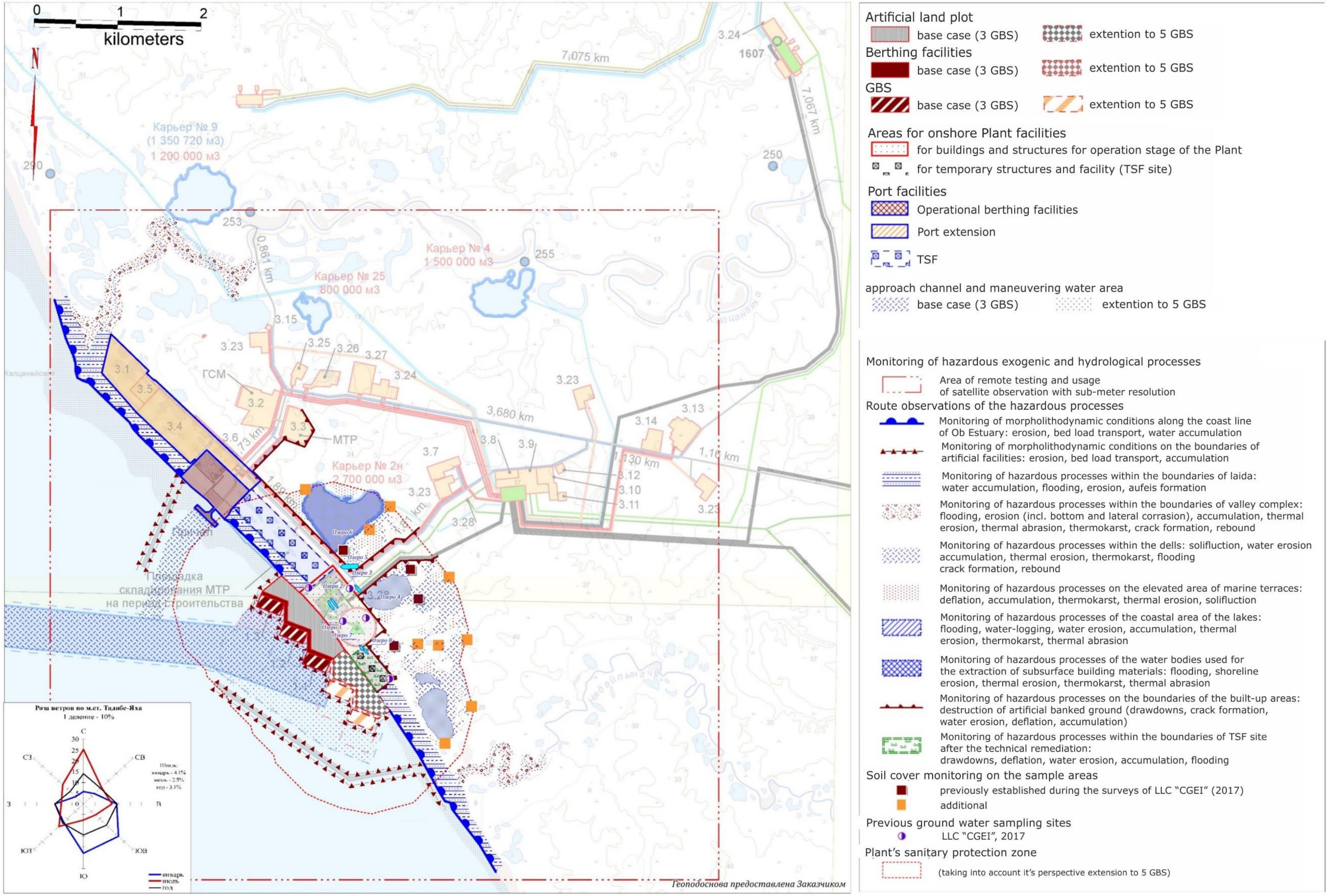


Figure 9.4.5: Situational layout for arrangement of the operational environmental monitoring exemplified by the designed site of the Plant and Terminal onshore facilities, and adjacent Field facilities

It is proposed that soil should be sampled on the annual basis for the entire construction period and the first 2 years of operation of the Project. Subsequently, in the absence of pronounced trends toward accumulation of pollutants in the soil, it would seem sufficient to take regular samples once every 2-3 years; during that period it will be important to monitor areas of accidental pollution – spills, leaks, accumulations of waste on unprotected surfaces. In such cases, according to the Table 9.4.6, it's not just the soil with visible signs of pollution that should be sampled but also supra-permafrost groundwater as a medium which is most likely to carry pollutants from pollution sources to adjacent lands and surface water bodies.

When choosing quality indicators of soils and groundwater as monitoring targets, one should be guided by the regulations and technical data on the parameters of impacts: emissions, discharges, leaks, etc. In general, the minimum set of required soil parameters is defined in Section 6.4 of SanPiN 2.1.7.1287-03, which should be supplemented by soil fertility assessments for reclaimed sites (NPK, organic matter, particle-size composition, acidity). The requirements as to groundwater monitoring are determined by SP 2.1.5.1059-01. For accidental pollution sites, the list of laboratory-tested parameters of soil and groundwater is supplemented by corresponding specific components.

9.4.9 Conclusion

Due to compact footprint of the Field, Plant and Terminal facilities, their impact on geological environment and soil will be limited and will not rich beyond the allocated land plots and adjacent territories (also water areas - for exogenous processes). The results of the preliminary assessment of the impact of the proposed activity are discussed below, separately for subsoil resources and the conditions for their use, exogenous geological processes, soils and groundwater.

1. Subsoil resources and conditions for their use. The Project effects in the geological environment will mainly result from a combination of local physical-mechanical (both static and dynamic) and thermal loads with low integral significance.

Under the Arctic LNG 2 Project, extraction of hydrocarbons, gravel and earth construction materials will irreversibly change the state of the subsoil, while the conditions for subsequent subsoil use in this land and water area will get more complicated with the appearance of numerous engineering facilities in the geological environment. Despite the fact that the license area is not classified as an earthquake-prone area – the field development can lead to the activation of local geodynamics, the most common variant of which is a slow stable subsidence of the land surface and sea bottom over the subject subsoil zone.

By experience of similar projects, over the whole period of field development, subsidence may develop to several dozens centimetres or even few meters (which is less likely), which may cause local incidents at the Project facilities, changes in the direction and intensity of exogenous processes in the adjacent areas, but will not have a significant impact on the land use conditions in Tazovskiy Municipal District, and also at the level of its established elements - Gydan and Antipayuta tundras. The areas of greatest geodynamic risk will be intersections of fractures, especially those near the well pads sites. No strong earthquakes due to induced seismicity are expected. Deformations of surface and individual structures at the Project sites will be subject to geotechnical monitoring.

2. Exogenous Geological Processes. The area of the Field, Plant and Terminal is characterized by a variety of intensive exogenous geological processes, with an average area prevalence over 75% in natural conditions. The terrain stability decreases from the interstream areas to the bottom surfaces of the Ob Estuary, and on the eastern macroslope of the Gydan Peninsula – compared to the western macroslope. In the coastal zone, which geomorphologically is the most complex one, there are relatively stable Laida lake-marsh assemblages, which may primarily be exposed to the risk of their shores destruction and changes of water conditions under the influence of construction. By contrast, the slopes of the second marine terrace, which are prone to gravitational, erosion and deflation, cryogenic and other exogenous processes, are very sensitive to technological impacts. The stability of the shoreface, foreshore and valley network is recognized to be low too, but unlike the stable equilibrium that is characteristic for the undisturbed slopes of the Gydan marine terraces, here the terrain features are being continuously altered by ice gouging, downcutting and lateral erosion, and by water accumulation.

Onshore, the Planned activity will mostly have direct physical and mechanical impacts on the geological environment contributing to the secondary activation of DEGP&HP, the most dangerous of which include cryogenesis, underflooding and waterlogging (with development of hydrogenous taliks), erosion-accumulative processes, thermoabrasion in river valleys and on shores of lakes, deflation and eolian accumulation. Locally developed processes will also include settling of slopes, suffusion, and other engineering processes within the contour of earth structures to be established and excavations.

Unlike the neighbour Yamal District, permafrost in the territory of Gydan Peninsula is less prone to the processes that result in development of frost heave mounds. These specific topographic forms are often associated with the engineering risk of explosion gas occurrences which is still fairly high also in the territory of the Salmanovskiy (Utrenniy) license area.

Along with this, the construction and subsequent operation of the designed facilities will have an impact on the thermal regime of the soil, and since the subject area is associated with the cryolithozone, the thermal effect will inevitably change not only the conditions of seasonal freezing and thawing of the soil, but will also contribute to the degradation of the permafrost and is likely to provoke activation of DEGP&HP outside the land allocation area. The implementation of the measures included in the design and proposed by the Consultant will minimize the negative processes listed above.

The underwater technical works and artificial structures to be established in the water area of the Ob Estuary and the coastal zone will redistribute ice and wave loads, transform the circulation of water and the balance of sediments, which will cause the inevitable reorganization of the underwater terrain.

In general, the impact associated with the intensification of dangerous exogenous geological processes are assessed by the Consultant as being of high significance, but the measures proposed in the ESIA will reduce its significance to moderate for the coastal zone and low for the continental area. In particular, adequate preparation of the coastal area will prevent or minimize the impact of associated processes - flooding and icing, thermal abrasion and other forms of shore erosion, water logging. Adequate monitoring of morphological and lithological conditions is required to track their development trends and ensure early prevention of potential accidents, in accordance with the proposals of the Consultant.

3. Soils. The most important ecological functions of soil in the area of the Field, Plant and Terminal are maintaining the fragile status of local ecosystems, including productive lichen pastures, conserving permafrost through thermal insulation, regulating the water regime of the seasonally thawed layer, and maintaining the stability of the terrain. At the same time, the soils of the subject area are also a natural depositing medium for pollutants and microorganisms, including causative agents of dangerous diseases.

Due to intensive exogenous geological processes, the Project area is characterized by poorly developed thin soils (psammozems / Arenosols, alluvial / Fluvisols) with no economic value. The soils loss will be followed by their rapid – within a few years or decades – restoration on sites free from buildings and pavements. Mature clearly profiled soils (Spodic Cryosols, Gleysols) and thick organogenic horizons (Histic Gleysols, Histosols, Histic Turbic Cryosols) were formed over hundreds and first thousands of years, but they are also highly sensitive to technological impacts, and restoration of their profile after physical and mechanical damage would not be practical.

To this end, given the above functions of the local soils, the key soil management recommendation is to take the utmost care to keep soils undisturbed. For those areas that will be disturbed but will be free from buildings, land reclamation and monitoring measures should be implemented in accordance with the Consultant’s recommendations (Appendix 9). The integral impact of the planned activity on the soil is assessed as being of moderate significance; effective reclamation of disturbed lands based on the Consultant’s proposals will reduce its significance to low.

4. Groundwaters within the designed sites of the Field, Plant and Terminal facilities are not used in economic activities and are not highly sensitive to technogenesis. The shallow groundwater horizon is generally represented by fresh, free-flowing, supra-permafrost waters of the seasonally thawed layer which undergo phase changes on the annual basis. Along with waters of hydrogenous non-through taliks, which are confined to modern alluvial, marine and biogenic sediments and hydrologically associated with surface water bodies that caused their presence, those horizons are not protected from the ingress of pollutants with surface runoff and act as a carrier medium.

One hydrogeological feature of the license area is cryohaline water (cryopegs) found in this area – these are intra-permafrost supercooled brines, occurring at a depth of 10-20 m, which occurrences on the surface are an accident factor due to the pressure levels, high corrosivity and negative temperature of these waters. It is predicted that the impact of the planned activity on the permafrost waters will be significant, but local and most pronounced during the construction period. During that stage, the occurrences of cryopegs are most likely, and the fact that the results of the current surveys do not allow accurate prediction of their occurrences should be compensated for by developing and implementing an appropriate action plan.

The integral significance of the Project impact on the groundwater within its sites can be assessed as low. Deeper aquifers will be affected by direct injection of a part of treated wastewater to formation. The risk of adverse ecological effects of this activity is assessed by the Consultant as low; however, wastewater containing reservoirs and sites of injection wells should be monitored for potential cross-flows, upflows of water, and other unexpected changes in geological environment.

9.5 Biodiversity Impact

According to the Convention on Biological Diversity (Rio de Janeiro, 1992) and the National Strategy of Biodiversity Conservation of the Russian Federation (Moscow, 2002), reduction in the diversity of living organisms representing the terrestrial, marine and freshwater ecosystems is one of the major problems of the present time, which can result in destabilization of biota, loss of the biosphere integrity and its ability to maintain the most important characteristics of the environment.

Due to the vast territories and water areas with a variety of natural conditions and relatively low human-induced modification of ecosystems, including the Arctic ones, Russia plays a crucial role in the global biological diversity conservation. About 80% of the Arctic species diversity and about 90% of the Arctic species of living organisms are concentrated in the Russian sector.

The state of the ecosystems of the polar regions and the tundra in Russia is generally safe, local impacts are associated with the development of hydrocarbon reserves and their transportation, the excessive load of traditional nature management, to a lesser extent, with other factors. The Gydan Peninsula is currently poorly developed and is characterized by a high degree of conservation of natural biodiversity.

Generally, the condition of ecosystems in the polar regions and tundra in Russia appears to be satisfactory, but there are some unfavourable trends associated primarily with the activities of metallurgical enterprises, production and transportation of hydrocarbons, the impact of remote sources of water and air pollution, the consequences of nuclear weapon tests, the operations of nuclear fleet and its bases, excessive load of traditional nature use, and, to a lesser extent – with other factors.

The ecosystem zones in the planned activity’s area of influence are described in detail in Section 7.6, and are characterized by the condition close to natural, high vulnerability to human-induced impacts, and the presence of relic components. At the same time, they are relatively understudied. According to the FEED survey materials, the level of biodiversity and their significance for the Arctic natural zone are relatively low, which is confirmed by significant remoteness – at least 70-100 km – of the Project area from designated conservation territories and water areas.

9.5.1 Classification of habitats in the Project’s area of influence

In accordance with the IFC Performance Standard 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources, a habitat is defined as a terrestrial, freshwater or marine geographical unit or airway that supports assemblages of living organisms and their interactions with the non-living environment. Habitats are identified and classified as modified, natural, and critical, where a critical habitat is a subset of modified or natural habitats.

A habitat is considered to be **modified** if its natural vegetation and/or fauna are largely replaced by non-native species; modified habitats can also include the ecosystems, where the natural functions and species composition have been significantly modified by economic activities. In absence of these conditions, the habitat is classified as **natural**.

A habitat that meets at least one of the following five criteria of IFC PS 6 should be classified as **critical**:

1. A habitat of significant importance to critically endangered and/or endangered species;
2. A habitat of significant importance to endemic and/or restricted-range species;
3. A habitat supporting globally significant concentrations of migratory and/or congregatory species;
4. Highly threatened and/or unique ecosystems; and/or
5. Areas associated with key evolutionary processes.

For the first four criteria, quantitative parameters of the classified habitats compliance are established (Table 9.5.1). In addition, a number of the IFC PS 6 requirements (in particular, paragraphs 13-19 applicable to natural and critical habitats) apply to **legally protected or internationally recognized natural areas**. Those include the UNESCO World Natural Heritage sites; biosphere reserves organized under the UNESCO Man and Biosphere Programme; key biodiversity areas (KBA); lands defined in accordance with the Convention on Wetlands of International Importance (so-called Ramsar Convention) – none of such territories is affected by the Project (refer to map in Chapter 7, Figure 7.6.73-74).

Table 9.5.1: Quantitative threshold values for critical habitat criteria from 1 to 4 (Guidance note to PS6 IFC)

Criterion	Definition/ level
Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species	Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (☐ 0.5% of the global population AND ☐ 5 reproductive units of a CR or EN species). Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR. As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species or species of corresponding categories of Red Books of Russia and constituent entities of Russia (regions).
Criterion 2: Endemic or restricted-range species	For terrestrial vertebrates and plants, restricted-range species are defined as those species that have an EOO less than 50,000 km^2. For marine systems, restricted-range species are provisionally being considered those with an EOO of less than 100,000 km^2. For coastal, riverine, and other aquatic species in habitats that do not exceed 200 km width at any point (for example, rivers), restricted range is defined as having a global range of less than or equal to 500 km linear geographic span. The threshold value for the allocation of critical habitat is an area that supports more than 10% of the global population of the species and more than 10 reproductive units .
Criterion 3: Migratory or congregatory species	Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle. Areas that predictably support ≥10 percent of the global population of a species during periods of environmental stress.
Criterion 4: Highly threatened and/or unique ecosystems	Areas representing ≥5% of the global extent of an ecosystem type meeting the criteria for IUCN status of CR or EN. Other territories and water areas not yet assessed by IUCN but determined to be of high priority for conservation by regional or national systematic conservation planning.

The text below presents the classification of habitats in the planned activity's area of influence, with the ecosystems being subdivided into terrestrial (including freshwater ecosystems of the mainland waterbodies), and marine ones (confined to the Ob Estuary of the Kara Sea), taking into account the statements in the Chapter 7, Section 7.6.

The terrestrial ecosystems of the Gydan Peninsula within the area of influence of the Project consist of natural and locally transformed habitats. The former, within the LA, is represented mainly by the northern hypo-Arctic tundra communities — shrub-moss and shrubby tundras, sedge and cotton grass marshes occupy 99.1% of the LA territory (as by Q1 2020). The modified environment comprises the sites of the Salmanovskoye (Utrenneye) OGCF Facilities Setup, as well as adjacent areas within 50 m strip with plant assemblages modified and degraded by the activated exogenous geological processes (Figure 9.5.1). After the implementation of the Project, the ratio of natural and transformed environment, taking into account the degradation of natural plant communities outside the boundaries of the land allotment, will have a ratio of about 97 % and 3%, respectively.

Figure 9.5.1: Natural (1) and transformed (2) habitats on Salman (Utrenny) LA. Transformed habitat: technological sites, infrastructural facilities, areas of their direct influence, for example, areas of local flooding and degradation of the tundra as a result of mechanical impact.

Source: JSC "IEPI", 2020

Areologically, more than 20 species of plants listed in the Red Data Book of YNAO and its annex can be present in the LA territory. The local environmental monitoring in the surveyed area identified presence of four species listed in the Red Data Book of YNAO under category 5 “rare species” (*Bromopsis vogulica, Luzula tundricola, Saxifraga cespitosa, Polemonium boreale, Thymus reverdattoanus*), and four other species (*Ranunculus nivalis, Papaver jugoricum, Parrya nudicaulis, Eremogone polaris*) listed in the annex to the Red Data Book with a status “requiring special attention” . Ozhika tundra (*Luzula tundricola*) grows in shrub-moss tundra on the heads of steep slopes. *Eremogone polaris* was found on sandy cliffs to the coast of the Gulf of Ob, as well as on sandy slopes in the valley of the Nyadai-Pyongche river. The most common species on the territory of LA is the northern bluefin (*Polemonium boreale*) found on sandy deposits in river valleys and the sea coast.*Papaver jugoricum* and *Parrya nudicaulis* were recorded on the patches of exposed soil on tops of ridges. *Bromopsis vogulica* and *Saxifraga cespitosa* are present in the seral[100] communities of shrubby tundras on the top surfaces of frost heave mounds. All finds of the rare and protected species were reported outside the land acquisition of the designed facilities. The aforementioned species are not included in the Red List of the International Union for Conservation of Nature (IUCN). According to the expert opinion of the Consultant, these species would have a status as “Least Concern” with reference to the regional level criteria of IUCN[101]. The above taxons are present in vast ranges and fail criterion 2 of the IFC PS6: their range of presence is circumpolar (*Polemonium boreale, Saxifraga cespitosa, Ranunculus nivalis*) or in the Siberian sector of the Arctic (*Bromopsis vogulica, Papaver jugoricum, Parrya nudicaulis, Eremogone polaris, Luzula tundricola, Thymus reverdattoanus*). According to the results of the simulation (Section 7.1.3.1), it is shown that the potentially suitable habitats for rare and protected species *Polemonium boreale, Luzula tundricola*, *Bromopsis vogulica* are 7.2%, 11.7%, and 9.3%, respectively. These suitable habitats have been identified throughout LA.

Thus, regionally protected plant species growing on the territory of LA are not a reason for the allocation of critical habitat, since they do not belong to the category of endangered (EN) or critically endangered species (CR). Partial loss.

The terrestrial vertebrates fauna in the Project area is generally typical of the tundra zone. Representative of three vertebrate species listed in the Red Data Books of the Russian Federation (2000) and Yamal-Nenets Autonomous Okrug (2010) have been encountered in the territory of the Salmanovskiy (Utrenniy) LA: Bewick’s swan (*Cygnus bewickii*), peregrine (*Falco peregrinus*), and snowy owl (*Nyctea scandiaca*). All of them are listed with a status of “Least Concern”. Apparently, these birds use the territory of the Salmanovskiy (Utrenniy) LA for nesting, however no nests have been registered.

[100] Serial communities are communities that develop in unstable edaphic conditions and continuous seral changes resulting therefrom. S. A. Gribova, T. I. Isatchenko. Vegetation mapping in survey scale // Field Geobotanics. L.: Nauka, 1972. P. 137-324.
[101] Guidelines for application of IUCN Red list criteria at regional and national levels: version 4.0. IUCN. 2012.

Migration routes of anseriformes pass through the Salmanovskiy (Utrenniy) LA, however, the main migration corridors are outside the license area - in the East Gydan and Taymyr. Wetlands of significance for global populations of birds, important bird areas, reserves, sanctuaries are located at a significant distance from the surveyed area. Wetlands in the east of Gydan Peninsula are categorised (with reference to criteria 1 and 3 of the IFC PC 6) as critical habitats, as they provide nesting habitats for protected species – red-breasted goose and lesser white-fronted goose, and represent important nesting habitats for anseriformes at a global level. These critical habitats are located at a distance of more than 25 km from the LA boundary, and 70 km from sites of the designed facilities[102] (refer to sub-sections 7.6.3, 7.6.4 for more details).

Marine ecosystems of the Ob Estuary within the Project's area of influence, are also natural habitats, except for the water areas where the waterside structures – existing berth – are constructed, as well as adjacent areas with modified bottom profile (access channel). As a result of survey in 2019 (IEPI JSC, 2019), the area affected by degradation of benthos communities, with low numbers and biomass of benthos, was identified within a belt of about 1 km from boundaries of the approach channel and construction areas of other hydraulic structures.

Based on the environmental, sanitary and hydrobiological indicators, the water area of the Ob Estuary within the Project's area of influence is characterized as slightly polluted. Generally, the ecosystems of the Ob Estuary cope with the existing pollution, although there are some local trouble spots mainly located in its southern part. The condition of ecosystems of the Ob Estuary as a whole appears to be satisfactory.

The considered habitats become even more important due to the fact that they are associated with the Ob Estuary as a single complex of marine ecosystems, and are only a part of a greater migratory range for some species. In 2014, in accordance with the procedures of the Convention on Biological Diversity, with the support of the Working Group of the Arctic Council on the Conservation of Arctic Flora and Fauna (CAFF) and the UN Environmental Programme (UNEP), the Ob and the Yenisei Estuaries, among 11 other major Arctic ecosystems, were included in the list of ecologically and biologically significant areas (EBSAs) requiring appropriate measures for their conservation and sustainable use in accordance with international law and national legislation (Section 7.6). Inclusion in the List of EBSAs means that the ecosystems within the identified contour meet, to a certain extent (see Table 9.5.2), the scientific criteria of significance approved at the Conference of the Parties to the Convention on Biological Diversity.

Table 9.5.2: Significance of the Ob and the Yenisei Bay in accordance with the Decision IX/20 of the Conference of the Parties to the Convention on Biological Diversity

No.	Criterion	Description	Significance of the Ob Estuary and the Yenisei Bay
1	Uniqueness or rarity	Areas containing either (i) unique ("the only one of its kind"), rare (occurs only in few locations) or endemic species, populations or communities; and/or (ii) unique, rare or distinct habitats or ecosystems; and/or (iii) unique or unusual geomorphological or oceanographic features	High
2	Special importance for species development cycle stages	Areas essential for a population to survive and thrive	High
3	Importance for threatened, endangered or declining species and/or habitats	Areas containing habitat(s) for the survival and recovery of endangered, threatened, or declining species; or areas with significant communities of such species	Medium
4	Vulnerability, fragility, sensitivity, or slow recovery	Areas containing a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion due to human activity or natural events), or those with slow recovery	Medium
5	Biological productivity	Areas containing species, populations or communities with comparatively high natural biological productivity	High

[102] Brauneder, K. M., Montes, C., Blyth, S., Bennun, L., Butchart, S. H., Hoffmann, M., ... & Pilgrim, J. (2018). Global screening for Critical Habitat in the terrestrial realm. PloS One, 13, 3.

No.	Criterion	Description	Significance of the Ob Estuary and the Yenisei Bay
6	Biological diversity	Areas characterized by comparatively high diversity of ecosystems, habitats, communities, or species, or by higher genetic diversity	Low
7	Naturalness	Areas with a comparatively higher degree of naturalness as a result of absence or low level of human-induced disturbance or degradation	Medium

The concept of ecologically and biologically significant areas identification under the Convention on Biological Diversity suggests that advanced environmental measures **may be** required within the EBSA, including the establishment of specially protected water areas, as well as the assessment of activity impact on the marine environment.

Despite the fact that critical habitats are more likely to be found within the EBSAs, the Consultant does not have any particular reasons for classifying the Project-affected marine habitats as critical. On the contrary, the engineering surveys conducted in this water area in 2012-2017 and environmental monitoring in 2019 did not reveal any spawning or wintering grounds of rare (including endemic) or valuable fish species, especially valuable benthic communities, and unique or seriously threatened marine ecosystems

In particular, known places of concentration of Siberian sturgeon (*Acipenser baerii*) – one of the rarest and, at the same time, most valuable commercial species in the Ob catchment – are located in the southern part and, less frequently, in the middle part of the Ob Estuary. According to the surveys and design calculations, reduced productivity in the water area affected by dredging works and dredged soil dumping during the ice-free period will be, to a certain extent, compensated by a significant part of plankton resources not eaten by fish in the fresh-water southern part of the Ob Estuary and carried into the brackish zone of its middle part.

Uneven biological diversity in the Ob Estuary is described in detail in Chapter 7, paragraph 7.6.2.1. Hydraulic structures of the Arctic LNG 2 Project, as well as the main part of their area of influence, are confined to the river segment of the estuary, where the primary production is formed almost entirely due to the winter pre-vegetation reserve of nutrients; therefore, this area is generally least productive in the Ob Estuary. Its role in maintaining the number of commercial, rare and endangered fish species is minimal compared to the southward zone of the Ob and the Taz Estuaries confluence (identified as an Arctic water area of a high environmental value "Ob-Taz sector of Kara Sea"), which is proposed to have the status of a fishery reserve area, since there is high concentration of wintering and spawning fish of multiple species, including the Siberian sturgeon (Matkovskiy et al., 2014).

The Project implementation in 120-140 km downstream of the boundaries of the water area of a high environmental value will minimize the likelihood of direct impacts on this area; it appears to be one of the studied marine habitats closest to the Project's hydraulic structures, which can be acknowledged as equivalent to critical in terms of its significance and, potentially, its legal status (as *protected by law*, see above).

According to the IFC Performance Standard 6, any **significant** modification or degradation to a natural habitat is prohibited, unless the following conditions are demonstrated:

- There are no other viable alternatives to the Project implementation in a modified habitat within the region under study;
- Consultations have established the opinion of stakeholders, including the affected communities, regarding the extent of modification or degradation;
- Consequences of any modification or degradation can be mitigated in accordance with the mitigation hierarchy.

All the above conditions are relevant or realistic for the Arctic LNG 2 Project; therefore, the planned activities do not fail to satisfy the requirements of the IFC PS 6, on condition that all reasonable measures are taken to mitigate the impacts on biodiversity.

In the areas of natural habitat, such measures should be designed to achieve no net loss of biodiversity where feasible, including the following:

- Prevention of impacts on biodiversity through the identification and protection of land areas excluded from general development;
- Implementing measures to minimize the habitat fragmentation, such as creating biological corridors;
- Restoring the habitat during operation and/or after operation;
- Implementing measures to compensate the biodiversity.

According to the international best practice, a Biodiversity Conservation Action Plan should be developed to exclude the net loss and, where possible, to improve the biodiversity state.

9.5.2 Assessment methodology and key impacts

The recipients of impacts on the biodiversity are plant and animal species, including rare and protected ones, their genetic diversity, populations, habitats, natural and modified ecosystems, and the areas of high biodiversity importance.

Basic assessment methodologies used in this ESHIA report preparation are described in Chapter 3. The methodology of assessment of impacts on biodiversity includes identification and assessment of significance of negative impacts and their consequences for affected populations and natural ecosystems as a whole; development of measures for impacts mitigation; prediction of residual impacts; and determination of measures aimed at improving the biodiversity status.

In assessing the significance of impacts on biodiversity, the same criteria are applied as in assessing the impacts on other environmental and social components, according to the general methodology used at Ramboll.

In accordance with the IFC Performance Standard 6, a mitigation hierarchy was applied in developing the environmental protection measures, which included compensatory measures for biological diversity conservation only after proper implementation of measures to prevent or minimize the impacts and to restore the biological diversity. The compensatory measures should be designed and implemented in such a way as to achieve measurable results that make it possible to reasonably predict no net loss of biological diversity, and, preferably, its absolute gain. These measures should be based on the best practices and available information.

During the impact assessment, the following major impacts and risks with respect to biodiversity and ecosystem functions (ecosystem services) were identified, which are discussed in detail in this section:

- Degradation of ecosystems and loss of habitats in the Ob Estuary water area;
- Damage to populations of rare and commercial fish species;
- Introduction of invasive species in the Ob Estuary water area;
- Decrease in number and death of marine mammals;
- Degradation and loss of aquatic ecosystems of the Gydan Peninsula;
- Disturbance of vegetation cover and reindeer pasture lands degradation;
- Decrease in number and death of migratory bird species;
- Decrease in number and death of animals;
- Introduction of invasive species into terrestrial ecosystems.

Further information on the assessment of significance of impacts on biodiversity, recommended mitigation and monitoring activities is provided in sub-sections 9.5.4 to 9.5.11 and summarized in Table 9.5.9.

9.5.3 Impact on ecosystems in water of Gulf of Ob.

The greatest impact on marine aquatic organisms will be directly associated with the impact on their habitat, primarily due to dredging, soil dumping under the water, and soil filling for the GBS installation.

At the stage of **construction** in the Ob Estuary in the area of the above works, the following types of negative impact are expected:

- Mortality of phyto- and zooplankton, caused by water pollution with high concentrations of suspended solids both in the dredging area and in the soil dumping zone;
- Reduced productivity of phyto- and zooplankton due to water turbidity increase during dredging, dumping and soil filling works;

- Mortality of benthos in the seabed areas damaged during dredging works and soil dumping under the water;
- Mortality of benthos in the sea bed areas silted by a layer of sediments more than 5 mm thick due to fine particles sedimentation during soil dumping under the water;
- Mortality of zooplankton and zoobenthos, caused by noise, vibration and shock waves during piling works;
- Habitat degradation, including
  - Disturbance of natural bottom relief, lithodynamic regime, and composition of soil layers necessary for benthic communities formation and development;
  - Increased content of nutrients released from excavated soils into water results to eutrophication of the aquatic ecosystem and impairment of water environment quality;
  - Water area contamination with rain and melt water (ablation) from construction sites, as well as due to potential sporadic and unintentional leaks of technological, flushing and domestic wastewater from vessels and machines engaged in the works;
  - Secondary contamination caused by pollutants washout from soil into water.

Pollution of water environment with wastewater discharged from vessels is not addressed since it is prohibited to discharge pollutants from vessels in accordance with the Federal Law No. 155-FZ dated 31 July, 1998, On internal marine waters, territorial sea and contiguous zone of the Russian Federation, Article 37, Part 2.

At the **operation** phase, in addition to all the negative impacts due to the need for regular dredging operations, the following impacts can also be expected:

- Impairment of habitat quality, caused by seawater contamination with treated domestic wastewater, rainwater and melt water (if the treated wastewater does not meet the requirements for discharge in fishery-grade waterbodies);
- Mortality of zooplankton and zoobenthos, caused by noise impact during the process train maintenance;
- change in salinity conditions due to the transformation of the hydrodynamic regime of the aquatoria;
- Impairment of habitat quality, caused by seawater contamination in the event of accidental spills of gas condensate, fuel, or other process liquids from vessels and fixed structures of the Plant and Port.

Despite the extensive evaporation during accidental spills, components of gas condensate are highly toxic, and reportedly[103] they can migrate through food chains, which enhances significance of emergency impacts on biota.

At the **decommissioning** phase, the impacts will be similar to those at the construction phase due to the works on dismantling of the process trains and ice barriers. One exception are solid wastes treatment and disposal sites. Given that disposal of low-hazard wastes does not allow for their subsequent removal elsewhere, adequate arrangements should be in place to provide for their safe isolation in the landfill cells. Certain facilities, in particular the Port, may be left in operation after decommissioning of the field facilities.

The above works worsen the living conditions of all hydrobionts, in both plant and animal forms, which disrupts the production processes at all trophic levels and significantly reduces the productivity of ecosystems.

One of the key impacts is expected to be the arrival of suspensions. The agitation of bottom sediments during dredging, dumping and hydraulic deposition of soil will lead to a violation of the habitat of phytoplankton by reducing the intake of light radiation into the water column, and will reduce the intensity of photosynthesis in microalgae cells. Phytoplankton quickly reacts by reducing photosynthesis and primary production at sufficiently low levels of suspension in water (20-30 mg/dm3)4[104][105]. These phytoplankton reactions are easily reversible, since single-celled algae are able to quickly (up to two or more times a day)

[103] Steiner R. Environmental Risks of Condensate Releases-Leviathan Offshore Gas Project, Israel. Independent Expert Opinion. July 15, 2018. https://zalul.org.il/wp-content/uploads/2018/09/Steiner-Opinion-07-15-18-.pdf

[104]

[105]

restore biomass and abundance with the weakening of adverse effects. Analyzing the experimental data of VNIRO with diatom Phaeodactulum tricornutum, A. A. Shavykin points out: (1) when suspended at concentrations up to 1000 mg/dm3, existing for up to 2 days, phytoplankton death does not occur; (2) when suspended at concentrations of 100 mg/dm3, the number of cells remains at the control level. Under natural conditions, significant changes in the abundance of phytoplankton (in amount and biomass) they can occur even with an increase in turbidity by 5-15 mg / dm3[106].

When organic substances and easily oxidized pollutants are washed out of bottom sediments, a temporary decrease in the content of dissolved oxygen (consumed during the oxidation of pollutants) is likely, which negatively affects aerobic species of hydrobionts.

The effect of turbidity zones on zooplankton consists in the impairment of respiratory system, worse performance of filtering systems, and disturbance of the rhythm of vertical migrations. This can result in mortality of the most sensitive groups and individuals of hydrobionts; slower growth, development and maturation of plankters, including some species of food plankton. The quality of water environment as a place of feeding and reproduction of all plankton organisms degrades in the turbidity zones.

The minimum threshold concentration of suspension at which the first signs of adverse effects can be observed (usually in the form of reduced photosynthesis in algae and deterioration of filter-feeding in invertebrates) is about 10 mg/l. When the concentration of suspended solids is less than 10 mg/l (MPC for fishery waterbodies of the top category), there are no negative phenomena in plankton communities.

The effects of poor nutrition, stunted growth, development, and reproduction may begin with a concentration of 20-30 mg/dm3 of suspension in water under chronic exposure, and noticeable zooplankton death may occur when exposed to a concentration of natural and/or anthropogenic suspension exceeding 1000 mg / dm3 for several days (Patin, 2001).

It should be noted that according to the Federal Agency for Fishery, the mortality of zooplankton is as follows:

- 50% in case of increase in suspended solids concentration from 20 to 100 mg/dm^3;
- 100% at the concentrations of suspended solids 100 mg/dm^3 or higher.

At the same time, however, the facts of the duration of the existence of clouds of suspensions are not taken into account.

The main way to estimate the scale of the impact of suspension clouds is mathematical modeling of suspended sediment transport (for more information, see Section 9.3). In the framework of this Project, as well as in the framework of research on the Yamal LNG project, the following 3D hydrodynamic models were used, on the basis of which numerical experiments were built:

- Three-dimensional thermohydrodynamic model of Princeton University, USA (POM) (Ecoexpressservice LLC, 2019);

- Model of the Institute of Computational Mathematics named after G. I. Marchuk of the Russian academy of sciences (INMOM) (JSC "IEPI", 2020);

- delft3d model (Computer Centre of RAS, 2015);

- model "aks-eco shelf" of the computer center of the russian academy of sciences named after A.A. Dorodnitsyn (LLC "FRECOM", 2020);

Models of the Kara sea, part of the Ob Bay near the Sea canal, the port of Sabetta (Lok) and three models in the immediate area of the Marine canal and in locations of dumps (Small 1, Small 2 and Small 3) (LLC "Cardinal Soft", 2020). In addition, to calculate the parameters of suspension propagation in the framework of the project Terminal of Liquefied Natural Gas and stable gas condensate "Morning" (OEP), a 2D modeling approach was applied without taking into account the inhomogeneity of the medium in depth.

The main parameters of hydrodynamic models are given in Appendix 20.

The complex hydrodynamic regime of the Ob Bay leads to different model estimates of the Project's impact on the ecosystems of the Ob Bay. The greatest differences are shown by the results of 3D and 2D modeling approaches without taking into account the complex hydrodynamic conditions of the water area. The

[106] Максимова О.Б. Влияние повышенной мутности воды на структурнофункциональные характеристики фитопланктона Сб. науч. тр. ФГНУ ГосНИОРХ. 2006. Вып. 331. С. 86–121.

geometry of the integral turbidity zone obtained in 2020 by IEPI JSC (INMOM model) (Figure 9.5.1) is similar to the results of modeling suspensions of Eco-Express Service LLC (2019, Princeton University model). The model is based on similar initial volumes of dredging and dumping. At the same time, the integral zone of turbidity from dredging in the area of the Terminal "Utrenny" of LLC "FREKOM" (model "AKS-ECO shelf") at the initial volumes of 627 thousand m3 is significantly different from that obtained by JSC "IEPI". With much smaller dredging volumes (627 thousand m3 compared to 1397 thousand m3 taken by JSC "IEPI" in the INMOM model), the predicted turbidity plume extends directly along the coast of the Gydan Peninsula.

The duration of suspension clouds is estimated according to the INMOM model (IEPI, 2019), the cloud of additional suspensions during dredging and dumping of 5.6 million m3 of soil at stage 1 will be 1314 hours (1.8 months). At the same time, according to the assessment of Cardinal Soft LLC, the lifetime of turbidity clouds during dredging and dumping of 7.5 million m3 of soil on underwater dumps of the sea channel will be about 19 hours.

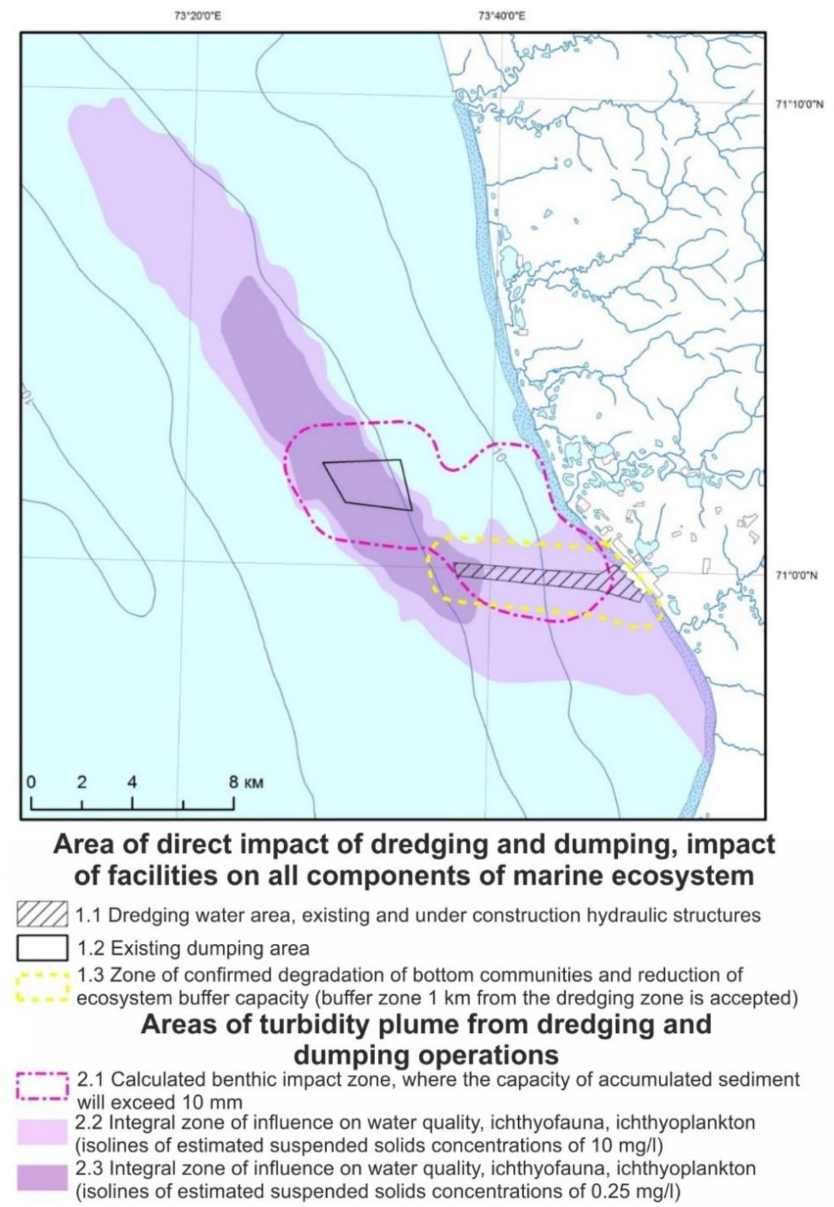
The restoration of plankton communities, provided that the organisms composing them multiply rapidly, will take no more than one season.

During dredging operations, the direct impact on benthic communities (phyto - and zoobenthos) has a direct mechanical destruction of zoobenthos, as well as its burial as a result of the deposition of suspended particles. The death of benthic animals buried under a layer of bottom sediments occurs at a layer thickness exceeding the vertical dimensions of organisms and at a sedimentation rate of more than 0.5 mm/day. sedimentation of particles of bottom soils of small thickness (1-5 cm) causes the death of small and medium - sized representatives of infauna and epifauna-polychaetes (except burrowing species), amphipods, small gastropods, juvenile bivalves and other benthic animals[107].

The review of A. A. Shavykin (2015) indicates that the negative impact of sedimentation on the bottom, on the one hand, is specific to groups of organisms, and on the other — from the types of ground that animals were covered with. According to the results of experiments with polychaete worms and bivalves, it was found that, regardless of the precipitation layer (1-10 cm), no mortality was observed for 14 days, the animals moved both in the depth of the ground and on the surface. Thus, the threshold levels accepted for calculations are indicative.

Based on the results of studies of the taxonomic composition of macrozoobenthos of the considered water area, performed in September 2019 (JSC "IEPI", 2020), the main part of the biomass of benthic invertebrates falls on organisms with linear dimensions of more than 5 mm. In this regard, it can be assumed that for large mobile forms of macrozoobenthos that form the main biomass (sea cockroach *Saduria entomon*, large mobile polychaetes *Marenzelleria arctia* and *Ampharete vega arctia*, to a lesser extent, amphipods *Pontoporeia femorata*), the impact of accumulating sediment with a thickness of up to 10 mm is not critical and they (or a significant part of them) they are able to leave the area of concern or not be buried under a layer of redeposited ground.

[107] В рыбохозяйственных разделах Проекта эти значения принимаются качестве критических для организмов: слой отложений 1-5 см (50% гибели бентоса) и более 5 см (100% гибели бентоса)



For sedentary and small forms of benthos that live on the soil surface, as well as juvenile infauna species, a much thinner layer of sediments can be destructive.

Silting of the seabed surface prevents the germination of phytobenthos spores, which reduces its biomass and, therefore, oxygen generation in the sea.

Figure 9.5.1: Areas of influence of the underwater operations in the Ob Estuary water area according to simulation by IEPI (2020)

Source: IEPI JSC, 2020

All zoobenthic organisms are valuable food resources for fish. Relict crustaceans are especially important for Coregonidae feeding. Destruction of the relict complex or reduction in the number of relict species will result in irreversible negative consequences for the valuable commercial ichthyofauna.

The underwater dumping area is estimated to be about 400 ha – within these boundaries (Figure 9.5.1), natural bottom communities will be exposed to the most intense mechanical impact, the severity of which will depend on dumping intensity. Usually, in such cases the dumping sites represent a combination of areas with different extent of bottom community transformation: from their partial or total burial under the disposed substrates, to benthic fauna recovering within a few months or the first years. The latter is successful, as a rule, on the periphery of the dumping sites due to the possibility of vertical and horizontal migration of bottom organisms through the thickness of settled particles.

In relation to the planned activity, a favorable factor will be the similarity of the dumped soil in chemical and physical characteristics with the bottom sediments of the dumping site. According to the results of engineering surveys and monitoring in the Gulf of Ob in the sediments there is no evidence of man-made pollution, pollutants from entering the water during dredging and dumping, thus, seems unlikely.

With regard to the Project activities, chemical and physical similarity of the dumped soil with the bottom sediments at the dumping site will be a favourable factor. According to the simulation conducted by Fertoing LLC (2017), the zone of significant impact of dumping on benthic communities will spread to no more than one kilometer; within this area, the thickness of accumulated sediments is expected to exceed the threshold value of 10 mm.

Project's area of influence on the Ob Estuary ecosystems is shown in Figure 9.5.1. Total area size of the integral zone of impact on water quality within the 0.25 mg/l isoline of estimated additional turbidity concentrations is 228 km^2. This area is equivalent to 0.05 % of the total area of the Ob Estuary, including the Taz Estuary (approximately 50,000 km^2).

It is noted that hydrobiological communities of the Ob Estuary are potentially resilient to the expected anthropogenic impact, as they are mostly composed of eurybionts that can live in a wide range of environmental conditions, and species predominating the macrozoobenthos communities have a pelagic juvenile stage in their life cycle, which enables their distribution on disturbed substrates. Benthic communities of the Ob Estuary being the main receptor of the impact have a natural self-restoration capacity in the conditions of continued disturbance. In the shallow-water zone, the main natural factor of disturbance is the thick ice that completely destroys bottom communities in winter; therefore, ephemeral coenoses develop in this zone during the vegetation season. Exaration gouges are also present in the Ob Estuary at the depths of 10-20 m, therefore, disturbance by ice (and related successions) is omnipresent.

According to the results of hydrodynamic modeling (JSC "IEPI", 2019; INMOM model), it is shown that salinity changes from the construction of the Project structures will average about 1-2% and will be localized only in the middle part of the bay. The greatest changes in water salinity will occur on a seasonal scale in the area of hydraulic structures of the project - the approach channel. In the protected water area, a negative salinity anomaly is formed on the surface, and in the bottom layer, increased salinity values are observed. A zone of increased salinity is also formed to the south of the hydraulic structures. Given the fact that hydrobiont species living in the project area have adaptations to inhabit a wide range of salinity, this impact will be negligible.

Diminishing fraction of silt in bottom sediments is a hindering factor for restoration of original communities. Considering the active lythodynamic processes in the Ob Estuary and the existing natural recovery mechanisms, restoration of communities of polychaetas *Marenzelleria arctia* and *Ampharete vega arctia* may take several seasons, due to their long period of development.

One of the factors of the project will be the appearance of artificial land plots and new forms of bottom relief. This will lead to a change in the regime of currents, temperatures and salinity. This question was investigated by modeling methods (see above). Changes in hydrological and hydrochemical parameters in the Ob Bay will be observed directly near hydraulic structures and will have little effect on the composition of hydrobiological communities. It is expected that as a result of regular dredging in this zone, they will be disturbed, and are represented by ephemeral cenoses.

The offshore concrete and metal structures to be installed under water will function as “artificial reefs” unusual of the Ob Bay, and will be populated mainly by filamentous algae.

Taking into account the need to clear the access channel and the Port water area at least every two years, **long-term** impact on phyto- and zooplankton is expected during dredging works in the middle and northern part of the Ob Estuary. Taking into account the predicted permanent and temporary damage, as well as the general decline in the productivity of ecosystems within a significant section of the water area, the impact severity is estimated as **medium**, with **reversible** consequences. Taking into account **medium** sensitivity of the recipient to the impact, the overall significance of the impact is also assessed as **moderate**.

The measures to mitigate the effects of ecosystems degradation and loss of habitats in the Ob Estuary area are presented in Table 9.5.4, taking into account the required hierarchy "from prevention to compensation measures".

The designed measures can somewhat mitigate the negative effect; however, the magnitude of residual impact and its significance still remain **moderate**, which makes it necessary to take some additional measures to achieve no net loss and total net benefits for biodiversity in respect of the affected habitats.

Monitoring of plankton communities should be carried out in a comprehensive manner, with simultaneous monitoring of aquatic environment and using chemical and biological analytical methods. When planning the monitoring network, it is necessary to consider the requirement for monitoring the pollution spreading from the coastal zone to the Ob Estuary, and its impact on ecosystems (see the area of influence outlined in Figure 9.5.1).

Taking into account the period of active development of phyto- and zooplankton in the Ob Estuary, it is advisable to conduct monitoring in the interval from June to October in accordance with the schedule and intensity of construction works.

It is recommended to carry out the monitoring of benthic invertebrates based on a grid of stations arranged in accordance with the design solutions with regard to the affected areas. It is advisable to carry out annual macrozoobenthos studies during the construction works and several years after the completion of construction.

9.5.4 Impact on populations of rare and commercial fish species

As with phyto-and zooplankton and zoobenthos, the greatest impact on the populations of rare and commercial fish will be associated primarily with dredging, underwater dumping of soils, and soil filling for the artificial land plot. These works worsen the living conditions of all hydrobionts, in both plant and animal forms, which disrupts the production processes at all trophic levels, reduces productivity and, ultimately, leads to decrease in fish reserves.

At the stage of **construction** in the Ob Estuary water area, the following negative impacts are expected:

- Mortality of fish eggs and juveniles as a result of a significant increase in the concentration of suspended solids during dredging, dumping and soil filling;
- Mortality of fish eggs and juveniles caused by physical effects, such as noise, vibration and shock waves during piling;
- Deterrence and redistribution of fish due to hydroacoustic impact from the works and vessels involved in the works;
- Reduction of forage base due to reduced productivity of phyto-and zooplankton during dredging, dumping and soil filling;
- Violation of migration routes during dredging and GBS installation in the coastal zone;
- Water area contamination with rain and melt water (ablation) from construction sites, as well as due to potential sporadic and unintentional leaks of technological, flushing and domestic wastewater, and accidental spills of petroleum products from vessels and machines engaged in the works.

At the **operation** phase, in addition to all the negative impacts described above, the following impacts can also be expected:

- Impairment of habitat quality, caused by seawater contamination with nominally treated domestic wastewater, rainwater and melt water (if the treated wastewater does not meet the requirements for discharge into fishery-grade waterbodies);
- Impairment of habitat quality caused by seawater contamination in the event of accidental spills of petroleum products from vessels.

At the **decommissioning** phase, the negative impacts on ichthyofauna as well as other hydrobionts will be similar to those at the construction phase due to the works on de-installation of the process trains and ice barriers.

The impact on the ichthyofauna will be mainly in the form of forage reduction and habitat degradation, which will be associated with the presence of pollutants (floating, suspended and dissolved impurities), and with physical impacts on the water area and coastal land areas (noise, vibration, light exposure); thus, the most intense impact is expected during construction of the Plant, Port and other facilities on the coast.

Wintering grounds of Coregonidae and Siberian sturgeon are located in the middle part of the Ob Estuary. Due to the absence of suffocation zone, this area is the only place where the main part of the population of sturgeon, Siberian white salmon, muksun, whitefish, peled, broad whitefish and other valuable fish of the entire Ob catchment spend winter. The dredging area is situated in approximately 120 km northward of the main places of fish concentrations in winter. At the same time, negative consequences of dredging and soil dumping can be expected for valuable commercial anadromous fish species such as the Arctic cisco and Arctic char migrating to the southern part of the Kara Sea for fattening.

The analysis of specific features of reproduction of fish living in the Ob Estuary area, including the water area where hydraulic structures of the Arctic LNG 2 Project will be constructed, showed that the ichthyoplankton community development takes place mainly in spring months and in the beginning of summer, so during this period it is particularly vulnerable to all kinds of impacts of both natural and human-induced origin. Restrictions on hydrotechnical operations are applied during this period. According to the instructions of the Nizhneobsky Territorial Department of the Federal Agency on Fishery, hydraulic engineering works in the Ob Bay are possible from July 1 to October 31.

Fish eggs, larvae and juveniles at the earliest stages of their development are most vulnerable to suspension (sticking to the membranes, damage to the covers, clogging of the mouth opening and water breathing organs). Mortality of 100% of pelagic eggs and fish larvae is observed at concentrations of suspended solids higher than 25 mg/l. Adult fish does not suffer much from dredging operations, since it usually avoids these areas and leaves due to water turbidity, nuisances (noise, vibration, intensification of navigation), and reducing forage base. Therefore, the effect of suspended solids on different groups of ichthyofauna is manifested in the form of reduction and/or loss of their forage base, as well as loss of spawning grounds as a result of silting.

Dredging and dumping can cause changes in the saturation of marine waters with oxygen due to the cost of its oxidation when compounds enter the water. The review by Nightingale and Simenstad[108] indicates that at suspension concentrations above 500 mg/dm^3, the dissolved oxygen content can drop to 0.1 mg/dm^3. At the same time, the dependences of the dissolved oxygen content and suspension concentrations depend on a number of hydrological factors, as well as the lifetime of the suspension cloud. The assessment of this impact on the waters of the Gulf of Ob requires additional study during monitoring. High observed dissolved oxygen content of 8.4-13.6 mg/dm^3 at all horizons in the Project area (JSC "IEPI", 2020) allows to suggest that a significant decrease in oxygen supply is unlikely.

Hydroacoustic impact of the works can lead to temporary redistribution of fish, resulting in decreased abundance of fish in the areas adjacent to the construction site for the duration of the works. (for more information on exposure levels, see section 9.2.1.3).

To minimize the adverse effects on the ichthyofauna, the construction period should be determined in consultation with the Federal Agency for Fishery. From the perspective of commercial fish fauna, the safest time for the works is in July-October.

Deterioration of habitat quality due to seawater pollution by potential sporadic and unintentional leaks of process, flush and domestic wastewater from vessels and machines are unlikely to have any significant effect against the background of the construction activities.

It is expected that underwater works will have the most widespread effect: the contours of the integrated turbidity zones generated by the dredging and dumping activity, with the input of solids being at least 1 mg/l, are presented in Figure 9.3.3 (Section 9.3). Turbidity plume will travel as far as 20–25 km downstream of the Ob River with the main plume zone deviating from the coast, and as far as 10 km upstream moving mostly along the coastline. This factor will have a significant impact on ichthyofauna when the threshold concentration of suspended solids reaches the level of 10 mg/l at a distance of about 8 km downstream of the underwater dump boundary (Figure 9.5.1).

The salinity regime is expected to change during the construction of the sea channel in the Gulf of Ob (for more details, see section 13.1.5). The forecasted change of the boundaries of salt water penetration in winter is estimated at 57 km from the Ob bar. This fact will not directly affect the resident ichthyofauna of the Project area, but it may change the timing and nature of seasonal migrations of whitefish in the Northern part of the Ob Bay.

A possible impact on the ichthyofauna is an increase in the number of people in the Project area who can potentially catch fish. This issue is being resolved (and will be resolved) by strict prohibition of fishing and sensitive sanctions for individuals and legal entities for violations of these prohibitions.

The impact on commercial and rare fish species is expected to be **long-term**. Predicted damage is also divided into permanent and temporary, and according to the above calculations, its value is estimated as **high**. **High** sensitivity of the recipient also determines the **high** significance of the impact.

The applicable Russian law requires that specific measures are designed and applied during works in fishery waterbodies to minimise the negative impact on aquatic bioresources, and on their living and reproduction environment. If such measures cannot fully prevent the negative effects on water environment and ensure conservation and reproduction of fishery resources and fodder organisms, an assessment shall be conducted to quantify the inevitable harm (damage) to aquatic bioresource - i.e. their loss in natural terms (loss of the fresh (biological) mass of total annual reserves of commercial and potential commercial objects under the impact of predicted influence factors of the planned activity), compensation measures are identified and their cost is estimated.

[108] Nightingale, B., & Simenstad, C. A. (2001). Dredging activities: marine issues. Washington State Transportation Center, University of Washington, Seattle, WA, 98105.

The above calculations have been originally included in individual designs for each of the Project components. Calculations of damage are based on the volume of water abstracted from the Ob Estuary for the construction and operation needs, acquisition of water areas for GBS installation and soil filling, areas affected by dredging, loss of food base of fish and ichthyoplankton in the turbidity plume, deposition of suspended matter, acquisition of floodplain sections. The aggregate damage to the Ob Estuary ecosystems during construction and operation of the Project hydraulic structures is estimated at 1364.8 tons of ichthyomass, of which 820.7 tons are attributed to the facilities in federal ownership, and 423.6 tons – to the Company's facilities. The designed compensation measures are summarised in Table 9.5.3, and supporting calculations are provided in Appendix 15.

Complete package of design documentation for each of the Project components is submitted for approval to the Federal Agency for Fishery (FAF) of the RF Ministry of Agriculture, which, prior to issuing the approval, transfers the materials for expert review to one of its subordinated institutions (according to the established practice - to FPFI TsUREN[109] or the Polar Branch of FPFI "VNIRO"[110]). When a positive conclusion is issued on the results of the expert review, the materials are approved by FAF (such approval is a mandatory prerequisite for passing the State Environmental Expert Review and the Main State Expert Review of the RF). At a later stage, following commencement of the designed activity, specific types, volumes and timing of measures for compensation of damage to aquatic biological resources must be agreed with territorial authority of FAF (in this case - with the Lower Ob Area Department).

This final stage also includes determination of specific format of the compensation to ensure annual replenishing of the commercial bioresources and augmentation of catch (production recovery) commensurate with the predicted damage. The Company conducts this activity on a voluntary basis, in the form of artificial hatching (fish stocking) in cooperation with fish-breeding enterprises in Tyumen Region. Since 2016, fish stocking has been conducted in cooperation with NPO Sob Fish-breeding Plant LLC with production premises on the shores of Sob River (Ob River basin). It should be noted that NPO Sob Fish-breeding Plant LLC establishment and operation is financially supported by NOVATEK (construction, extension and modernisation of existing production facilities to satisfy the needs of the planned compensation measures, which is also recognised by Russian law as an acceptable form of compensation of damage).

Table 9.5.3: Designed compensation of damage to ecosystems of the Ob Estuary

Compensation in kind (juveniles release quantity, thousand units):	Siberian sturgeon	Muksun	Nelma	Round-nosed whitefish	Peled	Sterlet	Siberian whitefish
Release of the listed species, total:	63,482	39,702	-	978	149,242	-	-
of which release in relation to the federal property components	48,005	30,178	-	-	103,874	-	-
of which release in relation to components owned by the Company	15,477	9523	-	978	45,369	-	-
Release of one of the listed species	11,066	678	1525	1016	871	444	678

The Company makes annual contract agreements with aforementioned companies for implementation of the fish stocking activities. Other businesses with suitable capacities may be also involved in the future. At present, the total amount of compensation provided so far is estimated at 40.5 tons of ichthyomass, in the form of release of 4.9 units of juvenile muksun and peled worth 63.2M RUB (903 thousand USD in current prices). This is equivalent to approximately 10% of the designed damage to aquatic bioresources of the Ob Estuary from the Company's facilities, and about 3% of the total damage resulting from the Project and associated facilities and activities. The Company has been conducting compensatory fish stocking activities annually since 2016 and intends to do so till year 2046.

[109] Federal publicly funded institution "Central Office for Fisheries Expert Review and Regulations on conservation, reproduction of aquatic biological resources and acclimatization"
[110] Polar Branch of the Federal publicly funded institution "Russian Federal Research Institute of Fisheries and Oceanography" (Knipovich PINRO)

Implementation of the compensation measures for restoration of abundance of valuable commercial species will reduce the impact significance to **moderate / low** level.

In this case, it is impossible to fully recover the ichthyofauna of impacted waterbodies, since stocking can be performed only with juveniles of certain species released into the waterbodies and watercourses located at some distance from the Project's area of influence. Such activities are most efficient for migratory Coregonidae species forming a single population in the Ob Estuary, the maintenance of which will be supported by the proposed activities of so-called direct action.

The criterion of efficiency of the actual compensation measures, in this case, will be the conservation of species diversity and abundance, and the forage base (especially benthos), confirmed by comprehensive monitoring conducted by the Company in the Ob Estuary.Introduction of invasive species in the Ob Estuary water area

9.5.5 Potential impact from the introduction of invasive species into the waters of the Gulf of Ob

Intentional or accidental introduction of alien (non-native) species of flora and fauna into areas where they are not normally found can be a significant threat to biological diversity, since some alien species can become invasive, i.e. spread rapidly and outcompete the native species. In accordance with the IFC PS 6, measures should be taken to prevent possible accidental or unintentional introduction of such species, including through transportation of substrates and vectors (such as soil, ballast and plant materials) that may contain alien species.

The main negative impact associated with accidental introduction of alien species is their introduction into the waters of the Ob Estuary with ballast water from LNG carriers at the stage of **operation**, which can result in reduced productivity of ecosystems, variations in their species composition, and decrease in the volume of harvested commercial fish species.

Arctic ecosystems are quite sensitive to external impacts. In view of climate change and ice melting, new species resistant to light conditions and temperatures, particularly, benthic organisms, are expected to invade actively, as is already the case in the Barents Sea.

Under the new conditions, some invader species can demonstrate higher survivability, plasticity and significant adaptive abilities compared to the native species, thus becoming dangerous invasions. They successfully compete with aboriginal organisms, displacing them, capturing their food base and territory, changing traditional relationships between the species and harvesting structures, and reducing the overall productivity of local ecosystems. Introduction of invasive species can lead to degradation of marine ecosystems, reduction of commercial fish populations, and to additional costs for fishery and navigation.

The Convention on Biological Diversity and the International Maritime Organization recognize the introduction of invasive species as one of the four major threats to the marine environment from economic activities, taking the second place after the direct destruction of marine habitats. For example, as early as in 2004, the Government of Canada adopted a special strategy for invasive alien species, consisting in the identification and making a list of species potentially hazardous for the national waters; strengthening preventive measures against invasive species intrusion; and implementing a set of measures to control these species.

The increase in ship traffic in the Arctic leads to an increase in the number of biological invasions[111][112][113]. It is indicated[114] that up to 6 introduced species are known in the Kara Sea, and in the context of global climate change, the number of species that can be introduced into marine Arctic ecosystems is growing.

Currently in the World Invasive Species Database (www.iucngisd.org) includes 49 zooplankton species that can be transported in ships ' ballast water. Of these, 4 species of planktonic invertebrates adapted to inhabit a wide range of salinity can be brought to the Ob Bay: *Cercopagis pengoi, Mnemiopsis leidyi, Phyllorhiza*

[111] Holbech H., Pedersen K. L. Ballast water and invasive species in the Arctic //Arctic Marine Resource Governance and Development. – Springer, Cham, 2018. – С. 115-137.

[112] Fernandez, L., Kaiser, B. A., & Vestergaard, N. (Eds.). (2014). Marine invasive species in the Arctic. Nordic Council of Ministers.

[113] Goldsmit, J., Archambault, P., Chust, G., Villarino, E., Liu, G., Lukovich, J. V., ... & Howland, K. L. (2018). Projecting present and future habitat suitability of ship-mediated aquatic invasive species in the Canadian Arctic. Biological Invasions, 20(2), 501-517.

[114] Chan, F. T., Stanislawczyk, K., Sneekes, A. C., Dvoretsky, A., Gollasch, S., Minchin, D., ... & Bailey, S. A. (2019). Climate change opens new frontiers for marine species in the Arctic: Current trends and future invasion risks. Global change biology, 25(1), 25-38.

punctata, Pseudodiaptomus inopinus. It is also possible to introduce two species from the list of the dangerous invasive species in Russia[115]: *Acartia tonsa* and *Oitona dayisae*.

In ballast waters and on ship hulls, 31 species of benthic invertebrates can be introduced into the Gulf of Ob: *Alitta succinea, Ascidiella aspersa, Asterias amurensis, Bugula neritina, Carijoa riisei, Cipangopaludina chinensis, Corbicula fluminea, Crassostrea gigas, Didemnum spp., Dreissena bugensis, D. polymorpha, Eriocheir sinensis, Geukensia demissa, Limnoperna fortunei, Musculista senhousia, Mya arenaria, Mycale grandis, Mytilopsis sallei, Mytilus galloprovincialis, Perna perna, P. viridis, Potamocorbula amurensis, Potamopyrgus antipodarum, Rangia cuneata, Rapana venosa, Rhithropanopeus harrisii, Sabella spallanzanii, Schizoporella errata, Styela clava, S. plicata, Tubastraea coccinea*. And the list of dangerous invasive species of Russia is theoretically possible to introduce the following species: *Amphibalanus improvises, Anadara kagoshimensis, Arcuatula senhousia, Dikerogammarus villosus, Gammarus tigrinus, Lithoglyphus naticoides, Magallana gigas, Molgula manhattensis, Monocorophium archerusicum, Mytilopsis leucophaeata, Paralithodes camchaticus, Platorchestia platensis, Pontogammarus robustoides, Rhithropanopeus harrisii, Teredo navalis.*

On the one hand, the hydrological regime and the physical and chemical characteristics of water in the Project area reduce the likelihood of survival of species demanding for water salinity or temperature, but, on the other hand, freshened water ecosystems can be vulnerable to the introduction of tolerant species with a wide ecological range, or to aggressive species living or penetrating in the marine environment in the areas of freshwater inflow. Invading species (mainly crustaceans, bivalves and algae) may be introduced with ballast water. Another potential habitat for alien species are the “artificial reefs” that will be installed in the Ob Bay - i.e. metal and concrete elements of the hydraulic structures.

Currently, according to the results of hydrobiological monitoring, however, the facts of introduction of invasive species with ballast water or with fouling in the Gulf of Ob are not registered. according to the results of hydrobiological studies in 2019 in Sabetta, where berthing facilities have been operated since 2013, only native species of microalgae were identified[116]

The basic requirements for proper management of ballast water to prevent the spread of dangerous invasive species are set out in the International Convention for Control and Management of Ships’ Ballast Water and Sediments (2004), where the Russian Federation is a party (with effect from 8 September, 2017). To manage the risk of invasive species introduction in course of the Project implementation, full scope of measures will be taken as prescribed by the relevant international requirements, including cleaning and dumping outside the shelf zone.

Researchers and fishermen are most concerned about invasive species of fish. In the Ob Estuary such species to be mentioned are bream and humpback salmon.

Consistent introduction of bream (*Abramis brama*) in the waterbodies in the south of Ob River basin started in the middle of 19th century. The species spread northwards in a slow pace and reached the Ob Estuary only by end of 20th century.[117] Reportedly, the numbers of bream have been increasing during recent years in its feeding grounds in the southern sector of the Ob Estuary. Until recently, estuary of Tadebeyakha River was considered the northernmost point where immature individual of bream was caught[118], but in 2018 monitoring of inland waterbodies within South Tambey License Area identified that bream was also present in Venuimuyeyakha River, i.e. near Sabetta. At present, this is the northernmost documented point of the species’ presence in the Ob Estuary[119], therefore, ichthyocoenoses of the Ob Estuary and rivers within the Salmanovskiy (Utrenniy) LA definitely include *Abramis brama* as one of the most successful introduced species.

Another invader species in the affected area of the Ob Estuary is humpback salmon *Oncorhynchus gorbuscha* - species of a high commercial value. Unlike bream which spread into the Ob basin from south to north, humpback salmon appeared in this area in early 1970-s, after successful acclimatization on the

[115] Самые опасные инвазионные виды России (ТОП-100) Москва, КМК, 2018, 688 с.

[116] Комплексная программа мониторинга экологического состояния Обской губы в зоне влияния проекта «Ямал СПГ». ОТЧЕТ ПО ЭТАПУ 4 «Итоговый отчет о результатах комплексного мониторинга экологического состояния Обской губы в зоне влияния Проекта Ямал СПГ». Книга 1. Пояснительная записка. ООО «ФРЭКОМ», ООО «ЦМИ МГУ». Москва, 2020. Книга 1. Пояснительная записка. 364 с.

[117] Ye. A. Interesova. Alien fish species in the Ob River basin // Russian Journal of Biological Invasions. 2016. No. 1. pp. 83-100

[118] Ecology of fishes in the Ob-Irtysh basin. ed.-in-chief D. S. Pavlov, A. D. Mochek – M.: Publishing House KMK, 2006. – 596 p. Quoted in: P. A. Popov. Freshwater fish migrations in Ob-Taz mouth region // Digest of the North-Eastern Federal University in Yakutsk. 2017. No. 4 (60). pp. 23-33

[119] Comprehensive Biodiversity Monitoring in the South Tambey License Area (YNAO) Final Report on studies in 2018. - M.: FRECOM LLC, 2018.

Kola Peninsula, i.e. it entered the Ob Estuary from the main area of the Arctic Ocean. According to the publications referenced above, this species has not yet naturalized, and no information is available about its reproduction in the rivers of YNAO. The catches would normally include single mature individuals that, before fast-ice period, move from the Ob Estuary to tributaries with pebblestone bottoms which also serve as breeding grounds by Coregonidae and Arctic cisco. Development of humpback salmon larvae in the rivers of Yamal and Gydan peninsulas is prevented by the rivers' long-term and often complete freezing, therefore, fodder base of Coregonidae is not undermined by juveniles of this species. Local fish species that may be exposed to the harmful effects of humpback salmon spawning activity (characterized by grubbing of bottom soil for the nest) reportedly include Arctic cisco, however, there is no evidence of competitive relations of cisco and humpback salmon, due to the low numbers of populations of both species[120].

According to the IFC Standard 6, if alien species have already established in the country or region of the proposed Project, efforts should be taken to prevent these species from further spread into areas where they have not established yet. Where possible, the Project should take measures to remove such species from the natural habitats under its management and control.

Measures to mitigate the damage caused by the introduction of invasive species in the waters of the Ob Estuary are presented in Table 9.5.4.

Taking into account the physical, chemical and hydrological characteristics of the Project water area, where the alien species can be actually introduced, and the magnitude of impact, its significance is estimated as **moderate**; and the risk of introduction is estimated as **medium**.

The presented mitigation measures are based on the international best practices and have proven to be effective; therefore, the risk of invasive species introduction will be **low**, and, correspondingly, the impact significance will be **negligible**.

It is recommended to conduct annual monitoring of alien species presence in the phyto- and zooplankton and zoobenthos in the Port area.

Further to the above, the Consultant considered the impacts of the massive compensation stocking with a limited number of fish species in the same water areas within the Ob River basin. In certain situations, stocking may cause ecological imbalance in the affected aquatic ecosystems. Genetically, lower Ob and Ob Estuary function as a single ichthyocoenosis which is substantially depleted by many-years fishing exploitation. In particular, experts highlight the small contribution of the current fish stocking measures, compared to the losses of Coregonidae population in the Ob basin as a result of long-term production without adequate control[121]. Therefore, artificial reproduction in combination with measures to reduce the load on spawning and wintering grounds of the commercial species, are considered as most preferable approach to conservation of Coregonidae population in the Ob basin[122]. The absence of homing (i.e. dependence on specific spawning grounds) and existing combined populations of many Coregonidae species in the Ob Estuary and discharging rivers mean that artificial stocking in tributaries of the Ob River effectively boosts abundance of respective species throughout the Ob Estuary. Juvenile fish released in the lower reaches of Ob rapidly disperse and increase the load on fodder base of local ichthyocoenoses; therefore, the Consultant refrains from assessing cumulative effects of fish stocking in the affected water areas. Theoretically, it is also possible to introduce and spread alien species of parasitofauna with the considered compensatory stocking. It is indicated[123] that the parasitofauna of whitefish of the Ob basin has a clearly defined geographical structure — there is its own parasitofauna in different populations. At the same time, when growing in lake farms, the appearance of species that can parasitize a wide range of hosts is possible. There are no documented facts of the spread of fish diseases during fishing in the Gulf of Ob, so the Consultant finds it difficult to assess such an impact. It should be noted that the existing system of compensatory stocking does not imply the release of fish directly in the water area of the Project, and therefore the risk of such an impact is small.

[120] V. D. Bogdanov, Ya. A. Kizhevatov. Humpback salmon - a new type of aquatic biological resources in YNAO // Newsletter of the Astrakhan State Technical University (AGTU). 2015. No. 3. pp. 7-14.

[121] N. I. Prilipko, N. V. Smolina, V. Ye. Tunev. Catches dynamics and age distribution of broad whitefish in Ob basin // Modern scientific development trends in livestock farming and veterinary medicine. 2019. pp. 231-234.

[122] V. D. Bogdanov. Current status and restoration issues of Coregonidae resources in the Lower Ob // Urals and Siberia Ecology. 2015. No. 1. pp. 22-26.

[123] Осипов А.С. Паразиты рыб семейства Coregonidae Cope? 1872 водоемов Обь-Иртышского бассейна. Дисс…. канд. биол. наук. Тюмень 2005. 145 с.

9.5.6 Changes in the number of marine mammals

The main factors of the negative impact of the underwater works during the Arctic LNG 2 Project **construction** on the marine mammals are as follows:

- Increased nuisance caused by the physical presence of the Project workforce and machinery during hydrotechnical works and infrastructure construction;
- Reduced productivity of forage base of marine mammals and disappearance of major feeding sites as a result of water roiling during dredging, underwater dumping of soil and soil filling for GBS installation;
- Changing the routes and time of migration; deterioration of traditional places of concentration and feeding of marine mammals due to increased level of underwater noise from vessels and works carried out in the water area;
- exposure to underwater noise during construction, dredging and ship operations;
- Risk of marine mammals death as a result of collision with vessels;
- Risk of poisoning with pollutants leaking from onshore facilities and vessels, particularly through food, taking into account the pollutants accumulation through the food chain;
- Disturbance of temperature regulation in animals in case of contamination of fur of marine mammals with oil and petroleum products.

During the Project **operation**, the above negative impacts will also be supplemented by the cumulative impact on ice-breeding species of marine mammals, due to potential death of babies of ice-breeding seals during ice-breaker escorting of vessels during the animals' breeding period. At present, populations of pinnipeds are also exposed to the impact of vessels traffic in winter, which is expected to further increase due to the Project, as the load created by icebreakers in the fairway section between the approach channels to the Sabetta Terminal and Utrenniy Terminal will increase both in numbers (by 60-75%) and in terms of vessels dimensions and capacity. It is noted[124] that the main effects of icebreaker traffic on seals are expressed in loss of cubs by their parents, death of newly born cubs due to ice breaking, and collisions with vessels'

At the same time, it is shown that the risks increase with the night escort of ships and the speed of escort more than 4 km/h. With that the impact in areas of flat ice is stronger than in areas of hummocky ice. It should be noted that the aerial surveys of marine mammals conducted within the framework of the Yamal LNG project (Scientific Centre "Marine Mammals", 2017-2019; LLC "FREKOM", LLC "CMI MSU", 2020) showed significant variability in the density of ringed seals in the Gulf of Ob, the main reason for which is the state of ice. The number of seals in the surveyed water area was determined by the ice conditions of each year. In the spring of 2019 it was 10,304 individuals, the density varied from 0.28 to 2.37, with an average of 0.97 individuals per km^2. In the spring of 2018, 4,479 individuals were counted, with an average density of 0.46 individuals per km^2. In the spring of 2017 – individual 21,491; density 0.47-10.73, with an average of 2.12 animals per km^2. In 2017 and 2019, the landfast ice covered about 50% of the surveyed water area, but in 2017, unlike in 2019, the rest of the area was covered with young ice forms (layered fields of gray ice), where the density of seals reached maximum values. In 2018 the whole study area was occupied by landfast ice which is not typical for the study area in recent decades. Analysis of the results of air surveys carried out in the spring of 2017-2019 showed that the population density of ringed seals on the landfast ice is the most conservative. Thus, the density of the seal on the lndfast ice can serve as one of the reliable parameters for monitoring the state of the population of the species in the Gulf of Ob. Taking into account this feature of the distribution of ringed seals in the northern part of the Gulf of Ob in the spring period, and the fact that ship traffic from the entrance to the Gulf of Ob at least to the port of Sabetta passes outside the landfast zone, it can be assumed that there is no direct negative impact on the seal. On the contrary, ship traffic contributes to the formation of ice habitats of the second type (landfast near-edge zone), the presence of which attracts animals and contributes to the local growth of their numbers. Section of the water area from the village. Sabetta to the terminal "Utrenny" is indicated as an area with a high density of this type.

Negative impacts during the **decommissioning** phase will be similar to those during the construction phase.

During the construction works, acoustic impact is a significant factor affecting the marine mammals. Marine animals, especially mammals, are highly dependent on underwater acoustic environment, which is essential

[124] Wilson, S. C., Trukhanova, I., Dmitrieva, L., Dolgova, E., Crawford, I., Baimukanov, M., ... & Goodman, S. J. (2017). Assessment of impacts and potential mitigation for icebreaking vessels transiting pupping areas of an ice-breeding seal. Biological Conservation, 214, 213-222.

for their communication and obtaining the information on surrounding conditions. Disturbance of animals from the floating machines and construction equipment operating in the water area will be expressed in short-term disturbed behaviour and avoidance of the works area. However, it often happens that pinnipeds do not avoid water areas of the ports and work sites; in particular, according to the records of the operational environmental monitoring in the Salmanovskiy (Utrenniy) LA, ringed seal was encountered in the immediate vicinity of the berth structures. An assessment of the impact of underwater noise on marine mammals is given in section 9.2.

The formation of high turbidity zones during dredging will inevitably reduce the forage base of marine mammals. As a result, it is highly likely that the cumulative impact of factors such as physical presence of vessels, increased underwater noise, high turbidity of water, and food base degradation will make some individual animals or their groups leave this water area for other places, and search for alternative feeding grounds within the Ob Estuary.

The Project area is outside the main range of presence of polar bear. However, occasional visits of bears are reported in the Ob Estuary areas as far as at Kamenny Cape[125], and single individuals were observed near Sabetta accommodation camp, both in winter and in summer. Therefore, appearance of polar bear is also possible at the Project sites. Considering the climate change processes in Arctic, particularly the weather anomalies that degrade the ice cover, is can be expected that in the future more single individuals of this species will appear on ice in the Ob Estuary, and also in tundra within the LA. The Project impact on polar bear can be expressed in a minor decrease of its forage base (refer to the risks to populations of ice-breeding seals discussed above). It is also possible that single units of bear may be culled if they attack the Company’s personnel and represent threat to their life.

Measures to minimize the risk of reduction in number and death of marine mammals in the Ob Estuary are presented in Table 9.5.4.

The impact on marine mammals in course of the Arctic LNG 2 Project implementation is assessed as a **local**, **short-term** and **non-regular;** the risk of injury to animals during navigation in the Ob Estuary on the pass from Sabetta to the Port water area is assessed as **constant** and **medium**, and the impact significance — as **moderate**.

By taking appropriate corrective measures to minimize the negative impact will reduce its severity and significance to **small** and **low**, respectively.

Marine mammals are at the top of food chain, therefore they are the key indicator of the impact and its main receptor. It is also noted that marine mammals are particularly vulnerable in the settings of potential warming and a wide range of anthropogenic impacts on ecosystems of the Arctic seas. In accordance with RF MNR Resolution of 22.09.2015 No.25-r, white whale and ringed seal inhabiting the Project water area are included in the list of indicator species of flora and fauna for the stability of marine ecosystems in the Arctic Zone of the Russian Federation. This means the need for systematic and comprehensive monitoring of marine mammals in the area of actual and potential influence of the Project.

The marine mammals monitoring is focused to identify negative impacts on populations of marine mammals. The monitoring activity is intended to:

- Identify areas with a higher density of marine mammals, water areas of high value for their life activity, and key breeding grounds;
- Identify migration routes and population attribution of seals in the water area exposed to the Project impacts;
- Monitoring of numbers to determine the influence of industrial activity.

The organizational structure of the marine mammal monitoring should include a census of the population and further studies of the biology of the species. Studies may include:

- Ship observations during the performance of industrial environmental monitoring in the marine area;
- Coastal observations, including observations at permanent observation points on the shore, tracking and recording of releases of dead mammals on the shore;

[125] A. A. Gorchakovsky. Polar bear and marine mammals of the southern Kara Sea // Fauna Urala i Sibiri [Fauna of Urals and Siberia]. 2015. No. 1. pp. 127-133.

- Aerial surveys of marine mammals. First of all, it is necessary to shoot during the breeding period of pagophilic species;

Monitoring is the basis for the development of measures to reduce the impact of the project, during which time limits can be set on icebreaking operations during critical breeding periods of animals, water areas with restrictions on the maximum speed of passage by icebreakers and water areas where such operations are recommended to avoid and change the route of escort. Such measures should be developed on the basis of actual observational data, provided that they are extrapolated using remote information on the state of the ice cover. To minimize the impact on marine mammals and preserve them in the world experience, the following measures are proposed[126][127][128][129]:

- Reducing the speed of ships in areas with the highest probability of occurrence of marine mammals;
- Control of the routes of ships near known concentrations of marine mammals;
- Development of routes for the movement of ships, taking into account the distribution of the most important ice for marine mammals;
- Organization of environmental training and instruction of service personnel before the start of work.

9.5.7 Impact to the ecosystems of water bodies of Gydan peninsula.

Freshwater ecosystems are highly valuable because they support important environmental processes such as control of gas level and composition, and water purification. Lake-bog complexes and watercourses are the habitats not only for hydrobionts, but also for birds that use them for feeding, nesting or intermediate stops during seasonal migrations. Rivers and some lakes within the Salmanovskiy (Utrenniy) LA are of high fishery value as spawning grounds for Coregonidae. Since the waterbodies freeze in winter, small rivers and brooks are used for spawning at a small distance from the estuary.

The most valuable and unique wetlands are located within the boundaries of the existing and potential DCAs, the nearest of which are situated in 70-100 km off the field facilities within the Salmanovskiy (Utrenniy) LA. Some wetlands in YNAO are recognized as internationally important for global biodiversity and are included in the list of so-called Ramsar wetlands; the distance from the field facilities within LA to the nearest of them will be more than 150 km.

Receptors of the planned activity will be fresh-water ecosystems of rivers and lakes within the LA, particularly Khaltsyney-Yakha and Nyaday-Pynche Rivers that drain the territory with the highest concentration of facilities of the Arctic LNG 2 Project. Sand quarries are or will be established in 14 lakes – both thermokarst lakes in watershed spaces, and meander lakes in the valleys of Khaltsyney-Yakha and Syabutoyakha Rivers. Five lakes will be used for temporary and permanent water intake.

During the **construction** period, the following negative impacts of the Project activities on freshwater ecosystems are predicted:

- Death of fodder organisms (zoobenthos, phyto- and zooplankton) in the areas of temporary or permanent acquisition of sections of river channels and lake areas.
- Death of zoo- and phytoplankton, juvenile fish and small non-commercial fish at water intake;
- Mortality of fish juveniles and aquatic organisms (including those at considerable distances from the working site), caused by suspended solids formed during sand and gravel extraction and drainage systems construction;
- Disturbance of feeding and spawning conditions for fish, due to acquisition of floodplain sections;
- Deterrence of fish coming to spawn in small rivers and brooks, by vibroacoustic impact of vehicles and construction works, as well as by the physical presence of hydraulic structures and watercraft;

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[126] Alliston W. G. The distribution of ringed seals in relation to winter icebreaking activities in Lake Melville, Labrador. – LGL limited, 1981

[127] Mansfield A. W. The Effects of Vessel Traffic in the Arctic on Marine Mammals: And Recommendations for Future Research. Department of Fisheries and Oceans, Arctic Biological Station, 1983. 110 p.

[128] Davis R. A. Report of a workshop on arctic marine mammals. Western Region, Department of Fisheries and Oceans, 1981. 13 p.Decker, M. B., Gavrilo, M., Mehlum, F., & Bakken, V. Distribution and abundance of birds and marine mammals in the eastern Barents Sea and the Kara Sea, late summer, 1995. Oslo, 1998. 85 p.

[129] Wilson, S.C., Crawford, I., Trukhanova, I., Dmitrieva, L., Goodman, S.J. Estimating risk to ice-breeding pinnipeds from shipping in Arctic and sub-Arctic seas // Marine Policy. 2019. https://doi.org/10.1016/j.marpol.2019.103694

- Risk of contamination of water ecosystems as a result of possible accidental leaks of process liquids, and pollutants runoff with storm water and melt water, if not adequately treated.

Development of sand jetting quarries results in complete loss of hydrobiological communities. However, the Project provides for some quarries excavated in lakes; potentially, they can contribute to the provision of suitable waterbodies for wintering of fish in this region, because the lake beds deepening will prevent them from full freezing and improve the oxygen regime, making them more favourable for the fish fauna.

The impact at the **operational stage** is the withdrawal of water from water bodies for household needs, as well as the discharge of treated wastewater into the Nyadai-Pyongche River. According to the calculations carried out in the design documentation, it is shown that the concentrations of all pollutants during the discharge of treated wastewater will not exceed the MPC of water for reservoirs used for fisheries purposes in the control range located at a distance of 500 m below the discharge site. If the design solutions for wastewater treatment are followed, the water quality of the Nyadai-Pyongche River will comply with the background level.

The greatest threat to aquatic ecosystems during the **operation** phase is the risk of contamination caused by accidental leaks of hazardous liquids, and pollutants runoff from the sites with rain and melt water. Aquatic biocoenoses recover relatively quickly after mechanical impacts, but they are highly sensitive to chemical pollution.

During **decommissioning**, the impacts on the onshore aquatic ecosystems are expected to be negligible.

Measures to reduce the degradation and loss of onshore aquatic ecosystems are presented in Table 9.5.9.

The scale of the impact on freshwater ecosystems will be **local** and **medium-term**; total or partial loss of some surface waterbodies in the location area of the field facilities within the Salmanovskiy (Utrenniy) LA, and possible temporary disruption of spawning grounds and traditional fishery areas of indigenous peoples in the lower reaches of the Khaltsyney-Yakha and the Nyaday-Pynche Rivers determine the integrated value and significance of the impact as **medium** and **moderate**, respectively.

A range of measures have been designed to mitigate the impact on aquatic ecosystems during the Project construction and operation, including:

- Restriction of works in waterbodies during the spawning season (May-June, September-October);
- Prohibition of construction of mechanical barriers on the migration routes of fish;
- The preparatory and main construction and installation works are conducted in winter, after freezing of the seasonally thawing layer, in order to prevent damage to water protection zones, and minimise the impact on surface waterbodies in low-flow conditions;
- Prevention of runoff water from site areas getting into surface waterbodies;
- Ensuring environmentally friendly management of solid waste, wastewater, liquid hydrocarbons, fuel and oil, paint and varnish, and other technical liquids;
- Provision of fish protection devices on all water intake facilities on surface waterbodies;
- Strengthening of banks and restoration of river banks and channels in case of their uncontrolled disturbance by the construction activity.

To minimise the damage to aquatic biological resources of waterbodies and watercourses of the Gydan Peninsula, the Project provides for compensation stocking with juvenile fish (refer to description of the compensation mechanism in sub-section 9.5.4). Table 9.5.4 provides a summary of damage to waterbodies and watercourses of the Gydan Peninsula during construction of the Field facilities and associated facility – Utrenniy Airport, in natural terms, and the designed mitigation measures. The damage calculations include both permanent (acquisition of river channel and lake sections for permanent structures, volume of water abstracted for operational needs) and temporary damage (short-term disturbance of bottom soil, occupation of floodplain sections). The permanent damage is estimated for the period of 25 years, and temporary damage is for 3 years. Detailed calculations of damage with a breakdown by the Project phases are provided in Appendix 15.

Table 9.5.4: Calculation of damage to waterbodies and recommended compensation measures

Facility/ site	Damage in natural terms (loss	Compensation in kind (juveniles release quantity of a listed species, thousand units):

	of ichthyomas, kg)	Siberian sturgeon	Muksun	Nelma	Taimen	Round-nosed whitefish	Peled	Sterlet	Siberian whitefish
Field Facilities Setup (total)	43,210.5	2910	1590	539	657	3575	8753	5671	7564
Utrenniy Airport	338.4	28	13	4	8	28	-	45	60

So far (over the period 2016 till present time) the Company has compensated 34% of the damage to ichthyomass (more than 14.8 tons), by releasing 809 units of muksun and over 3 million units of round-nosed whitefish (total worth about 20 M RUB or 285 thousand USD), under contract agreements with Yugorskiy Fish-breeding Plant JSC (in 2016), FSBI "Glavrybvod" (Abalak Fish-breeding Plant) (in 2015) and NPO Sob Fish-breeding Plant LLC. The juvenile fish is released into tributaries of the Ob River.

After implementation of the measures intended to preserve the ecosystem functions of onshore waterbodies, the impact significance will decrease to a **low level**.

To successfully recover the indigenous ichthyofauna in the affected waterbodies (rivers and lakes), it is necessary to ensure appropriate habitat conditions – to maintain the water regime close to natural; to protect coastal topsoil; to prevent silting and shallowing (and, consequently, full freezing and suffocation phenomena in winter), poaching, chemical pollution, as well as vibroacoustic effects during spawning.

Validation of the predictions against actual situation and assessment of efficiency of the environmental measures taken by the Company and other parties under its control is currently provided within the scope of the operational environmental control and local environmental monitoring programmes. As an additional measure, the Consultant suggests the necessity to conduct comprehensive biodiversity monitoring within the Salmanovskiy (Utrenniy) LA including studies of hydrobiological communities in the waterbodies directly affected by the Project, and in those not exposed to the impact.

9.5.8 *Impact on vegetation and reindeer pasture*

Soil and vegetation are the main components of ecosystems involved in the processes of pollutants removal from the environment through accumulation and modification of these substances. The vegetation will be exposed to mechanical and chemical (by pollutants released into the environment) effects of different intensity. The result of long-term exposure to low concentrations of pollutants is slower growth due to impaired gas exchange in plants. Human-induced impacts will result in the loss of floristic and coenotic diversity in the allocated areas.

At the stage of **construction**, the main types of potential negative impact on plant communities in the planned activity's area of influence are:

- Destruction of vegetation and topsoil as a result of filling the construction sites for temporary and permanent infrastructure facilities, temporary and permanent roads, and construction of pipelines within the Project footprint;
- Technogenic transformation of vegetation of adjacent territories as a result of changes in the conditions of its growth, including:
  - Overall reduction and fragmentation of areas covered by natural vegetation;
  - Transformation and degradation of vegetation in the areas directly adjacent to the Project footprint due to the planned activities (including the areas of secondary activation of exogenous processes and hydrological phenomena, and soil cover degradation);
- Suppression and degradation of vegetation and reindeer pasture lands as a result of pollutants input from the atmosphere and their accumulation in the snow cover and topsoil;
- Accumulation of pollutants, impairment of growth and mineral nutrition, degradation of plant communities due to pollution and reduced fertility of soil caused by accidental leaks of hazardous liquids, polluted rain and melt waters, and spills of petroleum products;
- Dusting of vegetation as a result of deposition of suspended solids occurring in the ambient air during preparatory and construction works and vehicles traffic;
- Increased fire hazard and risk of plant communities burning in connection with the fire-hazardous works and non-compliance with safety requirements.

During the **operation** phase, the negative impacts will be related mainly to the operation of the Arctic LNG 2 Project facilities:

- Degradation of vegetation in the areas adjacent to the Project sites, including reindeer pastures, due to pollutants emission into the environment (e.g. air emissions) from the Project facilities;
- Changes in composition and structure of phytocoenoses due to atmospheric precipitation, primarily with nitrogen compounds;
- Introduction of invasive species due to appearance of technogenic habitats, introduction of diaspores of alien plants from other regions, including the grass mixes used in biological reclamation;
- Destruction of vegetation cover in case of fire in an emergency situation and during response activities.

Also, at the **operation** phase, there will still be some risk of plants dusting with suspended pollutants as a result of their precipitation from the atmospheric air.

At the **decommissioning** phase, there can be some local impacts associated with infrastructure facilities de-installation, along with the generally positive effect of land reclamation.

The extent of impacts at issue depends on the type of works. At the pre-construction and construction phase, the most significant form of impact is mechanical damage of vegetation: destruction of shrubs, subshrubs and herbs, and topsoil. Pollution emissions from the construction activities als9o contribute to the impact on topsoil in the adjacent areas. Destruction of vegetation results in general decrease in the biodiversity of the territory and weakens the environmental functions of the vegetation cover.

In the process of construction of the designed facilities, the vegetation cover will be fully destroyed or changed significantly within the planned activity’s footprint. The tundra vegetation will be almost entirely disturbed. The vegetation of the bogs will be partially disturbed. Construction works (site leveling, trenching, etc.) often affect the hydrological and geocryological conditions in adjacent areas, which leads to changes in the habitat of plant communities and, as a consequence, to transformation of their composition and structure.

Every time a motor vehicle drives off a dedicated road, it causes noticeable and persistent damage to the vegetation cover. In addition, there is a compaction of the soil, a change in its water-physical properties.. As a rule, technogenic mechanical impacts destroy plant communities and lead to the development of permanent secondary communities. The structure of vegetation cover changes, with the emergence of communities where quickly restoring species (gramineous plants, sedge and cottongrass) that occupy technogenic substrates within a relatively short time. Thereat, results of the local monitoring indicate that restoration of tundra communities is a long process that will take several decades (refer to Sub-section 7.6.2).). The revealed regularities are also confirmed by the literature data. it is shown (Yamal peninsula, plant..., 2006) that in the main types of plant communities, restoration processes take at least 30 years, and the consequences of disturbances of the 1940s are still observed at the Prudhoe bay field in Alaska[130].

The impact of pollutants and physical and mechanical factors depending on their intensity can lead to metabolism disruption in plant organisms and their depression down to the death of plants.

Accumulation of harmful substances in the soil worsens its fertility, brings disorder in the mineral composition of the soil, facilitates its salinization and kills the beneficial microflora. As a result of these factors and penetration of pollutants into the root system of plants, impairment of the root systems and the vegetative part of plants is observed, as well as their slower growth and development, and, in severe cases, their death. The extent of negative impact of pollutants on vegetation depends on their properties and concentration in the fertile soil layer.

The phytocoenosis elements most sensitive to air pollution are lichens and mosses. Dusting of vegetation with suspended solids depositing from the atmospheric air is dangerous, since it prevents the plants from normal breathing. In addition, the dust absorbs harmful substances and facilitates their co-deposition, including some organic substances, nitrogen and sulphur oxides, and heavy metal compounds that have an oppressing effect on vegetation. High concentration of suspended solids in the air is observed primarily during the earthworks in the period of construction, and in case of using access roads with dusty paving.

[130] Walker D.A., Walker M.D. 1991. History and Pattern of Disturbance in Alaskan Arctic Terrestrial Ecosystems: A Hierarchical Approach to Analyzing Landscape Change // Journal of Applied ecology. V. 28. P. 244-276.

It is shown[131] that the arrival of road dust in tundra ecosystems leads to (1) early snowmelt in roadside areas due to lower albedos, resulting in a snow-free band of vegetation within 30 to 100 m of the road in early spring, which is used by waterfowl and numerous other species of wildlife; (2) a decrease in Sphagnum and other acidophilous mosses near the road; (3) an increase in many minerotrophic mosses; (4) a decrease in soil lichens, particularly species *of Cladonia, Peltigera*, and *Stereocaulon*; (5) a general opening of the ground cover near the road and a consequent colonization of these barren surfaces by many taxa that are common on mineral-rich soils; (6) few effects on vascular plant abundance except in areas of very high dust, where ericaceous taxa are affected; (7) increased depth of thaw within 10 m of the road, possibly due to decreased plant cover and earlier initiation of thaw; and (8) contribution to thermokarst in roadside areas.

The composition and structure of vegetation communities will presumably change due to eutrophication caused by the activation of the plant groups that use the input nitrogen for growth acceleration, phytomass formation, and taking dominant position in the communities. It was found that more nitrogen in the soil corresponds to a greater abundance and phytomass reserve of gramineous plants. This may also be the reason for higher role of herbal communities. These indirect impacts are expected within the sanitary protection zones based on air emissions within the radius of 1 km from the Project facilities.

The magnitude of losses of the plant communities is illustrated in Table 9.5.5.

[131] Walker, D. A., & Everett, K. R. (1987). Road dust and its environmental impact on Alaskan taiga and tundra. Arctic and Alpine Research, 19(4), 479-489.

Table 9.5.5: Plant communities acquisition areas

No.	Plant communities	Replacing natural vegetation with bare soil sections, or with restored vegetation						Impact on vegetation through atmospheric precipitation (within SPZs of the Field, Plant and Port, considering overlapping and less facilities' sites areas)		Acquisition of vegetation during construction of the Utrenniy Airport						Impact on vegetation through atmospheric precipitation (SPZ of the Utrenniy Airport)	
		Long-term replacement with the Project buildings and installations		Short-term replacement for the period of construction, with subsequent biological reclamation		Total Project land acquisition				Long-term replacement with the Project buildings and installations		Short-term replacement for the period of construction , with subsequent biological reclamation		Total land acquisition			
		ha	share , %	ha	share , %	ha	share , %	ha	share, %	ha	share , %	ha	share , %	ha	share , %	ha	share , %
1	Polygonal and spotted-jointed subshrub tundras	194	11.5	203	10.5	397	11.0	1440	11.6	54	21.1	30	15.9	84	18.9	36	11.3
2	Mixed grass - subshrub - moss tundras	534	31.6	681	35.1	1215	33.5	2648	21.3	114	44.8	85	44.8	200	44.8	103	32.0
3	Willow, sedge and cottongrass tundras	502	29.7	521	26.9	1023	28.2	2953	23.7	26	10.0	19	10.0	45	10.0	81	25.4
4	Hillocky tundras and chionophilous communities	38	2.3	52	2.7	90	2.5	254	2.0	10	3.9	7	3.9	17	3.9	12	3.8
5	Subshrub willow tundras	73	4.3	102	5.3	175	4.8	658	5.3	1	0.2	0	0.2	1	0.2	3	0.9
6	Vegetation complexes of small river valleys; meadows, subshrub tundras, sedge bogs	119	7.1	177	9.1	296	8.1	1117	9.0	10	3.9	17	9.1	27	6.1	29	9.0
7	Subshrub and subshrub-lichen tundras	49	2.9	49	2.5	98	2.7	255	2.1	8	3.1	4	2.2	12	2.7	14	4.4
8	Sedge and cottongrass bogs	115	6.8	74	3.8	188	5.2	700	5.6	33	12.8	26	13.7	59	13.2	35	10.8
9	Sphagnum, sedge-sphagnum bogs with willows	42	2.5	55	2.8	97	2.7	321	2.6	1	0.3	1	0.3	1	0.3	5	1.5
10	Sands on foreshores, deflated areas, fills with pioneer vegetation	17	1.0	22	1.1	38	1.1	587	4.7	0	0.0	0	0.0	0	0.0	3	0.9
11	Waterbodies with aquatic and wetland vegetation	4	0.3	5	0.3	9	0.3	1522	12.2	0	0.0	0	0.0	0	0.0	0	0.0
Total:		1686	100.0	1941	100.0	3627	100.0	12455	100.0	256	100.0	190	100.0	446	100.0	320	100.0

Table 9.5.5 provides information only on the loss of plant communities in the areas that fall under the withdrawal. Technogenic transformation of plant communities will also occur outside the land allotment areas due to the activation of exogenous geological processes and mechanical disturbances. Analysis of vegetation dynamics at the Kharasaveyskoye and Bovanenkovskoye fields in Yamal shows changes in the structure of vegetation cover under the influence of exo-and endogenous factors. Exogenous dynamics are associated with the construction of engineering structures, transport impacts, cryogenic processes, and runoff disturbance. Vegetation dynamics is associated with an increase in the area of lakes due to thermal erosion, flooding due to thermal erosion and flow disturbance, and overgrowth of drained lakes (khasyreys)[132]. Estimates of the extent of vegetation disturbance are given (Yamal Peninsula, Vegetation..., 2006). At Kharasaveyskoye OGCF complete transformation was observed at 0.2% and on Bovanenkovskoye OGCF at 1.5%. At the same time, the zone where vegetation disturbance is more than 10% is estimated at 11% and 46% of the field area, respectively. The area of impact of the drilling site is estimated at an average of 9.6 hectares, but only 0.3 hectares of vegetation is destroyed, and on an area of 6.8 hectares of vegetation is disturbed by 10%. During the construction of each kilometer of the road, the area of vegetation disturbance is estimated at 16 hectares, of which 1 hectare of vegetation is completely destroyed, and 12 hectares are characterized by weak disturbances. The assessment of the area of violations at the Prudhoe Bay field in Alaska was carried out based on the results of large-scale mapping of key sites for the period from 1968 to 2011. By 2010[133], over 34% of the intensively mapped area was affected by oil development. In addition, between 1990 and 2001, coincident with strong atmospheric warming during the 1990s, 19% of the remaining natural landscapes (excluding areas covered by infrastructure, lakes and river floodplains) exhibited expansion of thermokarst features resulting in more abundant small ponds, greater microrelief, more active lakeshore erosion and increased landscape and habitat heterogeneity. This transition to a new geoecological regime will have impacts to wildlife habitat, local residents and industry. It is shown that in the period from 1990 to 2001, under the conditions of warming, 19% of the preserved natural landscapes (with the exception of water and infrastructure objects) changed their appearance due to the development of thermokarst phenomena, as a result of which a new geoecological regime was formed. Based on the results of comparison with similar objects, we estimate the total area of communities that will be degraded outside the land allotment areas to 50% of the total land allotment area, about 1.8 thousand hectares. The total area of natural habitats transformed by the project will be about 2.5% of the total area of the LU. It is indicated[134] that mapping is a key method for assessing the disturbance of ecosystems and its change over time

The greatest damage during the construction of the designed facilities will be caused to reindeer pastures which are supposed to be withdrawn for permanent and temporary use, after which their hundred-percent restoration will be almost impossible. Winter reindeer-feeding capacity of pastures in the Project area is from 3 to 20 reindeer-days/ha; in summer, it is from 2 to 6 reindeer-days/ha; the average reindeer-feeding capacity of pastures is 12 reindeer-days/ha. The Project permanent and temporary land acquisition will affect 1710 ha of lichen pastures and 1779 ha of pastures with predominantly green fodder. The sanitary protection zones include 4343 ha and 5749 ha of such pastures, respectively.

Natural plant communities of the Gydan peninsula have different resistance to man-made impacts. The stability data obtained on the territory of the Bovanenkovsky NGCM (Yamal Peninsula, plant..., 2006) can be applied to the plant communities of LA, Table 9.5.6.

[132] Московченко, Д. В. 2013. Особенности многолетней динамики растительности Бованенковского месторождения (полуостров Ямал) // Вестник Тюменского государственного университета. № 12. С. 57-66.

[133] Raynolds, M. K., Walker, D. A., Ambrosius, K. J., Brown, J., Everett, K. R., Kanevskiy, M., ... & Webber, P. J. (2014). Cumulative geoecological effects of 62 years of infrastructure and climate change in ice-rich permafrost landscapes, Prudhoe Bay Oilfield, Alaska. Global change biology, 20(4), 1211-1224.

[134] Walker D.A., Cate D., Brown J., Racine C. Disturbance and Recovery of Arctic Alascan Tundra Terrain: A review of Recent Investigations. CRREL Report 87-11. USA, Hanover, NH, 1987

Table 9.5.6: Differentiation of plant communities in terms of resistance to mechanical stress

Sustainability indicators	Communities	Numbers at vegetation map	Share of the total area affected by the project*
Stable, easy to recover	No	-	-
Relatively stable, recovering with difficulty or not recovering	Yernik and willow grass-moss tundras of flat floodplains, thickets of yernik and willow	5	4,8
Unstable, relatively easy to recover	grass-moss tundra, grass-moss swamps, meadows	3, 6, 8	41,5
Unstable, recovering with difficulty or not recovering	All lichen, lichen-moss, shrub tundra, polygonal and hilly swamps	1, 2, 4, 7, 9	51,3

* with the exception of pioneer vegetation and water bodies

Natural recovery potential is only 4.8% of the area of plant communities affected by the Project, and unstable, difficult-to-recover communities predominate.

Further degradation of pasture land not subject to acquisition can result from the damage by motor vehicles, contamination by fuel spills, careless handling of fire and other actions that will lead to impossibility for using the pasture lands. This risk should be eliminated by proper traffic management.

Restoration of vegetation cover is a critical factor for overall community restoration[135]. The disturbed areas can be divided into two categories: areas without soils and biota, and damaged areas with remaining fragments of the original communities. These two types require different approaches to restoration: reclamation for the first category, and restoration for the second. If disturbance is minor, such areas can be left for self-restoration (Magomedova et al., 2006).

In the Arctic conditions, the preferred material for reclamation of areas without soils are Poaceae plant mixes that develop meadow-type phytocoenoses. Those include *Poa pratensis*, *Alopecurus pratensis* which produce up to 1.25-1.5 tons of biomass per hectare, during the first year of vegetation[136][137]. In the area of Bovanenkovskoye OGCF with similar bioclimatic conditions, good results have been achieved using seeds of local species of *Deschampsia, Poa, Festuca* and *Arctagrostis* for reclamation. Communities developed using local seeds demonstrated higher resilience compared to the areas where Canadian seed material was used. Reclamation efficiency is enhanced when hydroseeder is used (machine that sprays a mixture of water, seeds, mulch, fertilisers, and stabiliser). For erosion protection during the first years of reclamation, it is proposed to use geotextile: two layers of biologically-degradable material with a reclamation mixture between them comprising seeds of perennial plants, nutrients and water-retaining agents[138].

O.V.Khitun indicates a set of natural flora species suitable for remediation of different substrates[139] :

- for clay soils: *Puccinellia sibirica, Deschampsia glauca, D. borealis, Calamagrostis neglecta, Alopecurus alpinus, Arctagrostis latifolia, Arctagrostis arundinaceae, Eriophorum scheuchzeri, Carex arctisibirica, Tripleurospermum hookeri, Senecio congestus, Cochlearia arctica, Artemisia tilesii, Polygonum viviparum, Astraglus subpolaris*.

- For sandy soils: *Poa alpigena; Festuca rubra* ssp. *arctica; Festuca ovina, Deschampsia glauca, Luzula confusa, Tanacetum bipinnatum, Oxytropis sordida, Astragalus subpolaris, Pachypleurum alpinum, Cerastium arvense, Polemonium boreale, Rumex graminifolius, Arabis septentrionalis, Antennaria villifera.*

- *For exposed pea*t: *Carex concolor, Eriophorum angustifolium, Polemonium acutiflorum, Rubus chamaemorus, Calamagrostis holmii, Poa arctica, Poa alpigena, Rumex arcticus, Nardosmia frigida.* В увлажненных понижениях: *Eriophorum russeolum, Dupontia fisheri, Arctophila fulva.*

[135] Ecological restoration in Arctic: review of the international and Russian practices. – Edited by T. Minayeva. Syktyvkar–Naryan-Mar, 2016. 288 pp.
[136] A. V. Baranov, K. L. Unanyan. Assessment and prevention of hazardous erosion processes during development and operation of gas production and transportation facilities on Yamal Peninsula // "Vesti Gazovoi Nauki" ("Gas Science Newsletter"). 2013. No. 2 (13).
137 A. Kh. Sariyev, V. M. Zelenskiy. Perennial grass studies for biological reclamation of disturbed land in the North Yenisei area // "Dostizheniya Nauki i Techniki APK" ("Science and Technology Achievements for Agroindustrial Complex"). 2013. No. 1
138 I. P. Aistov, A. Ye. Gagloyeva. Prospects of application of geotextile for reclamation of disturbed land in the Far North // Systems. Methods. Technologies. - 2013. No. 4. pp. 188-191
[139] Khitun, O. V. (2003). Natural recovery of man-made disturbances in the west Siberian arctic and recommended species for rehabilitation. Linnaeus Eco-Tech, 37-46.

It should be noted that reclamation with grain varieties results in development of meadow communities, while tundra plant communities are extremely slow to recover. Therefore, prospective approach is focused on restoration of tundra plant communities. The need for restoration of the original communities is dictated by the needs of the traditional agricultural activity in the Arctic areas - reindeer herding, as deer grazing is not possible before tundra vegetation has fully restored. Therefore, development of phytocoenoses with grain varieties is not seen as final and optimum method of ecosystems' restoration (Magomedov et al., 2006).

Recommended restoration measures include transplantation of plants with long rootstock, such as cottongrass (*Eriophorum* spp.), or of root mats. In the latter case, vegetation mat is taken from a donor habitat (sphagnum/dwarf-shrub bog, as a rule) and relocated to the habitat being restored. Such activity requires identification of a safe strategy to protect also donor habitats (Minayeva et al, 2016).

As optimum approaches to reclamation of disturbed land in the Arctic have not been developed, it is recommended to identify preferred methods to be used for reclamation and restoration through research work. Areas of restored vegetation should be subject to industrial environmental monitoring.

The local environmental monitoring in the Salmanovskiy (Utrenniy) LA identified presence of four species listed in the Red Data Book of YNAO under category 3 "rare species" (*Bromopsis vogulica, Luzula tundricola, Saxifraga cespitosa, Polemonium boreale, Thymus reverdattoanus*), and four other species (*Ranunculus nivalis, Papaver jugoricum, Parrya nudicaulis, Eremogone polaris*) listed in the annex to the Red Data Book with a status "requiring special attention". All registered locations are outside the sites of existing and designed industrial facilities.

The populations of *Polemonium boreale*, *Thymus reverdattoanus* and *Eremogone polaris* are most closely adjacent to the Project sites on the slopping hil to the southeast of the flare site. These populations will potentially experience impacts from the construction and operation of Plant facilities, both direct due to changes in thermal conditions and indirect. According to the results of monitoring in 2020, it is shown that the population of *Reverdatto thyme* (category 3 rarity) is brought in by sand carried out by the wind from the construction site. To minimize the impact on populations of rare species, it is recommended to use these species during reclamation and restoration work. *Polemonium boreale, Thymus reverdattoanus* and *Eremogone polaris*, which exist in unstable substrates and have biological mechanisms for colonization of uninhabited substrates, are suitable for restoring vegetation cover with a natural structure on disturbed sands: worked-out hydro-washing pounds, slopes and sand deposits. For restoration purposes, it is recommended to collect seed material and sow it in disturbed areas. The possibility of using these psammophytic species for restoration purposes is indicated in the literature (Khitun, 2003). This is confirmed by the findings of *Polemonium boreale* on exposed sands on the sea coast to the north of the Terminal, which were revealed in 2020.

Under the condition of increasing the anthropogenic load on the vegetation cover, the introduction of diasporas of alien species with grass mixtures during remediation, the appearance of adventitious plant species on the territory of LA is not excluded. Some facts of the introduction of alien species were recorded in 2020 (for more information, see Chapter 7.6). Taking into account the available data on drift species in the conditions of the northern-hypo-arctic and Arctic tundras of the West Siberian Arctic, including the Bovanenkov and South Tambey OGCF located in similar bioclimatic conditions on the Yamal Peninsula, the introduction of these species into natural communities is unlikely, the drift species will grow only on anthropogenic habitats, with a high probability they will vegetate only one season, without forming local populations.

Measures to reduce impacts on vegetation and reindeer pastures are presented in Table 9.5.7.

The expected impact on vegetation will be **local**, but **long-term**. Taking into account the sensitivity of the recipient, the impact magnitude can be **high**, leading to the degradation of ecosystems and pastures valuable for the indigenous population of the Gydan Peninsula, and requiring the payment of appropriate compensations as per the legislation of the Russian Federation, as well as reinstatement of disturbed habitats. Based on the above, the significance of impact can be assessed as **high** in terms of pasture degradation, and as **moderate** in terms of vegetation cover disturbance.

The measures taken to prevent and minimize the destruction of vegetation cover, to reduce the negative impact and to restore the areas of disturbed lands will reduce the impact significance to **moderate**; nevertheless, some additional measures will be required to achieve No Net Loss for biodiversity.

Considering the zonal location of the LA territory where alien plant species may be introduced, and magnitude of the impact, its significance is assessed as **low**; the risk of invasion is **low**.

The environmental monitoring programme should include the observation of recovering vegetation communities and productivity of phytocoenoses on reinstated lands. Status of the identified populations of rare and protected species is subject to annual monitoring. Special attention shall be paid to occurrence of alien flora species.

The scheme of the vegetation cover monitoring system in the LA is shown in Figure 9.5.2.

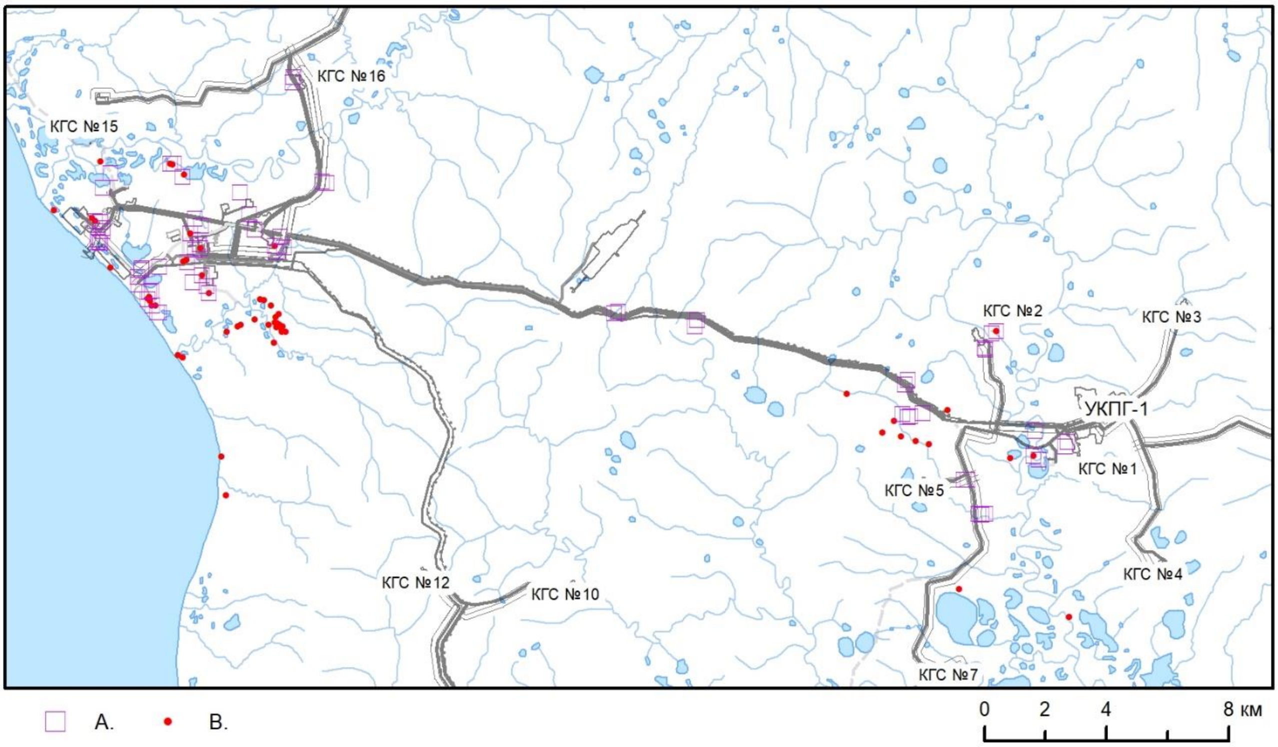

Figure 9.5.2: Existing monitoring system of vegetation cover at Salmanovskoye (Utrenny) license area:

A. permanent monitoring sites, B. finding points of rare and protected plant species

It is further recommended to conduct detailed comprehensive survey of vegetation cover within the LA to address the following objectives:

- Clarify the regional higher plants flora;
- Through field surveys, make lists of brioflora, mycoflora, and lichenoflora species;
- Develop classification of habitats, classify them by value, identify rare and vulnerable plant communities;
- In case of identification of new points of growth of rare and protected species within the land plots of facilities under construction or in the area of their impact, measures for their conservation are required. If it is impossible to preserve these habitats, identify the negative dynamics of populations adjacent to the land allotment, it is necessary to organize compensation works in coordination with the Department of Natural Resource Regulation, Forest Relations and Development of the Oil and Gas Complex of the Yamalo-Nenets Autonomous District. Compensation measures should take into account the biological characteristics of species, they can include:

- transplantation of individual species (for species with the potential for vegetative renewal) or fragments of sod to areas with similar natural conditions, free from economic impact;

- collecting seeds in local populations of rare and protected species and using them for the purpose of restoration of disturbed areas with suitable conditions.

9.5.9 Impact on migratory bird species

The area of the planned activity is situated in a vast zone where three global migration routes of waterfowl, shorebirds and schooling bird species intersect; however, the birds do not form any mass clusters or nesting sites immediately within the affected territory and water area; they appear there mainly on migration, i.e. for a limited time, and seasonally. Nevertheless, some species of birds can form temporary gatherings in the wetlands in valleys of tundra rivers and waterlogged laida areas of the Ob Estuary, during migration. In addition, migrating birds use the waters of the Gulf of Ob for stops.

The negative impact on the avifauna during **construction** of the Salmanovskoye (Utrenneye) OGCF Facilities Setup is limited by the time of migration of birds and is associated with changes in habitat conditions and, in particular, with the following factors:

- Nuisance due to the presence of people and equipment in the immediate vicinity of bird clusters;
- Disturbance of clusters of migratory bird species, caused by navigation;
- Decline in forage base productivity as a result of acquisition of parts of wetland areas used as resting grounds on the birds' migration routes, for sand fill sites in river valleys;
- contamination of water bodies used for stopping (for example, when mining sand in quarries);
- Disorientation of migratory species of birds by coastal lights and lighting of the infrastructure facilities;
- Indirect impact of the planned activity, associated with better accessibility of birds' habitats for hunters and poachers thanks to built roads and associated facilities.

During the **operation phase**, it is expected that migrating bird species will be disturbed and possibly disoriented due to the operation of the Plant, Port, and power supply facilities (noise, lighting, and other factors). In addition, high-voltage power lines can be a factor resulting in the death and injury of birds.

The impact on migratory birds during the implementation of the project may be manifested in the alienation of suitable habitats for their stops. this factor is of low importance due to the small proportion of suitable habitats affected by the project (near-water habitats account for 5.4% of all natural habitats affected by the project). In addition, the most important habitats suitable for migration stops in the valleys of large rivers within the LA are located outside the zones of concentration of industrial facilities.

Migrating birds can die when they collide with power lines. Such collisions are more likely to occur in conditions of poor visibility and scaring the flock. It is indicated that the risk for migrating birds is different when the power line goes through different biotopes[140], and the different risk for power lines of different designs is also indicated. Structures with fewer wires and their horizontal arrangement have the lowest risk. The total length of power transmission lines in the project area is 247 km, of which 132 km are 10 kV overhead lines and 115 km are 35 kV overhead lines. In order to make the wires more visible to birds, including in adverse weather conditions, already during the construction of power lines in areas with large concentrations of birds (at the intersection of valley complexes of rivers), it is necessary to equip special means of repelling birds. These tools should contrast with the environment, have moving parts and light-reflective elements. In the course of ornithological monitoring, it is necessary to lay routes along power lines in different types of biotopes to search for dead species, and thus assess the specified impact on the avifauna.

Among the birds, there are day and night migrants. The latter include most passerines and some near-water birds. Many nocturnal migrants (such as passerines) have positive phototaxis, and the bright lights of cities, lighthouses, or work site spotlights can throw them off the migration route. Heavy light pollution affects not only nocturnal migrants, but also sedentary birds, and can cause important changes in reproductive biology[141][142,143] . As shown in albatrosses (Rich and Longcore, 2006), light pollution strongly affects the mortality of young birds attracted by light. It is indicated[144], that the impact of artificial lighting on migrating birds can extend to 15 km.

Given the location of the project area in the Arctic and the extremely low densities of wintering birds, the main negative impact of lighting will occur during the autumn migration period in the second half of August-

[140] Бронсков А. И., Мосин Г. Г., Бронскова М. А. Факторы гибели птиц на линиях электропередачи средней мощности (35-110 кВ) в Северном Приазовье //Бранта: Сборник научных трудов Азово-Черноморской орнитологической станции. 2016. С. 31-52.

[141] Sanders, D., Frago, E., Kehoe, R., Patterson, C., & Gaston, K. J. (2020). A meta-analysis of biological impacts of artificial light at night. Nature Ecology & Evolution, 1-8.

[142] Dominoni, D., Quetting, M., Partecke, J. Artificial light at night advances avian reproductive physiology // Proceedings of the Royal Society B: Biological Sciences. 2013,280. Стр. 1756 (doi: 10.1098/rspb.2012.3017)

[143] Rich, C., Longcore, T. (Eds.) Artificial Night Lighting // Washington, Covelo, London. IslandPress. 2006. p. 480

[144] Commonwealth of Australia 2020. National Light Pollution Guidelines for Wildlife. (January). 1–7. Retrieved from https://www.cms.int/sites/default/files/document/cms_cop13_doc.26.4.9.1_rev.1_australia-light-guidelines_e.pdf

September. The highest impact of light pollution is expected from the coastal objects of the project, due to the concentration of lighting sources, as well as their location on the sea coast along the main migration routes. The significance of this impact, given the long period of daylight during major migrations, is estimated to be moderate. It can be reduced by recommended light pollution management measures (Commonwealth of Australia 2020).

To minimize the impact of light pollution, it is recommended to carry out the following list of measures.

Light pollution strongly affects both migratory and sedentary birds. There are simple approaches to minimize light pollution:

a. Adaptive lighting control: turn on the light only when necessary;

b. Only cover areas where work is being done;

c. Use the lowest possible power for a specific task;

d. Do not use reflective surfaces;

e. if possible (for example, to indicate the position of objects), use flashing lights. It has been shown to have less effect on birds.

The Utrenniy Airport (associated facility of the Project) will be a major source of impact on migrating birds. Airports may impact avifauna in the form of nuisance and stress during manoeuvering, takeoff and landing of aircraft, noise, vibrations, gust disturbance, and also direct collision with birds. At the operation phase, aircraft noise during takeoff, landing and manoeuvering will be one of the key factors of biodiversity impact of the Utrenniy Airport. The most sensitive species may avoid using the noisy area, which may result in reduction of species diversity. Interference with song communication is a major factor of anthropogenic noise impact on birds[145].

Vertical flyby distance of approximately 600 m and about 900 m from takeoff/landing sectors are recognised as safe distances to colonies and nesting gatherings of birds[146]. Considering aircraft noise as the main factor of influence, it is proposed to adopt so called "seventh sub-zone" specified in the design documentation, which is defined by the equivalent daytime noise level of LAe=55 dBA (night time noise 45 dBA). On the other hand, it is known that many species of birds do not avoid the airport areas and often use their territories or areas close by sources of noise for nesting. In this case they can adapt by modifying the daily activity and singing patterns to pauses in the air traffic[147]. Furthermore, the warmer (compared to surrounding territories) and illuminated runway area often attracts birds[148], as both sedentary and migrating species can find grounds for feeding, nesting and rest near it.

The "Utrenny" airport will have an impact on the entire avifauna of LA, with the highest level of impact expected for migratory species. Besides the impact of the airport on birds fauna an population, the risk of collision of aircraft with birds should be also considered from the traffic safety perspective. It is known (Silayeva, Zvonov, 2017) that the highest risk of collision is related to birds on migration, while local birds quickly adapt to the circumstances, recognise the hazard of landing and taking-off aircraft, and rarely collide with aircraft. The main periods of bird migrations within the Salmanovskiy (Utrenniy) LA are June, August and September. The period of migration to the wintering grounds is reportedly more extended, as birds to migrate in several waves. In particular, mass migration of waders takes place in late July - early August[149], while geese fly in several waves between the third decade of August and end of September. Anseriformes represent the greatest hazard in case of collision with aircraft, due to their significant weight. It is also expected that migrating birds, primarily geese, will be the main receptor of the impacts of airport, as they will keep away from convenient resting grounds within the area of its noise impact. The greatest potential clashes are the most abundant species are: white-fronted goose, bean goose, Wigeon, long-tailed duck, Heuglin's gull, grey plover. The greatest impact from the airport is expected within the boundaries

[145] Gil D., Brumm H. Acoustic communication in the urban environment: patterns, mechanisms, and potential consequences of avian song adjustments // Avian Urban Ecology: behavioural and Physiological Adaptations. Oxford University Press, Oxford. 2014. Pp. 69–83.

[146] Harris C.M. Aircraft operations near concentrations of birds in Antarctica: the development of practical guidelines // Biological Conservation. 2005, Vol. 125 N 3. P. 309-322.

[147] Dominoni D.M., Greif S., Nemeth E., Brumm H. Airport noise predicts song timing of European birds // Ecology and Evolution, 2016. Vol. 17, N 6. P. 6151-6159.

[148] O. L. Silayeva, B. M. Zvonov. Prevention of biodeterioration of birds activity in aviation and on power transmission lines // Russian Ornithological Journal. 2017. Vol. 26. No. 1451. pp. 2202-2207

[149] V. A. Zhigulskiy, M. B. Shylin, N. S. Tsarkova, N. B. Glushkovskaya. Impact of construction in the Arctic on ornithofauna, exemplified by the Sabetta Port // Transactions of the Russian State Hydrometeorological University. 2017. 48. pp. 281-295

of the 7th sanitary break zone (Figure 9.5.3). Figure 9.5.3 shows that the most important habitats used in bird migrations are poorly affected by the Project.

In addition to the impact on the fauna and bird population from airports, it is necessary to take into account the risk of collision of aircraft with birds from the point of view of transport security.

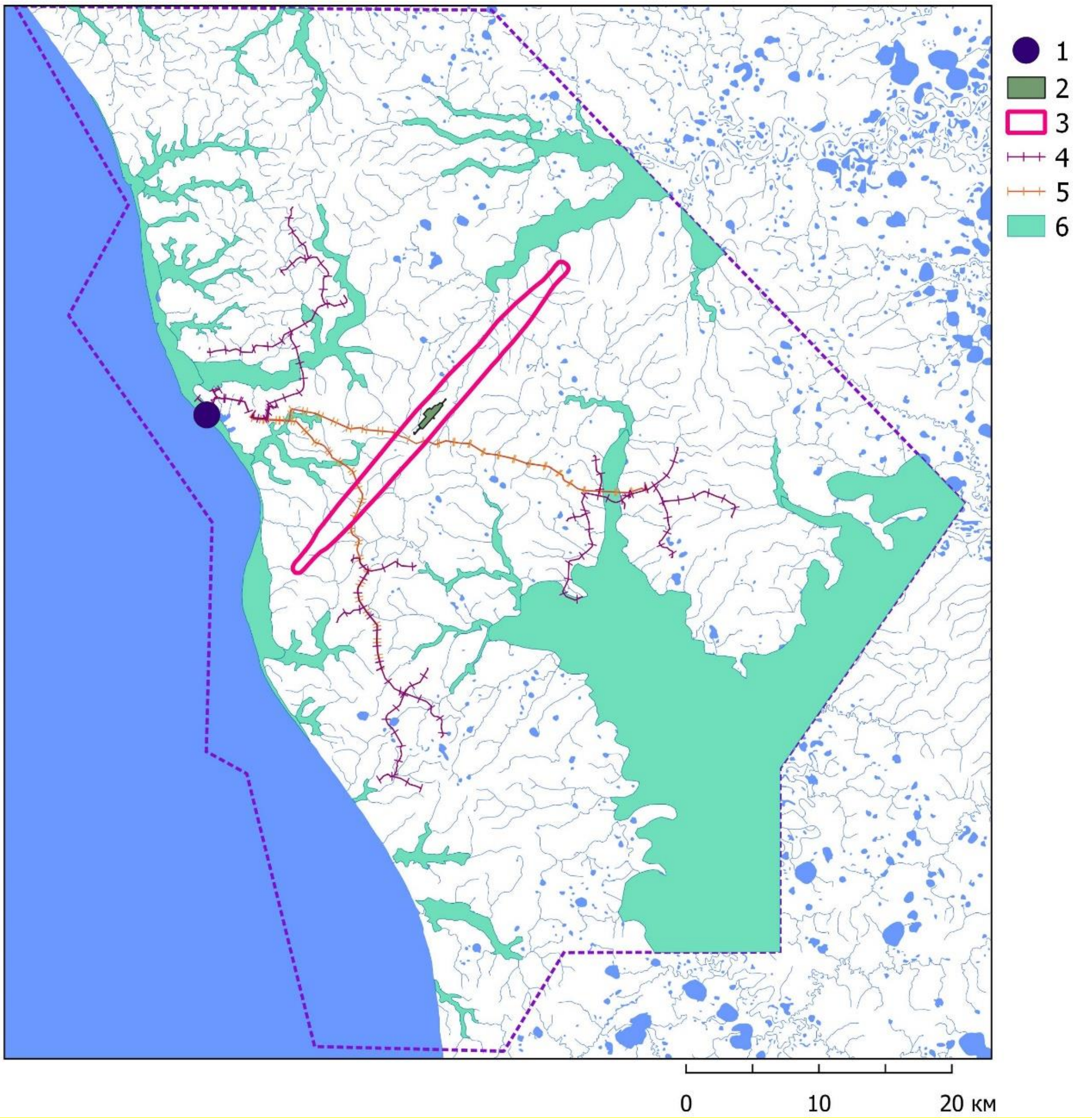

Figure 9.5.3: Impact of the Project on migratory birds. symbols: 1-coastal facilities of the project (terminal and plant); 2 - airport "morning"; 3-sanitary gap zone of the airport — the seventh subzone; 4-10 kw overhead line; 5-35 kw overhead line; 6-wetland habitats — the main places of transit and stops of migratory birds

The internationally recognised methodology approach to minimisation of bird collisions with aircraft[150] provides for arrangement of an information system for control of ornithological situation in the airport area, and deterring birds in different ways. The Utrenniy Airport design provides for application of a bio-acoustic system for deterring birds. This system function is based on playing pre-recorded alarm and distress signals of the target bird species, with irregular intervals. One of the most effective methods of protecting aircraft from collision with birds, and preventing death of birds in collisions with airplanes and helicopters, is ecological-ornithological survey information system covering the airport territory and surrounding area within a 15-30 km band. The survey is intended to identify factors attracting birds to the airport and surrounding territories. Professional monitoring of such areas shall produce the following output information: 1) numbers and directions of flights of sedentary and migrating bird species; 2) places and times of birds gatherings for feeding and night rest; 3) height distribution of migration flights and flying

[150] Airport Services Manual Part 3 Wildlife Control and Reduction Fourth Edition – 2012

height of resident birds; 4) seasonal and daily distribution of birds species, considering their mass and hazard to aircraft, with special focus on the runway strips and taxiways; 5) activity cycles and speed of bird movements depending on time of a day and season; 6) description of vegetation cover and information on numbers of rodents and other components of the birds' forage base. The monitoring data informs identification of the causes of aviation hazards and adjustment of the adopted mitigation measures, as appropriate. Along with the ecological-ornithological survey, other measures to prevent collisions and protect aircraft from birds include identification of specie of bird involved in collision with aircraft, and, if possible, its population attribution. The proposed measures will help to control ornithological situation in the airport and on the aircraft flying paths, and to identify the risks and conditions related to the greatest risk of collisions - i.e. season, time of a day, flying height, and phase of aircraft motion. Recommended intervals for the ecological-ornithological monitoring is once in 1-3 years[151].

At the Project **decommissioning**, the impacts on migratory bird species are expected to reduce to a negligibly low level (if the major works are not performed during migration seasons).

When studying the effects of oil and gas production on migratory birds in the North Sea, it was found that under a certain combination of weather conditions, the birds are attracted and disoriented by general lighting on oil and gas platforms, especially the red region of the spectrum. Structures and flare units illuminated at night act as light traps for birds.

Dredging is a potential source of turbidity zones. This factor can have a negative impact on the feed base of fish-eating birds. When turbidity plumes are formed during dredging and, consequently, the feed base degrades there, the animals can leave this water area for other places with better conditions.

During the Project construction and operation, there will be quite significant acoustic impact. Exposure to technogenic noise affects the behaviour of birds, in particular, distorts their communicative acoustic signals. Susceptibility of shorebirds and waterfowl to noise differs depending on the species, and also depends on the number of birds in clusters. The birds can react in different manner, from fright or worriment caused by small movements of vessels, up to leaving the area of impact.

Measures to minimize the impact on migratory birds are presented in Table 9.5.8.

Taking into account the fact that the Project area is located within important migration routes, and massively migrating bird species will be affected by the construction of economic facilities on Salmanovsky (Utrenny) LA, as well as the nature of this impact, its value can be estimated as **moderate**. Taking into account the geographical coverage of the migration routes of a number of species and the international community's concern about the growing threats to the state of bird populations throughout the range, the significance of the impact is assessed as **moderate**. A number of restrictive measures (such as lighting control) are needed to demonstrate that there is no additional negative impact on migratory bird species from the Project.

In particular, it is recommended to carry out additional studies to identify the biotopes in the Project's area of influence, that are crucial for migratory bird species. Accurate knowledge of the time of migration for protected species is needed, in order to take restrictive measures during these periods.

To fill the gaps in knowledge on ornithofauna within the license area, it is recommended to conduct ornithological studies on the following topics:

- Search for waterfowl nesting grounds. Counting and mapping of waterfowl broods and birds on molting grounds (July);
- Conducting additional studies to identify places of concentration of geese (nesting, linnaeus and large migration gatherings of birds) by air surveys (involving light aircraft and unmanned aerial vehicle) throughout the license area.
- Survey of migration patterns, identification of places of concentration of migrating birds, mainly geese (September).

As a separate survey activity, it is proposed to conduct marking of birds with satellite tags. Such studies will help to identify territorial links of nesting species with migration passage areas and wintering grounds, and verify the role of the Project area in the system of migration routes and key breeding areas of the Arctic birds. Proposed indicator species for the telemetric studies are rare and protected species — red-breasted goose (*Branta ruficollis*) and lesser white-fronted goose (*Anser erytropus*), which nesting habitats

[151] Guidelines for ornithological support for civil aviation (ROOP GL-89), USSR Ministry of Civil Aviation Order of 26.12.1988 No. 209

serve as criterion for identification of critical habitats in the context of IFS PS6. Migration routes of these species pass through the LA territory, and single encounters of the birds are reported in the concerned area. Tagging can be conducted in the birds' habitats nearest to the Project area – in the Yuribey River valley, as well as in other areas of the Gydan Peninsula.

9.5.10 Decrease in number and death of animals

It should be assumed that the fauna will be affected by the entire complex of industrial facilities within the LA. The negative impact on animals will be manifested in the changes in their living conditions, primarily due to the loss of habitats and high disturbance during the Project implementation.

The main negative impacts on the fauna at the **construction** phase are as follows:

- Destruction of habitats of terrestrial vertebrates within the footprint of industrial facilities and infrastructure (roads, pipelines, power lines, etc.);
- High nuisance caused by construction, the presence of people and motor vehicles, and, consequently, occurrence of abandoned habitats in the areas adjacent to the Project sites within the LA;
- Decrease in the forage base due to degradation of natural ecosystems as a result of the Project implementation, including the forage base of near-water species of terrestrial vertebrates;
- Disruption of routine and seasonal migration routes of terrestrial vertebrates as a result of linear facilities construction (roads, pipelines and other utilities);
- Degradation of habitats due to unauthorized disposal of construction and household wastes;
- Risk of death of animals, mainly small mammals, due to traffic;
- Risk of death of birds, especially birds of prey, from electric shock on overhead power supply lines or in collisions with above-ground structures;
- Risk of death of birds in collisions with aircraft;
- Risk of death of birds, especially those migrating in low natural light conditions, as a result of their disorientation and getting into hot air flows from flare units, or into so-called light traps;
- Impairment of habitats due to pollution of the environment, including the increasing content of contaminants in food (hydrobionts, plants, various species of mammals and birds) and their accumulation in food chains;
- Indirect impact of the Project, resulting from better accessibility of animal habitats for hunters and poachers using the built roads and associated facilities;
- Changes in the existing migration routes of reindeer, the location of reindeer pastures and calving areas, caused by the construction of infrastructure facilities, including linear ones;
- Decrease in the abundance of valuable commercial species of mammals and birds, especially those traditionally hunted by indigenous people.

The above impacts are expected, and they will be minimized by a set of measures (Table 9.5.9), the results of which depend on the effectiveness of particular devices (e.g. bird protection), structures, management and technical measures selected during the design phase for the habitats and fauna of the Gydan tundra.

At the **operation** phase, the effects of high noise and lighting from the facilities within the Salmanovskiy (Utrenniy) LA can increase the nuisance for wild and domesticated animals, and contribute to further degradation of habitats and reduction of biodiversity in the planned activity's area of influence.

The **decommissioning** phase will be associated with a short-term negative impact due to higher disturbance during the infrastructure demolition, after which a sharp increase in the number of most animal species can be expected.

It should be noted that the territories used for construction are characterized by low abundance of terrestrial mammals. Moreover, there are vast natural fluctuations in the numbers of mouse-like rodents, which can be even greater than such fluctuations caused by human-induced effects.

During the construction period, i.e. when the vegetation is destroyed and the site is filled, the animals living in the Project sites will be displaced or killed. The populations of sedentary species of small rodents will be completely destroyed, and the density of other animals will significantly decrease under the influence of nuisance. In technogenic landscapes, dramatic reduction in the abundance and biomass of invertebrates is observed.

The presence of people and machinery will lead to decreased abundance in the adjacent territory, primarily for sedentary species sensitive to the nuisance. This is due to changes in the rhythm of daily activity, territoriality, behavior of animals, especially in the periods of mating and breeding of younglings.

Modification of animal habitats changes the ratio of species: the abundance of species sensitive to disturbance will decrease, or they will disappear on the construction site; the abundance of other species, on the contrary, can increase (or appear on these sites). The latter are so-called synanthropic species and species not much sensitive to disturbance, but for which the developed territory will provide feeding grounds or convenient shelters to hide from predators and to build nests or holes.

Among the fauna species in the Project area, Arctic fox is most prone to synanthropization. Kitchen wastes from the accommodation camps, and operating solid municipal, construction and industrial waste disposal site may provide food resources that will attract the animal to the Project sites and provoke its rapid growth in numbers. The anthropogenically induced growth of Arctic fox population density may entail degradation of animal population in adjacent tundra habitats, as the fox will destroy birds' nests and put populations of small mammals under increased pressure. Furthermore, Arctic fox is a vector of zoonotic diseases. Specific regulation measures may be required to address the problem of rapid growth of Arctic fox population.

Gulls, namely Heuglin's gull, may be prone to synanthropization, too. This species is likely to concentrate at the Port and search for food in this area. As gulls destroy nests of other birds and prey on chicks, increased density of their population may result in a decline in numbers of other birds in the Port area.

As anthropogenic habitats will appear, the LA territory may become populated with human companion species that are unusual in tundra zone. One example is hooded crow which is regularly registered in Sabetta[152] and is likely to develop its range of presence to cover also the Gydan Peninsula. According to the monitoring report of JSC IEPI in 2019 the crow was met at the LA Construction of buildings and structures in tundra will extend the nesting range of raven which is currently present in the LA but does not make nests there.

During operation, the Plant, Airport and other facilities can become major sources of noise and other nuisances. Exposure to noise and vibration from operating mechanisms, especially during the nesting period, can make the birds stop laying eggs and leave their nests, especially if the bird species are sensitive to disturbance (geese, some ducks, large species of waders, birds of prey).

The Project implementation will change the appearance, properties and functions of the land, expressed in occupation of land, damage to vegetation, reduction of animals' forage base. Direct impact on habitats results in significant changes in living conditions, irreversible transformation or destruction of habitats. As a result, many species lose a certain part of their forage lands, shelters, resting and breeding grounds; the conditions for animals' movement over the territory become worse. In addition, there is qualitative deterioration of the animals' habitats, such as worsening of their protective and nesting properties; the land becomes accessible to humans and to the species that had not inhabited this area before.

Changes in traditional migration routes are also possible. Under the most unfavourable circumstances, the animals can leave for the neighbouring areas within the range.

The operation of power lines can have a negative impact on the number of birds, primarily large birds of prey (such as rough-legged buzzard) which will use power transmission towers for roosting in open areas. In conditions of high humidity and in the rain, large birds are killed by electric current when touching bare wires. Taking into account the important role of birds of prey in coenoses, such losses can have a serious negative impact on the stability of the ecosystem as a whole. Roads are also dangerous and can cause the death of animals and birds running out on the lanes.

When detecting violations of the legislation of the Russian Federation in the field of environmental protection and nature management, the damage to the fauna is calculated in accordance with Article 56 of the Federal Law of 24.04.1995 No. 52-FZ On Fauna, based on the Methods for calculating the extent of damage caused to hunting resources (Order No. 948 of the Ministry of Natural Resources of the Russian Federation, dated 08 December, 2011), and in accordance with the Standards of permissible withdrawal of hunting resources (Order No. 138 of the Ministry of Natural Resources of Russia, dated 30 April, 2010). These fees and methods do apply to design documentation development and compensation payments.

[152] O.B.Pokrovskaya, S.V.Volkov. New data on distribution of birds in the north-east of Yamal // Ornithology. 2016. Vol. 40. P. 139-142.

A lot of people coming to the region and bringing modern technical means of transportation usually become a factor of higher poaching load already at the early stages of the field development. In order to reduce poaching, it is necessary to take a number of special practical measures relating to management. An effective measure to prevent poaching is administrative prohibition to bring all kinds of hunting tools (weapons, traps, etc.), as well as dogs, to the region.

Special attention should be paid to the activities related to seasonal restriction of works. Season-to-season distribution of wildlife resources in the surveyed territory is extremely uneven. Their maximum concentration falls on the period from May till September. At this time, anseriformes, waders, tundra passerines, willow grouse can be present in the construction area. In autumn, all waterfowl migrate from the tundra. In winter, some Arctic fox, willow grouse, and, varying hare population may be present in the area. Thus, in winter period, the number of animals is not large. It is winter (October–March) that is the most preferable season for construction work in terms of the presence of terrestrial fauna.

The proposed facilities are located on agricultural lands (reindeer pastures). The leading branch of agriculture in this area is reindeer husbandry. The Project will provide for the construction of pipeline and road crossings for animals (domestic reindeer), the location of which has been agreed with the reindeer herders.

The planned activity’s area of influence can affect the ranges of rare and protected animal species. In particular, in course of fauna studies in the license area, the presence of red-breasted geese, long-tailed ducks, Bewick’s swans, snowy owls and peregrine falcons was registered. Known habitats of rare and protected species are subject to environmental monitoring.

Mammals and birds can be sedentary or move to long distances, and their hunting grounds and habitats can extend for many kilometers, partially or fully overlapping with the Project area. For this reason, the planned activity’s area of influence covers some breeding sites which can be directly affected by the Project activities. As a rule, the area of influence for terrestrial animals is limited to the size of the sanitary protection zone and zones of Project-related operations (for example, transportation of personnel, etc.), but it can extend further along watercourses or, for example, taking into account the range or conservation status of the species. The negative impact on the fauna is considered to be **long-term**, but **local** in scale and **small**, not affecting the functioning of ecosystems or faunal communities. At the same time, due to the **high** sensitivity of the receptor, the impact significance before taking appropriate measures is assessed as **moderate**.

Measures to minimize the impact on the fauna are summarized in Table 9.5.9.

Implementation of the described set of environmental measures, especially with regard to habitats of rare and endangered species listed in the Red Data Books of Russia and YNAO, will reduce the impact significance to **low**.

A regular (annual) monitoring of vertebrates is required.

Priority areas of monitoring:

- For avifauna: inventory of nesting fauna of birds (end of June-beginning of July), their number; route observations and records (for small waders, passerines); mapping at monitoring sites; special search and mapping of nesting sites of rare and protected bird species included in the Red Books of the Russian Federation and the Yamal-Nenets autonomous district. Organization of regular observations along power lines to account for dead birds.
- For mammals: Survey of small mouse-like rodents and insectivores with Hero snap traps or pitfall traps. Timing of the mammals surveys can be selected to combine them with surveys of birds; Search for, description and mapping of settlements of Arctic fox and other carnivores, counting with camera traps.

All surveys must be conducted in accordance with specific procedures under the Biodiversity Monitoring Programme, in order to facilitate calculation of the species abundance and monitor developments over a long-term period.

Prospective areas for monitoring of terrestrial vertebrates are shown in Figure 9.5.4.

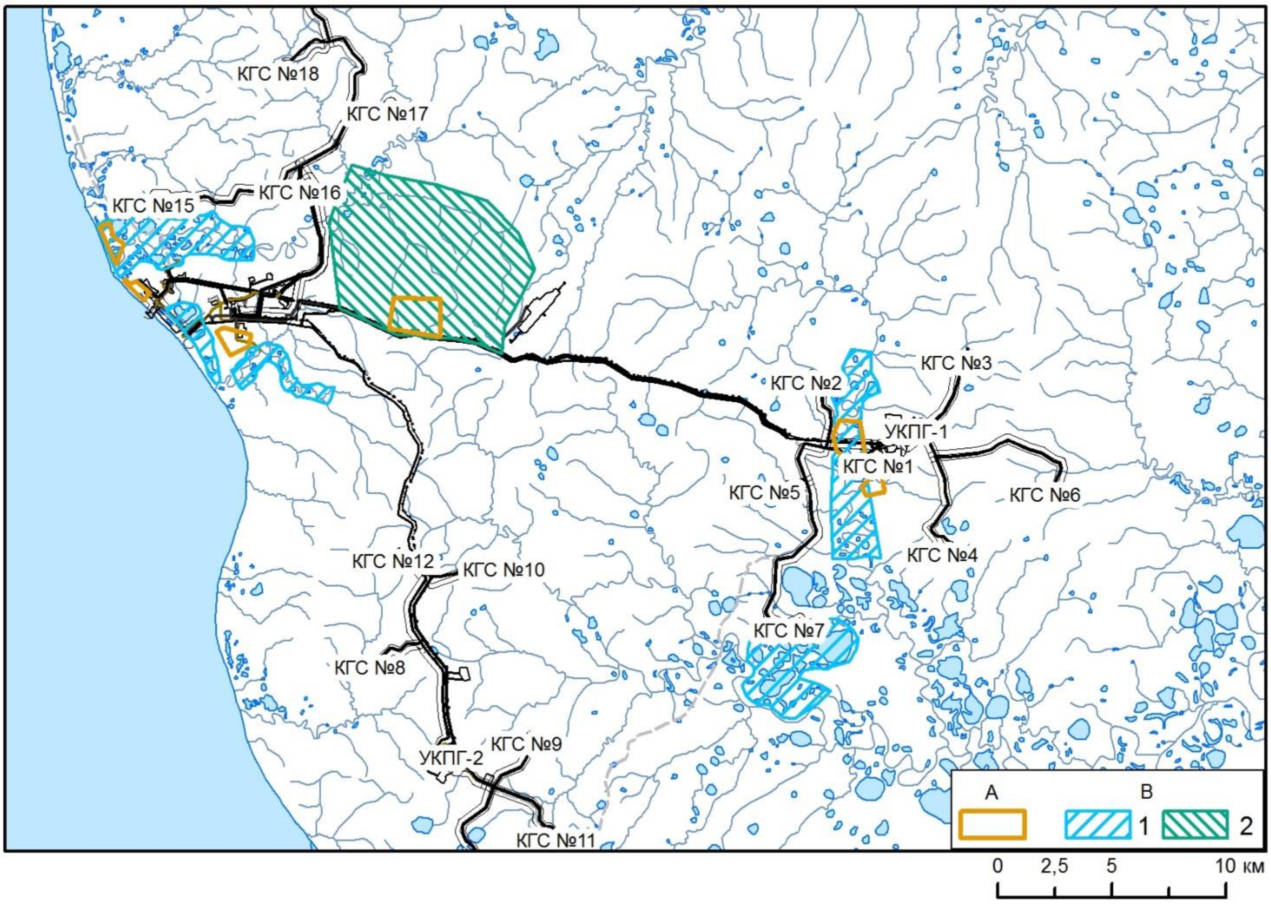

Figure 9.5.4: Location of the recommended key areas of observations for terrestrial vertebrates (areas shown are approximate).

A-Monitoring sites for recording small waders and passerines; B-monitoring sites for recording birds with large nesting territories: geese, loons, raptors, owls, and arctic foxes: 1-wetlands; 2-tundra

9.5.11 Summary of the recommendations for monitoring biological diversity

Monitoring of biological diversity at different project life cycles is the most important set of measures to confirm the conclusions of the previous impact assessment, scientifically-based assessment of the boundaries of the actual impact and identification of environmental risks for subsequent management decisions to reduce the negative impact.

It is recommended to conduct monitoring of the biological diversity of terrestrial and aquatic ecosystems using the concept of essential biodiversity variables[153][154]). This concept involves the organization of systematic observations of components of biological diversity at different levels of observations. It includes a system of indicators, approaches to collecting field data, standardization of their accumulation, methods of processing and directions of their interpretation. The biological diversity monitoring system (including additional special observations, the need for which is discussed in Section 7.6.6) should, on the one hand, provide an objective answer to the question of the response of components of biological diversity to man-made impacts, and, on the other hand, consider this response in the context of global changes, especially brightly highlighted in the Arctic. The logical monitoring scheme is shown in Figure 9.5.5.

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[153] Proença, Vânia; Martin, Laura Jane; Pereira, Henrique Miguel; Fernandez, Miguel; McRae, Louise; Belnap, Jayne; Böhm, Monika; Brummitt, Neil; García-Moreno, Jaime; Gregory, Richard D.; Honrado, João Pradinho; Jürgens, Norbert; Opige, Michael; Schmeller, Dirk S.; Tiago, Patrícia; Van Swaay, Chris A.M. (2017). "Global biodiversity monitoring: From data sources to Essential Biodiversity Variables". Biological Conservation. 213: 256–263. doi:10.1016/j.biocon.2016.07.014

[154] Pereira, H. M.; Ferrier, S.; Walters, M.; Geller, G. N.; Jongman, R. H. G.; Scholes, R. J.; Bruford, M. W.; Brummitt, N.; Butchart, S. H. M. (2013). "Essential Biodiversity Variables". Science. 339 (6117): 277–278.

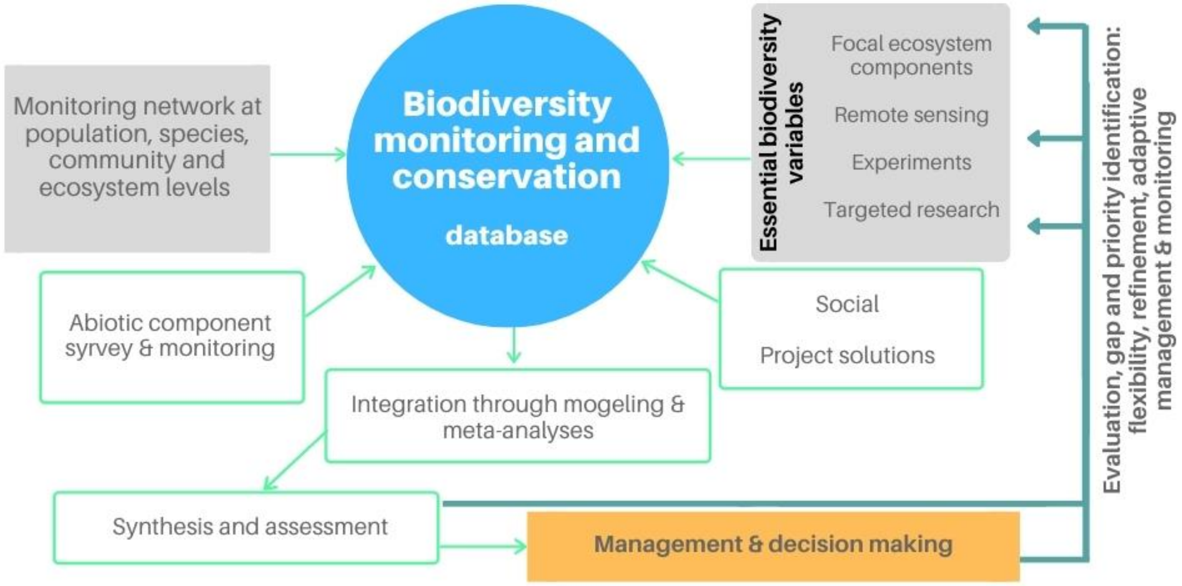

Figure 9.5.5: Block diagram of an adaptive biodiversity monitoring system

The system of indicators of biological diversity of the Gulf of Ob is considered in the reports on the integrated monitoring program of Arctic LNG 2 LLC and Yamal LNG JSC (IEPI, 2019; FRECOM, CMI, 2020). These reports indicate the applicability for monitoring purposes of species — indicators of the sustainable state of marine ecosystems of the Arctic zone of the Russian Federation[155] , living in the northern part of the Gulf of Ob. At the same time, it is indicated that the system of indicators of the state of planktonic and benthic communities needs to be improved, taking into account the brackish-water nature of the ecosystems of the Ob Bay.

Approaches to integrated monitoring of Arctic biological diversity are considered in the CAFF plans[156][157][158]. These plans include indicator systems, suggestions on the frequency of observations, and best practices for collecting and processing field material.

In 2020-2021, the Company is carrying out large-scale environmental studies in the waters of the Gulf of Ob from the Khasryo-Seyakha river in the south to the borders of the Kara Sea in the north, the program of which includes comprehensive work on biological diversity:

- Hydrobiological studies at 104 stations (bacterio -, phyto - and zooplankton, chlorophyll content, ichthyoplankton, zoobenthos);

- Ichthyological studies (12 net fishing in the Gulf of Ob and 2 – in the mouths of rivers Halziney-Yakha and Nyadai-Pingche);

- Control of the presence of alien species in ship tanks (5 samples) and fouling on existing berthing facilities of Salmanovsky (Utrenny) OGCF.

- Studies of populations of pagophilic pinnipeds in the Project's area of influence

[155] Распоряжение Минприроды России от 22.09.2015 N 25-р «Об утверждении перечня видов флоры и фауны, являющихся индикаторами устойчивого состояния морских экосистем Арктической зоны Российской Федерации»

[156] Caff. (2013). Arctic Terrestrial Biodiversity Monitoring Plan. 7, 164. www.caff.is

[157] GIll, M. J., Crane, K., Hindrum, R., Arneberg, P., Bysveen, I., Denisenko, N. V., Gofman, V., Grant-Friedman, A., Gudmundsson, G., Hopcroft, R. R., Iken, K., Labansen, A., Liubina, O. S., Melnikov, I. A., Moore, S. E., Reist, J. D., Sirenko, B. I., Stow, J., Ugarte, F., … Watkins, J. (2011). Arctic Marine Biodiversity Monitoring Plan. Conservation of Arctic Flora and Fauna, January.

[158] Christensen, T., Barry, T., Taylor, J. J., Doyle, M., Aronsson, M., Braa, J., Burns, C., Coon, C., Coulson, S., Cuyler, C., Falk, K., Heiðmarsson, S., Kulmala, P., Lawler, J., MacNearney, D., Ravolainen, V., Smith, P. A., Soloviev, M., & Schmidt, N. M. (2020). Developing a circumpolar programme for the monitoring of Arctic terrestrial biodiversity. Ambio, 49(3), 655–665. https://doi.org/10.1007/s13280-019-01311-w

In addition, the work includes studies of acoustic impact using acoustic bottom stations[159][160][161], as well as sampling of surface water and bottom sediments at complex stations to determine physical and chemical parameters and pollution levels.

The work includes monitoring of the water area using remote sensing data. These studies will allow us to clarify the spatial boundaries of the distribution of suspensions and their impact on the state of plankton communities.

Based on the results of comprehensive monitoring, new data will be obtained to assess the impact on the ecosystems of the Gulf of Ob, the boundaries of actual and potential impacts will be clarified, and critical habitats in the water area will be identified. In addition, the marine environment monitoring program is expected to be finalizedMonitoring of the biological diversity of terrestrial ecosystems is currently carried out by the external organizations. According to the results of monitoring, the most detailed and up-to-date information about the biota of the Salman (Utrenny) LA was obtained. The implementation of additional recommended studies of terrestrial biodiversity will allow the development of a new program of observations of biological diversity.

[159] Рутенко А.Н., Борисов С.В., Ковзель Д.Г., Гриценко В.А. Радиогидроакустическая станция для мониторинга параметров антропогенных импульсных и шумовых сигналов на шельфе // Акустический журнал, 2015. Том 61. № 4. С. 500-511.

[160] Рутенко А.Н., Гриценко В.А. Мониторинг антропогенных акустических шумов на шельфе о. Сахалин // Акустический журнал, 2010, том 56, № 1, с. 77–81.

[161] Rutenko, A. N., Gritsenko, V. A., Kovzel, D. G., Manulchev, D. S., & Fershalov, M. Y. (2019). A Method for Estimating the Characteristics of Acoustic Pulses Recorded on the Sakhalin Shelf for Multivariate Analysis of their Effect on the Behavior of Gray Whales. Acoustical Physics, 65(5), 556-566.

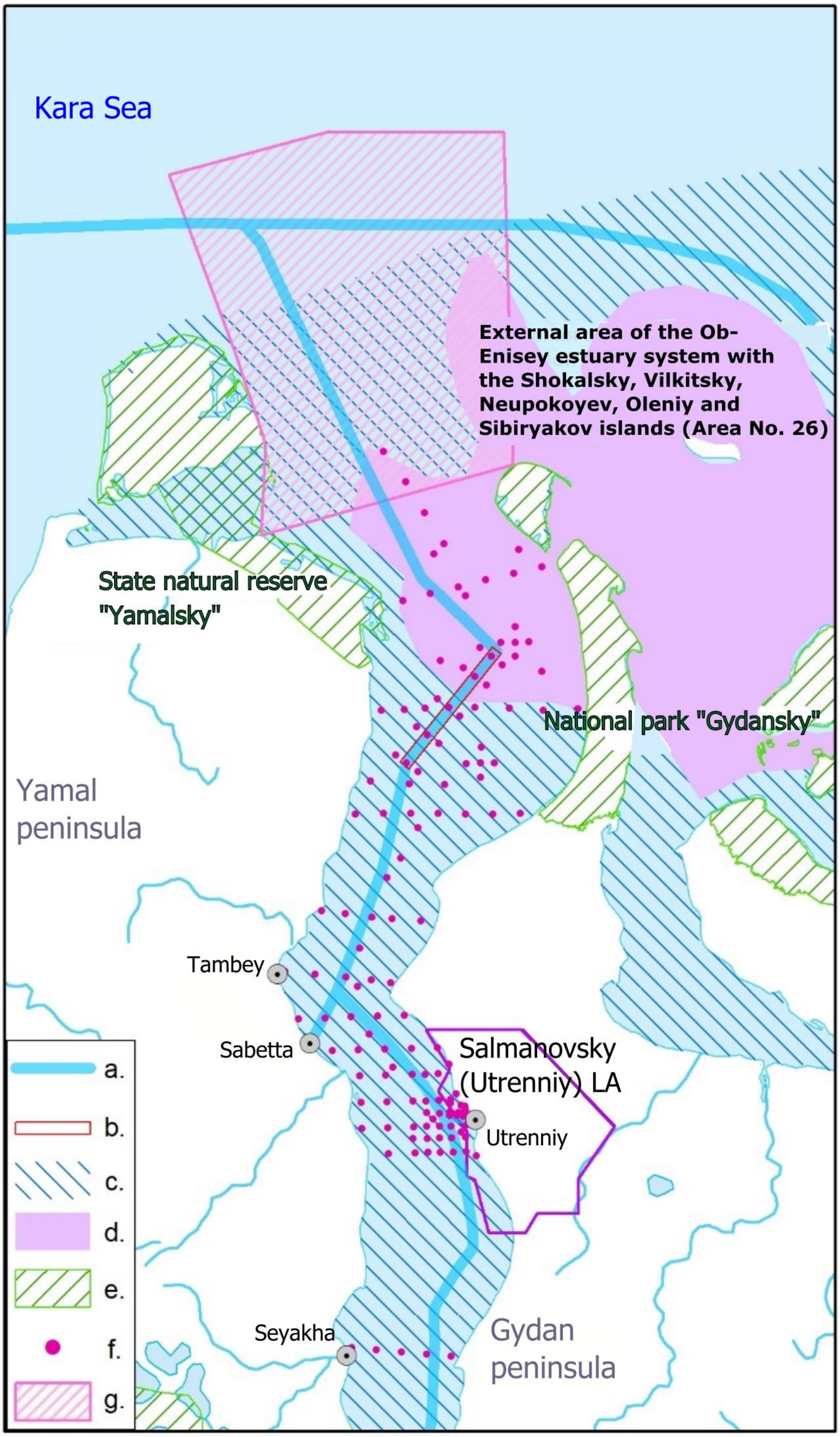

Figure 9.5.6: Scheme of monitoring of marine ecosystems of the Ob Bay

Monitoring conditions: a. Northern Sea Route, b. Sea channel, s. Environmentally and biologically significant area, d. WWF-identified Marine Protected Area, e. Specially protected natural areas and water areas, f. complex research stations 2020, g. Area for which it is planned to expand monitoring in terms of research of biological diversity .

Observations of the biota of terrestrial ecosystems are currently being carried out as part of industrial environmental monitoring at LA. Based on the results of these studies (JSC "IEPI", 2018-2020), a database of biological diversity of terrestrial and aquatic ecosystems of the Salman (Utrenny) LA is being formed. To eliminate the existing gaps in knowledge, it is recommended to conduct special studies (including detailed identification of taxonomic diversity, mapping of biotopes, special studies of avifauna, etc.). Based on the results of these studies, a program for the conservation of biological diversity will be developed, within the framework of which system monitoring will be carried out.

Summary recommendations for monitoring biological diversity, including additional ad hoc studies, are discussed below (Tables 9.5.7-9.5.8).

Table 9.5.7: Summary of requirements for monitoring and additional studies on the biological diversity of marine ecosystems

Aspect	Phase	Types of activities	Controlled parameters, parameters of observation	Aquatory covered	Periodicity
Impact of hydrotechnical works on the state of marine communities	Construction	Studies of planktonic and benthic communities at complex stations	Chemical and organoleptic parameters of water and bottom sediments; species composition, distribution and abundance of phyto-and zooplankton, fauna, benthic abundance and biomass, species composition and abundance of invasive species	Water areas of the seaport and approach channel, ground dumping sites, areas of identified potential impact	once a year during the open water period
Impact of the operation of ships and structures of the seaport on the state of marine communities	Operation		chemical and organoleptic parameters of water; distribution and abundance of phyto-and zooplankton, benthic biotope fauna	Water areas of the seaport and approach channel, places of dumping of soil Set-ups in the water area	once a year during the open water period
mpact of hydrotechnical works on the ichthyofauna	Construction/Operation	netting and non-water fishing	total catch, species and quantitative composition of ichthyofauna, presence of invasive species	Netting in the water area	once a year during the open water period
		Sampling of biological material	content of pollutants in fish tissues		
Invasive species	Operation	control of the presence of alien species (invasive species)			Once a year
			sampling of fouling agents	Terminal and the existing jetty	
Marine mammals	Construction/Operation	Ship observations	side-by-side visual observations from the ship during the performance of IEM works	The water area of the Utrenny Terminal, the Ob Bay and the southern part of the Kara Sea, within the ship routes	Annually
		Coastal observations	Visual observations from the shore (elevations or man-made structures). determination of the species composition, number, and condition of animals. tracking and recording of releases of dead mammals on the shore.	In the area of the coastal structures of the Project	Annually, monthly, during the open water period In case of detection of animal corpses — all year round
		Air records	Aerial photography and visual observations from an aircraft (helicopter or slow-flying turboprop aircraft)	Northern part of the Gulf of Ob in the Area of Influence of the Project	during the breeding period of pagophilic species (May-June), at least once every three years

Table 9.5.8: Summary of requirements for monitoring and additional studies of the biological diversity of the Gydan Peninsula ecosystems

Phase	Types of activities	Controlled parameters, parameters of observation	Aquatory covered	Periodicity
Design/Construction	Inventory of rare species habitats	Search for habitats of rare species, obtaining up-to-date data on their distribution by modeling the suitability of habitats	Territory of the license area	once, with subsequent additions
Construction Commissioning	Observations of vegetation restoration, dynamics of plant communities, dynamics of deer pastures	Species composition, abundance, structure of plant communities, abundance of indicator species, presence of alien species. observation at established permanent test sites, setting up new observation areas	Plots within a radius of 1 km from construction sites, background plots	Annually during summer period
	Avifauna	Detailed records of the number of birds at nesting sites, determination of population densities for each species by biotope, mapping of nests at monitoring sites, determination of productivity (average number of eggs per nesting pair, average number of offspring per year per nesting pair). records during migration	the territory of the license area, recommended monitoring sites (fig. 9.5.2)	3 times a year (nesting period (last decade of June, first decade of July), brood season (last decade of July, first decade of August), autumn migration (first and second decades of September), annually
		Determination of the number, detailed search for nesting and breeding aggregations of waterfowl by air surveys using light aircraft and unmanned aircraft	Territory of the license area	once, when identifying places of concentration, nesting or feeding stations of rare species-organization of additional annual surveys
	Avifauna (migratory)	Determination of routes and directions of migration of key species	Territory of the license area	during 3 years
	Terrestrial mammals	Species composition, abundance, density. Route records, trapping on trap lines for studying the number of small mammals (lemmings) important for the functioning of Arctic ecosystems in different types of biotopes, winter route records	Territory of the license area, recommended monitoring sites (Figure 9.5.2)	2 times a year (instrumental accounting at the end of summer, winter route accounting (March-April)
	Freshwater ecosystems	Hydrobiological monitoring of fresh water (phytoplankton, zooplankton, zoobenthos)	continuation of observations at 10 water bodies	once a year
	Ichthyological monitoring	The value of the total catch, the species and quantitative composition of ichthyofauna	continuation of observations on 10 water bodies The major affected water bodies (Kalzinei-Yakha, Nyadai-Pingche, Salpada-Yakha)	once a year

9.5.12 Summary

1. The predicted integrated significance of the planned activity's impact on the various components of biodiversity of **terrestrial** and **aquatic** ecosystems and on related ecosystem functions (ecosystem services[162]) is assessed by the Consultant as **moderate** and **high**, respectively, and can be reduced to **low** and **moderate** by taking effective measures aimed at prevention, minimization and compensation for expected damage. At the same time, according to the IFC Performance Standard 6, in the land and water areas with natural habitat, mitigation measures should be aimed at excluding the total loss of biological diversity as completely as possible, which necessitates additional measures aimed at compensating for residual effects.

2.The most significant habitats on the Gydan Peninsula which can be identified as critical are located in the existing and planned nature conservation areas, as well as nesting areas of rare anseriformes, the nearest of which are situated in 70-110 km from the Project sites within the LA. No habitats meeting the "criticality" criteria of IFC PS6 are present within the LA. However, the known presence of four rare and protected species of birds, passage of migration routes through the license area, and presence of four species of plants listed in the Red Data Book of YNAO trigger the need for detailed biodiversity monitoring.

3. The most significant habitats in the Ob Estuary – the Arctic water areas of a high environmental value (identified as critical habitats in the contest of IFS PS6) – are located at least 110 km from the Project area of influence. The Project water area location within the environmentally and biologically significant areas (EBSAs) dictates the need for comprehensive biodiversity monitoring of the Ob Estuary ecosystems.

More information on the assessment of the significance of impacts on biodiversity, recommended mitigation and monitoring activities is presented in Table 9.5.9.

[162] See Chapter 10 for detail

Table 9.5.9: Summary sheet of assessment of the Planned activity impact on biological diversity

Impact	Sign	Receptor	Receptor sensitivity	Phase	Impact significance	Risk	Impact prevention and mitigation measures	Residual impact
Impact on ecosystems in the Ob Estuary water area	N	Phyto- and zooplankton Hydrobionts	H	C, DCm Cm, O	M M	H H	**Prevention.** Optimization of underwater dumping area. Prevention of the marine environment pollution by accidental leaks of pollutants from onshore facilities. **Minimization.** Minimization of roiling during soil excavation and dumping, by using modern technologies and special measures, including: • Prevention of technical water overflow when filling suction hopper dredges; • Unloading of material from hopper barges and suction hopper dredges at the dump site only when the craft fully stopped (adrift); • During backhoe dredger operation, lowering the bucket as close as possible to the water surface in the hopper barge hold, to avoid spillage and splashing of slurry; • Making sure that bucket is filled with ground by 75% (with no heap), to prevent ground release back into water; Using vibration methods of pile driving in all cases where ground conditions allow it. Establishing threshold values and water quality control in dredging and dumping areas. Development of measures to minimize pollution of the marine environment in case of accidental spills of petroleum products from vessels **Restoration.** Development of monitoring programme to screen the environmental indicators, rates of rehabilitation/modification of benthic communities. **Compensation.** Calculation of and payment for the damage to aquatic biological resources caused by zooplankton and zoobenthos mortality, to compensate the costs for rehabilitation of the damaged aquatic resources through their artificial reproduction. **Additional (offset) measures.** Development/support of regional initiatives aimed at identification of/establishing the conservation status to particular areas in the Ob Estuary, reducing human-induced load, and increasing the productivity of water ecosystems.	Loss and degradation of habitats of bottom communities in the areas of dredging, dumping and GBS installation (H) Reduction of marine ecosystems productivity in the areas of dredging, dumping and soil filling for GBS (H) <u>Cumulative:</u> decrease in the productivity of hydrobionts caused by increasing concentrations of suspended particles brought with river runoff, and as a result of construction works and implementation of other infrastructure projects in the Ob Estuary water area (H)
Impact on populations of rare and commercial fish species	N	Ichthyofauna (rare and commercial fish species)	H	C, DCm Cm, O	H	H	**Prevention** of the marine environment pollution by accidental leaks of pollutants from the onshore facilities. **Minimization.** Chemical analysis to control water and bottom sediments quality of the Ob Estuary before, during and after dredging. Carrying out works outside the main periods of spawning, juveniles growth and migration of fish. Continuous operational monitoring of compliance with the technology for underwater technical operations. Collection, treatment and disposal of wastewater according to the design, prevention of the discharge of untreated wastewater. Using vibration methods of pile driving in all cases where ground conditions allow it. **Restoration.** Release of juveniles of commercial fish species in the rivers of the Ob-Irtysh catchment. **Compensation.** Calculation of and payment for the damage to aquatic biological resources caused by zooplankton and zoobenthos mortality, to compensate the costs for rehabilitation of the damaged aquatic resources through their artificial reproduction. **Additional measures**. Support of regional initiatives aimed at rehabilitation of populations of commercial fish species and Siberian sturgeon.	Reduction of marine ecosystems productivity in the feeding grounds of commercial fish species (M, L) Death of fish juveniles due to elevated concentrations of suspended solids (L, Mr) Changes in migration routes and places of commercial fish concentration in the Ob Estuary water area adjacent to the dredging sites (L, Mr)
Introduction of invasive species in the Ob Estuary water area	N	Natural biocoenoses Endemic species	M-H	C, O	M	M	**Prevention.** Ensuring compliance with the requirements of the Ballast Water Management Convention, in particular: • Provision for a special system for mechanical, chemical or biological treatment of ballast water on LNG carriers (Standard D-2); • Ballast water replacement to at least 95% at a distance of at least 50 nautical miles from the coast, at a depth of at least 200 m (Standard D-1). **Minimization.** Additional requirements for regular cleaning of vessel hulls, especially LNG carriers, from fouling. **Rehabilitation** and **compensation** measures are not required if impact prevention and minimization measures are duly taken. **Additional measures**. Focus on earlier identified invasions as part of regular hydrobiological surveys	There is still a slight risk of alien species introduction associated with hull fouling, and their invasion into the artificial reef communities (I, N) There is a risk of alien species occurrence in the water area of the Terminal as a result of maritime navigation by other economic entities
Impact on marine mammals	N	Marine mammals	M-H	C, O, DCm	M	H	**Prevention.** Training vessels' crews, including those of LNG carriers, to prevent collisions with and to reduce disturbance to marine mammals. **Minimization.** Using vibration methods of pile driving in all cases where ground conditions allow it. Use of modern technologies that ensure the minimum roiling during soil excavation and dumping. Monitoring of underwater noise. Observation of marine mammals staying in close vicinity to work sites; suspension of works if they approach to a potentially hazardous distance. Limiting icebreakers speed in the seals breeding areas. **Rehabilitation** and **compensation** measures are not required if impact prevention and minimization measures are duly taken. **Additional measures**. Support of regional initiatives aimed at conservation of marine mammals in the Ob Estuary. Funding for research of spatial and temporal distribution of marine mammals, identification of as well as identification of ice-based dens of seals, their breeding grounds, so as to minimize the negative impact of navigation in the Ob Estuary. Surveys of migrations of marine mammals using satellite telemetry.	The number of marine mammal populations may decrease due to the forage base reduction (L, Mr) Changes in the timing of feeding and in the areas of concentration of marine mammals (L, Mr). Babies of ice seals may die during ice-breaker escorting of LNG carriers in the period of reproduction (M, Mr) Cumulative: The abundance and the time of migration of marine mammals can be affected by a number of natural and human-induced factors, including navigation by other economic entities, and poaching by third parties.

Impact	Sign	Receptor	Receptor sensitivity	Phase	Impact significance	Risk	Impact prevention and mitigation measures	Residual impact
Impact to water ecosystems of the Gydan Peninsula	N	Aquatic ecosystems	M	C	M	M	**Prevention.** The maximum possible exclusion of habitats along the channels of watercourses from economic activities, as there are nesting sites of the majority of rare and protected bird species listed in the Red Data Books of Russia and YNAO. Prohibition of washing and refueling the vehicles and construction machinery on the banks and shores of waterbodies. Prohibition of works affecting inland waterbodies during spawning and development of eggs (May-June), as well as during migration of semi-anadromous fish (September). **Minimization.** Regular analytical monitoring of water quality in affected water bodies (the frequency of testing is determined depending on the type of use of the water body). Mandatory approval of storage areas for construction materials, excavated soil etc. at local fishery authorities; prevention of soil, construction and household wastes disposal and untreated wastewater discharge in waterbodies. Carrying out construction of waterbody crossings in winter (October-March), when the channels of watercourses are least vulnerable. Use of engineering solutions for temporary management of surface water and alluvium retention during construction phase. Transport parking and refueling, as well as oil and lubricants draining should be carried out only in dedicated equipped sites. **Restoration.** Shore protection and restoration of watercourse channels damaged during construction works and production of inert materials. Reclamation of water protection zones and shores or watercourses and lakes affected by construction. **Compensation.** Calculation of and payment for the damage to aquatic biological resources caused by zooplankton and zoobenthos mortality, to compensate the costs for rehabilitation of the damaged aquatic resources through their artificial reproduction. **Additional measures.** Regular fauna monitoring in aquatic ecosystems.	Partial loss of some traditional fishing grounds (without provision of a fishery area) in the estuaries of the Khaltsyney-Yakha and Nyaday-Pynche Rivers due to the construction of the Port infrastructure facilities (L). Loss of spawning grounds of grayling and Arctic cisco is also possible in these rivers (L). The impact of wastewater discharges on the lower reaches of the river Nyaday -Pingche (M). A positive effect is expected from lakes deepening during the production of inert materials, which, according to available data, increases the biodiversity and productivity of the waterbodies.
				O	L	Mr		
Impact on vegetation cover	N	Vegetation cover	M-H	C, DCm	M	M	**Prevention** of spills and leaks; full prevention of untreated wastewater discharge onto terrain. Compliance with the requirements for collection, transportation and disposal of construction and household wastes. Provision for wastewater segregation and treatment in full compliance with the Russian legislation and design solutions. Instructing the personnel to avoid destruction of vegetation cover outside the footprint areas where earthmoving and associated construction activities are planned. Prohibition to burn the vegetation out. **Minimization.** Strict observance of the boundaries of land plots and strips allocated for construction, and prevention of occupation of excess land. Functional zoning of the territory taking into account the process interfaces, sanitary and hygienic standards and fire safety requirements. Construction of linear facilities, such as power lines, pipelines, motorways, etc. within a common corridor, to minimise land acquisition. Carrying out construction works when ambient temperature is consistently negative and snow cover is thick enough, to minimise disturbance of the vegetation (where possible). Carrying out earthworks strictly within the right of way; timely cleaning of debris; and strict control over the civil and installation works. To avoid disturbance of soil and vegetation, embankment filling should be started close by the pit, so that machinery bringing soil to further sections move on top of previously filled material. Strengthening slopes, e.g. with geotextile made of biodegradable materials, fertilizers and seeds, to create a fertile layer and prevent erosion by wind and surface water. Arrangement of vehicles and construction machinery traffic only on approved roads (existing roads, winter roads). Use of the pool of construction machines and mechanisms with the minimum possible specific pressure of chassis on the underlying soils, in order to reduce the mechanical impact on vegetation. Snow clearing without damaging the moss and vegetation layer. Compliance with the fire safety rules during the construction and operation of the facilities. Use of modern diesel generators that meet the environmental standards and requirements with regard to ambient air protection. Using low-sulphur diesel fuel. Delivery of soil for construction works in winter period. Provision of biotoilets on the construction site. Bunkering the concrete and mortar into metal containers that prevent contamination of soil. Full sealing of technological processes. Compliance with the rules for fuels and lubricants storage. Storage of dusty materials in closed containers. Transport parking and refueling, as well as oil and lubricants draining only in dedicated equipped sites. Emergency draining of liquids from equipment and pipelines into underground drain tanks in case of accidents and before repair. Where conservation of habitats of rare and protected plant species is not possible, the plants shall be relocated to areas with similar environmental conditions that are not exposed to the industrial impact. **Restoration.** Reclamation of disturbed land and restoration of tundra ecosystems. Area improvement and landscaping of the industrial sites. Use of zonal plant species for reinstatement, and selection of the optimal parameters for grass mix planting.	Destruction of vegetation cover in the area occupied by the infrastructure facilities and allocated for the construction of roads and other linear facilities (M) Degradation of plant communities in the Project's area of influence (L) Cumulative: As a result of climate change, natural transformation of plant biocoenoses is possible in the Project's area of influence (L)
				Cm, O	M	L		
Impact on reindeer pasture lands	N	Indigenous people	H	C, DCm	H	H		Loss and reduced productivity of reindeer pastures located in the Project's area of influence (M)
				Cm, O	M	H		

Impact	Sign	Receptor	Receptor sensitivity	Phase	Impact significance	Risk	Impact prevention and mitigation measures	Residual impact
							Selection of grass mix seeds of local origin, which will be more resistant to adverse effects and suitable for reindeer feeding. **Additional measures.** Support of regional initiatives aimed at researching and conservation of rare and protected plant species on the Gydan Peninsula. Development of a vegetation monitoring program. Support of environmental activities aimed at maintaining and increasing the area size and fertility of reindeer pastures, in particular, the Gydan population. Identification of the best methods of reclamation and restoration of tundra communities through dedicated research activities, and application in the Project. Comprehensive surveys of vegetation cover and identification of vascular plants flora and cryptogamous biota, places with presence of rare and protected species of plants, make an inventory record of plant communities, and produce a detailed map of vegetation to enable identification of rare plant communities. Reclamation of lands damaged by previous economic activities within an area equivalent to the area of lands damaged in the course of the Project implementation, in order to achieve No Net Loss for biodiversity. when remediating rare and protected species (seed or vegetatively, in suitable habitats) to minimize the impact on the regional population	
Impact on migratory bird species	N	Migratory bird species	H	C, O	L-M	M	**Prevention.** Prohibition of hunting and bringing of firearms for the Project personnel and contractors. Identification of biotopes vital for migratory birds species in the planned activity's area of influence, and their exclusion from the planned economic development of the territory. **Minimization.** Restriction of high-noise operations in the period of mass migration of birds. Control of light pollution in the period of autumn migrations. installation of means of repelling birds from power lines. **Rehabilitation** and **compensation** measures are not required if impact prevention and minimization measures are duly taken. **Additional measures**. Support of national and international initiatives for research and conservation of migrating bird species. Identification of resting grounds of birds on migration, and of the transit corridors within the Project's area of influence. Birds migration studies using satellite telemetry to assess cumulative impact on vulnerable species	Nuisance due to high levels of noise and lighting, presence and traffic of vessels in the water area; decrease in the forage base (L) Cumulative: The abundance of migratory birds and the timing of their migration can be affected by a number of natural and human-induced factors related to their habitat in the breeding and wintering grounds, as well as in the entire distance of the seasonal migratory routes; by the impacts of navigation within the projects of other economic entities. Migratory birds can be affected by licensed hunting and poaching by third parties.
Impact on terrestrial animals and birds	N	Terrestrial animals Birds	H	C, O	M	M	**Prevention**. Locating the infrastructure facilities away from known habitats of rare and protected species of animals and birds (if detected); ensuring their adequate protection from disturbance by the Project personnel and contractors; conducting awareness-raising activities with regard to inadmissibility of the bird nests destruction. The maximum possible exclusion of habitats along the channels of watercourses from economic activities, as there are nesting sites of the majority of rare and protected bird species listed in the Red Data Books of Russia and YNAO. Prohibition to bring and keep all kinds of hunting tools in the planned activity's territory (hunting weapons, traps, etc.); prohibition to keep dogs; prohibition of amateur hunting. Provision for protective systems in containers and tanks to prevent animals from getting inside. **Minimization.** Keeping within the boundaries of the area allocated for construction and operation. Construction of linear facilities, such as power lines, pipelines, motorways, etc. within a common corridor, to minimise disturbance of habitats and migration routes. Carrying out civil work mainly in winter, outside the season of wildlife reproduction. Prohibition of traffic of all-terrain road construction vehicles outside the site. Prohibition for vehicles to leave the construction site and access roads without special permits. Limiting the speed of vehicles near known habitats of rare and protected species of animals. Equipping the power transmission towers with insulated bird-protecting devices that prevent the birds from touching the wires. Collection of food waste in designated sites inaccessible to birds and mammals. Strict observance of waste accumulation and storage requirements, as well as schedules and destinations of waste disposal. Proper collection of household wastewater and bilge (oil-containing) water and transfer to licensed contractors for neutralization and disposal, to prevent contamination of wildlife habitats. Minimization of nuisance in adjacent areas, especially in the periods of animals breeding and birds migration; in places of mass reproduction, molting, and younglings feeding, by restricting movements of personnel in the natural habitats. Noise control in the work area, to avoid noise pollution of the environment. Use of low-noise machinery to minimize nuisance to wildlife. Covering the equipment with soundproof enclosures, use of noise and vibration dampers. Installation of metal mesh fencing around the work sites, to prevent access of animals. Strict compliance with fire safety rules during all work activities. **Restoration** of natural habitats disturbed as a result of works and construction of temporary infrastructure.	Loss of animal habitats in the area occupied by the infrastructure facilities and allocated for the construction of roads and other linear facilities. Disturbance of animal migration routes by the construction of linear facilities. Death of animals caused by traffic of motor vehicles. Cumulative: Some animal species can be affected by licensed hunting and poaching by third parties.

Impact	Sign	Receptor	Receptor sensitivity	Phase	Impact significance	Risk	Impact prevention and mitigation measures	Residual impact
							Removal of temporary structures, equipment and trenches upon the construction completion, to avoid trapping of small mammals. Construction of pipeline and road crossings for animals to restore the disturbed migration routes. **Compensation.** Compensation of damage to rare and protected species of animals and their habitats according to the Order No. 107 of the Ministry of Natural Resources of Russia "On approval of calculation methodology for the damage to wildlife listed in the Red Data Book of the Russian Federation, as well as other wildlife not relating to commercial hunting and fishery, and their habitats", dated 28 April, 2008. **Additional measures**. Liaison with regional authorities for wildlife regulation and protection to limit the access of third parties to the planned activity's area of influence. Financial support for specialized scientific research of fauna and animal population of Gydan tundra. Support of regional initiatives aimed at conservation of habitats of rare and protected animal species on the Gydan Peninsula. Support of environmental activities aimed at the recovery of abundance of rare and protected animal species.	

9.6 Visual and Aesthetic Landscape Impacts

Assessment of the landscape impacts within the Project's area of influence is based on two parameters: sensitivity of the landscapes, including physical parameters and visual aspects, and extent of changes in landscape under the impact of the planned activity, which is defined as the extent of modification or loss of landscape components and takes into account degradation of the landscape value and duration of impact. Definitions and criteria of the above characteristics are provided in Chapter 3.

Summary of assessment of sensitivity and value of the landscapes within the Project's area of influence is included in Sub-section 9.6.1. Sub-section 9.6.2 describes sources and types of impacts at different phases of the Project – from preparation and construction to decommissioning; and assessment of intensity, magnitude and duration of the impacts. Measures to mitigate the negative impacts on landscape are covered in Sub-section 9.6.3. Sub-section 9.6.4 provides a summary table with results of the assessment of landscape impacts.

9.6.1 Characterization of landscapes in the Project's area of influence, their sensitivity and value

In accordance with the Landscape Zoning Scheme of the Yamal-Nenets Autonomous Okrug, the Project facilities are located in the Yavai-Gydan and North-Yavai areas of the Yavai-Mamonta sub-province, north-tundra sub-zone of the Gydan province of the Yamal-Gydan tundra region, tundra zone of the West Siberian Plain land.

The Yavai-Mamonta landscape province occupies lowland areas in the north of the Gydan Peninsula, with Yuribey elevation along the Ob Estuary. The main background settings are shaped by flat lacustrine plains on post-Eemian deposits (sandy loams and clayey loam) of the third marine terrace. Their surface is fragmented by barrancas and lakes.

The area of Salmanovskoye (Utrenneye) OGCF is characterised by extensive horizontal linear fragmentation with valleys, gulches, troughs and gullies, as well as significant lacustrine fragmentation.

Flat-domed laked plains of the fourth marine terraces are composed of Eemain sands, sandy loams and clay loams, rise to the height of 70 m, and have signs of extensive erosion. Flat-heavy interfluves with jointed-polygonal, polygonal-hummocky and hillocky-tussocky predominate in the microrelief. Baidzherakh relief is typical on valley slopes in upper reaches of the rivers. Slopes of watersheds and sides of ravines feature thermoerosional and solifluctional topography.

Humus-gley supra-permafrost-humus soils, peaty-gley and peaty-bog soils have developed in well-drained areas. In the north-eastern, more continental part with sandy–loamy sediments, predominant types of soil are humus-gley, supra-permafrost-humus saturated and non-differentiated supra-permafrost-gleyic soils. Slopes with small-polygonal relief and open plant communities are composed of spotted tundra soils (mainly tundra and illuvial-humus soils) in combination with tundra gley soils in faults.

Interfluve areas and their gentle slopes include small-polygonal and polygonal-spotted microrelief features. On the near-valley slopes those are succeeded by solifluctional sinter forms of relief and thermoerosion depressions. Better drainage and sandy soils induce predominant development of illuvial-humus soils, and of dwarf shrub-lichen-moss and dwarf shrub-moss tundras.

In terms of structural-geomorphological zoning, the Project area belongs to West Siberian physiographic land, Ust-Ob district of low marine and river terraces ("Ust-Ob depression"). In terms of the landscape zoning, the area is a part of the Yamal-Gydan tundra province, at the junction of the northern and typical tundra provinces, and junction of the North-Gydan and Central-Gydan regions. The landscape type is flat-domed fragmented laked plain with moss-lichen and dwarf willow tundras.

Ecological structure of the local landscape is defined by a combination of lithogenic, cryogenic, hydrological, climatic, biogenic and anthropogenic factors of landscape differentiation. The most important natural factors shaping the landscape structure are the location within cryolithozone with a continuous occurrence of permafrost, poor drainage in the central watershed area, and very rough relief.

Elevations above water level of rivers in the territory of the Salmanovskoye (Utrenneye) OGCF vary from insignificant – 10-25 m (in flat areas with poorly broken terrain) to 50 m (extensively dissected upland areas).

9.6.1.1 Natural Landscapes

The largest territories are occupied by flat-domed watershed tundras. Vegetation is composed of subshub-moss-lichen assemblages. Predominating soils are peaty tundra gleysols in combination with peat bog soils (Figure 9.6.1).

Figure 9.6.1: Flat-domed watershed tundra landscape

(Photo by NIPIgaspererabotka JSC, 2018)

Tundra landscapes on drained near-valley slopes are present in sloped near-valley sections of runoff valleys, lows of the ravine and gully network, and thermoerosional relief. Typical soils for this type of terrain are tundra gleysols and non-differentiated layered soils on slopes. Vegetation consists of subshrub-sphagnum assemblages combined with sedge-cottongrass groups in waterlogged areas.

The ravine and gully network complexes and peaty runoff valleys represent a small-valley-tundra type of landscape. Subshrub-grass-moss communities on tundra gleysols predominate in the vegetation cover.

Waterlogged areas with sedge-sphagnum vegetation represent tundra-bog landscapes. Such landscapes include both waterlogged watershed territories and peaty runoff valleys. Vegetation cover with predominance of sedge-sphagnum associations is similar in all stows. Predominant soils are peaty tundra gleysols and peat bog soils.

The river-valley landscapes (Figure 9.6.2) are present in the floodplain-channel sections of rivers and streams in the surveyed area, and feature alluvial deposits and typical floodplain vegetation.

Figure 9.6.2: River-valley landscape, Khaltsyney-Yakha River

(Photo by the Institute of Environmental Survey, Planning and Assessment, IEPI JSC, 2019)

Some of the designed facilities (specifically - the onshore facilities) are located in the immediate vicinity of the Ob Estuary of the Kara Sea, in the area with marine type of landscape (Figure 9.6.3). This territory is characterised by presence of small laida lakelets with sandy and partially slimy bottom.

Figure 9.6.3: Marine landscape. Laked lagoonal-marine laida surface and berth structures

(Photo by the Institute of Environmental Survey, Planning and Assessment, IEPI JSC, 2018)

Areas with overgrowing lake basins and small completely freezing lakelets represent lake-basin type of landscape. Such landscapes are characterised by presence of overgrowing lake basins. Vegetation is composed of sedge-reed, sphagnum-cottongrass groups, with patches of dwarf willows. The soils are represented by weakly-differentiated tundra bog formations.

9.6.1.2 Anthropogenically Modified Landscapes

More than fifty exploratory and prospecting wells drilled in the territory of the Salmanovskoye (Utrenneye) OGCF belong to the "old well stock", and 6 wells are owned by LLC "Arctic LNG 2".

In 2019, activities within the Salmanovskiy (Utrenniy) LA included the following: development of the Salmanovskoye (Utrenneye) OGCF Facilities Setup, Utrenniy Terminal, the LNG Plant construction activities at well pads Nos. 2 and 16, and drilling of exploration well 279PO. The total of 6 sand jetting quarries were functioning. Construction of roads and filling of sites was in progress.

At this stage of the field development, significant modification of vegetation cover is caused by hydraulic production of sand, and filling for the linear and areal facilities. Modification of habitats hydrology and consequential changes in permafrost conditions will entail seral changes in vegetation cover (Figure 9.6.4).

Figure 9.6.4: Degraded vegetation in the land acquired for methanol pipeline on the left side of the Khaltsyney-Yakha River valley

(Photo by the Institute of Environmental Survey, Planning and Assessment, IEPI JSC, 2019)

Observations in 2019 demonstrated an extremely slow restoration of vegetation on sand-filled surfaces, regardless of watering conditions. This result correlates well with findings of previous monitoring seasons. In disturbed areas, vegetation restoration process is slow too, which is common for tundra ecosystems. Only slight developments of coverage and species diversity parameters are reported in the primary succession areas, compared to year 2018.

Vegetation restoration in the area of the berth structures is rather slow. Apparently, the rate of progressive successions depends on the richness of soils and extent of their modification, and restoration involves local species of plants.

9.6.1.3 Landscapes Functions, Resilience and Sensitivity

Most natural complexes in the Salmanovskoye (Utrenneye) OGCF represent resources of medium and low value. On the other hand, landscapes of near-valley, bottomland, lake-basin, tundra-bog, valley-river types play an important environmental role. All natural complexes perform a landscape-stabilising function, i.e. conservation of landscape structure and prevention of development of exogenous processes. Another key function of the landscapes is permafrost stabilisation, i.e. maintaining constant level of permafrost. Disturbance of vegetation cover triggers solifluction and thermocarst, as deeper layers of soil are exposed to thawing and freezing.

Soils in the area Salmanovskoye (Utrenneye) OGCF feature poor resilience to mechanical and geochemical impacts. In terms of geochemical pollution, natural tundra complexes below to a fragile and relatively resilient category. Their self-restoration capability upon cessation of impact (biological resilience) varies from fragile to resilient.

Considering the poor resilience of local landscapes in the field territory, and the region-specific natural conditions with omnipresent PR, the natural-territorial complexes with the field can be classified as fragile ecosystems with a weak self-restoration capacity.

The Project area does not include any designated conservation areas or heritage sites with unique landscapes that would represent a high aesthetic value and special features. The area's legal status does not preclude modification of scenic characteristics of local landscapes.

The virgin and scarcely populated areas of the Arctic tundras in the territory of the Salmanovskoye (Utrenneye) OGCF lack contrasting effects, diversity or high scenic attractiveness. However, for the indigenous small-numbered peoples of the North engaged with customary economic activities (deer herding, hunting, fishing, etc.), the landscape represents a high value in terms of visual perception, and at the ecosystem level.

The archaeological survey in Salmanovskoye (Utrenneye) field near Khaltsyneysalya cape at the eastern shore of the Ob Estuary identified two cultural heritage sites listed in the national register – medieval Khaltsyneysalya sites 1 and -2. Khaltsyneysalya-1 is a pentagonal site of 1450 m^2, Khaltsyneysalya-2 is a quadrangular site of 630 m^2. In 2019, the record of boundaries of CHS Khaltsyneysalya-1 was removed from the Unified State Register of Real Estate[163].

About 20 sacred sites are known within the Salmanovskiy (Utrenniy) LA (Figure 9.6.5). The nearest sites in relation to the Field facilities are as follows:

- Varku' ngeva khebidya-ya - The site is located at the upper reaches of Nyan-Yakha-2 River, near a small stream which Nenets people call Varkungevayakha. Distance to the linear facilities of the Salmanovskoye (Utrenneye) OGCF Facilities Setup is 1100 m;
- Tatngamla - The site is located on a rise at the upper reaches of Parejlak-Yakha River and is surrounded by cliffs. Distance to the linear facilities of the Salmanovskoye (Utrenneye) OGCF Facilities Setup is 900 m;

[163] Letter No.01-08-03/1848 dated 27.05.2019 from the YNAO Branch Office of FPFI "Federal Cadastral Chamber of the Federal Agency for State Registration, Cadastre and Cartography".

- Oleg khebidya-ya ('Oleg's sacred site'), No.11 - A hummock in at the upper reaches of Parejlakyakha River, not far from one of its left-side tributaries. Distance to the linear facilities of the Salmanovskoye (Utrenneye) OGCF Facilities Setup is 100 m.

Positions of the CHS and sacred sites are shown in the schematic maps (Figures 9.6.6 and 9.6.7).

Figure 9.6.5: Sacred worship site of Nenets Tadibe-ya seda

(Photo by PurGeoCom LLC, 2015)

Sensitivity of landscapes in the territory of the Salmanovskoye (Utrenneye) OGCF is medium, as they still persist as arena for customary land use practices of indigenous small-numbered peoples of the North.

Assessment of the landscape impact should take into account that, besides the landscape exposed to technogenic modification, receptors of the impact will also include the users of its valuable resources (ecosystem services) and aesthetic properties, particularly local communities and other stakeholders.

Information on the main receptors, their location and sensitivity is provided in Table 9.6.1. The receptors' identification is based on field survey materials, and analysis of map documents and satellite images.

Table 9.6.1: Classification of existing receptors

Receptors	Receptor location	Receptor Sensitivity
Local communities		
Indigenous small-numbered peoples of the North engaged with customary economic activities, their attention is focused on surrounding landscape.	Project area	High
Crews and passengers of vessels navigating in the Ob Estuary		
Landscape is important, but attention of the receptors is to a large extent aligned with the navigation route.	Ob Estuary	Low
Personnel		
Personnel present in the Project area during construction, operation and decommissioning. Attention of personnel is focused on their professional activity, therefore, this receptor is weakly susceptible to changes in the landscape.	Project area	Low

9.6.2 *Landscape Impact Assessment*

Key impacts on natural habitats in the area of the Plant and associated facilities with the highest visibility potential will be:

- Construction of the Project facilities (berth, LNG plants) on the shore of the Ob Estuary;

- Development of a significant area in the coastal laida and first marine terrace with a cluster of buildings and installations that will look dissonant against the tundra landscape of the Gydan Peninsula;
- Development of the Salmanovskoye (Utrenneye) OGCF facilities (CGTP, well pads other areal and linear facilities) in the tundra landscape of the Gydan Peninsula;
- Local land clearing of vegetation in the site areas, and disturbance of vegetation at the boundaries of the sites;
- Increased area illumination due to the use of lighting fixtures on permanent structures and vehicles.

In the structure of local stows, areas exposed to greatest losses due to the Project implementation are laida and surface of marine terraces: within the boundaries of the Project sites, protective and fire break belts they will be completely displaced with buildings, pavings and secondary associations (in the reclaimed and landscaped areas). The disturbed stows are not unique and do not bear any aesthetic elements typical exactly for the local landscape, which is why their partial loss within the development boundaries will not cause any significant damage to the landscape and ecosystem resources of the Gydan Peninsula.

Changes induced by the planned activity can be partially or entirely assimilated by the general scene of local landscape, and will cause its heavy transformations during the whole period of construction, operation, decommissioning and liquidation of the designed buildings and installations.

The Project sites are located in the areas with natural landscapes that have not been exposed to anthropogenic impacts. The planned developments will introduce new technogenic elements into virgin landscape. The Arctic LNG 2 Project and associated facilities will not match the existing model of land use in the area. Stemming from the above, the Consultant considers visual landscape impacts from the planned activity to be adverse and their local intensity – medium.

In this context, adaptive capacity of the landscape in relation to visual impacts of the planned activity is low/medium: any building or installation, or a large vehicle will be immediately visible against the existing background of tundra landscape on the Gydan Peninsula.

The visibility zones have been assessed using GIS ArcGIS Pro 2.5. The input data was sourced from digital model of terrain in ArcticDEM (ver.7) with 2 m spatial resolution, pre-processed with the Fill tool; spot layer of the construction and operation phase facilities, with pre-defined elevations of the equipment; input linear and spot facilities related to activities of receptors - migration routes of Nenets reindeer herders, motor roads used by personnel, TAC, approach sea channel, etc. The visibility zones were mapped using the Mutual Visibility 2 tool, and vertical shift was set for the permanent and temporary facilities in accordance with height of structure. Atmospheric refraction index is 0.13. Maximum visibility range of marine vessels navigating through the channel is defined by the sighting height of “Taimyr” and “Vaigach” icebreakers (about 45 m) operating in the Ob Estuary. Data used in the analysis describe clear weather daylight conditions. Also, it should be noted that tundra vegetation in the Project area will not obstruct visibility of the Project facilities.

Landscape changes will occur within the Project sites and their adjacent and systematically related areas. In the settings of relatively dissected terrain and tundra vegetation, such changes will be visible to receptors in most scenery spots and routes (Figures 9.6.6 and 9.6.7) at a significant distance. At dark time, the construction sites and field facilities will visually dominate and be visible in the landscape due to light pollution by the artificial lighting and vertical flares. A map of visibility zones was compiled for assessment of the Project impact on visual attractiveness of the landscape (Figures 9.6.6 and 9.6.7).

This Section provides an integral assessment of each type of impact for all phases of the Project.

9.6.2.1 Construction

Site preparation and construction activities (excavation and filling) will directly disturb the original terrain, soils and vegetation, resulting in overall modification of the landscape including its visual characteristics. At this stage, the most significant impact on landscapes is expected in relation to the following activities/facilities:

- Clearing of sites for construction of various facilities, stripping of soil and vegetation, levelling, filling;
- Development of areal facilities (elements of the Arctic LNG 2 Plant), well pads, and linear facilities;
- Development of quarries for production of building materials;
- Vehicles traffic;

- Drilling of wells;
- Artificial lighting of construction sites.

Impact on natural landscapes

Earthworks during preparation and construction will directly affect all landscape components - from relief to vegetation. Clearing will result in complete destruction of soil and vegetation cover, levelling and filling of bases for construction of areal and linear facilities will destroy the existing relief features and create new ones, and entail disturbance of runoff conditions and changes in ground water levels. Water erosion of unreinforced bases may cause pollution of adjacent areas with mineral ground material.

Indirect impacts of filled banks will include disturbance of water regime, and consequential waterlogging or draining of territories, which will result in succession of plant formations, depending on the host landscape (this opinion is supported by the results of LEM 2018-2019). In particular, blocking of surface runoff with filled soil and banks results in increased ground water levels and accelerated waterlogging of natural habitats, with consequential succession of plant community and development of technogenic waterlogged landscapes. Earthworks in the transit slope landscapes may activate negative exogenous processes, such as caving, landslide, solifluction, erosion, and ultimate modification of the landscape configuration.

It is also possible that snow accumulation and temperature conditions in soils will change entailing modification of surface runoff and groundwater flows.

Therefore, earthworks will induce fundamental changes in the natural landscapes that will loose their ecosystem value and aesthetic properties, and development of technogenic landscapes. Landscape impact of this factor is assessed as **local, long-term, high-intensity.**

During the construction, impact with the largest spatial extent will affect landscapes on the marine terraces within the Salmanovskoye (Utrenneye) OGCF. The direct impact is expected only within the Project sites, however, DEGP&HP, if activated, may extend to the adjacent landscape complexes. The highest concentration of the impact is expected in the landscapes of laida and first marine terrace that will accommodate the main areal facilities and be exposed to most extensive construction activity of the Project.

Visual impact

Most significant modification of visual properties of the landscapes is expected within the Project area, however, indirect impact, as well as impact on visual perception of landscapes will also affect receptors (elements of natural and social environment) located outside the Project area and outside the territory of the Salmanovskiy (Utrenniy) LA. The visibility zones map for the Project construction phase is shown in Figure 9.6.6.

The Project construction activity will include deployment of building machinery, installation of areal and linear facilities. The visual impacts are expected during the whole period of construction, until construction equipment and temporary facilities are dismantled following completion of the construction works. This impact on aesthetic properties of the landscapes is assessed as **local, medium-term, and high-intensity.**

In clear weather, facilities under construction will be visible from 38,5%of the OGCF territory. They will be clearly visible from the ISPN migration routes on watershed surfaces in central part of the Salmanovskoye (Utrenneye) OGCF. Facilities under construction will be directly visible from 8 out of 12 sacred sites within the field territory, i.e. visual properties of the landscapes will be affected. Spatial extent of visual impact on landscapes will slightly surpass the boundaries of the Salmanovskoye (Utrenneye) OGCF. The littoral part of the field, particularly the well pads located north of the onshore facilities, will be clearly visible from the Ob Estuary water area. The field facilities will be also clearly visible from the field roads and TAC. The main visual dominant element will be the Liebherr crane (152 m in height) in the Port. In dull weather conditions with limited visibility, the visual impact on landscapes will be lower.

During the construction period, visual characteristics of the landscapes may be affected by dust pollution from extensive traffic of motor vehicles and machinery in dry weather conditions. This impact is assessed as **local, short-term, low-intensity.**

Construction activity is accompanied by artificial lighting of construction sites and machinery during dark periods, which will affect illumination conditions in the adjacent territories as far as 10-15 km. This impact is assessed as **local, short-term, low-intensity.**

In terms of visual perception, natural landscapes in marine terraces (the region's most typical landscape) are moderately sensitive to the impact. Also, it should be noted that some auxiliary field facilities are already operating in the territory of the Salmanovskoye (Utrenneye) OGCF. Therefore, visual landscape impact of the Project extension at the construction phase can be considered as **local, long-term, medium intensity**.

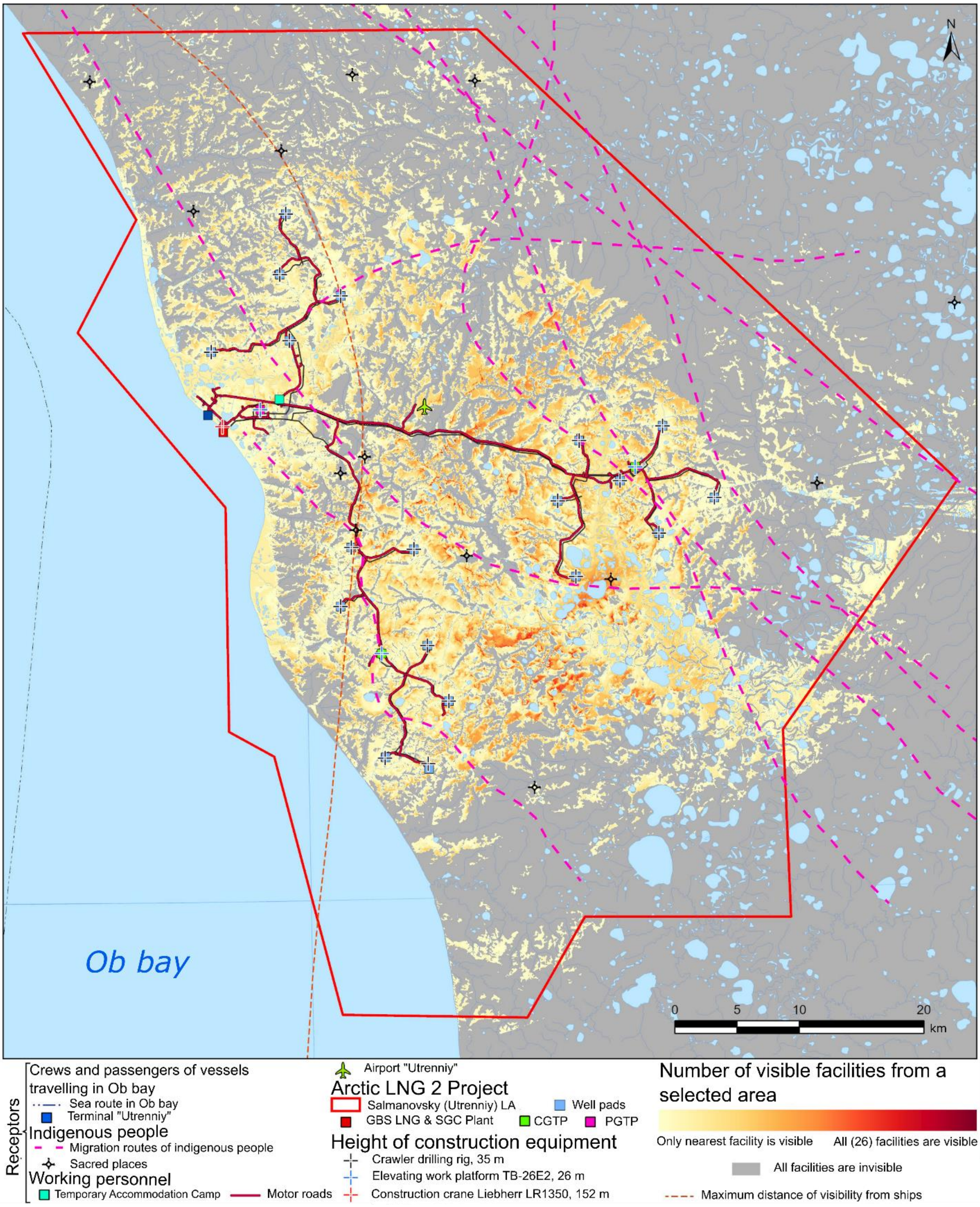

Figure 9.6.6: Schematic map of the Project facilities visibility during construction

9.6.2.2 Operation

Impact on natural landscapes

At the operation phase, the main sources on landscape impacts will include facilities of the Arctic LNG 2 Project, onshore facilities, and the Port, as well as facilities at the Salmanovskoye (Utrenneye) OGCF, well pads and CGTPs that will be visually dominating elements in the territory of the Salmanovskoye (Utrenneye) OGCF, and will produce significant direct and indirect impact on the landscapes. Linear facilities, such as motor roads and pipelines, will be significant sources of impacts, particularly due to the activation of exogenous processes including underflooding and waterlogging. In certain situations, degradation of permafrost may result in technogenic activation of congeliturbation processes.

The LNG Plant facilities on the shore of the Ob Estuary will be a dominating feature in the laked marine laida. Due to its large area, it will produce significant direct and indirect impacts on surrounding landscapes, with increasing extent in the course of operation. Besides the immediate effects on the terrain, the concerned facilities will also influence local hydrographic network (underflooding), as well as succession of plant communities and modification of landscapes near the linear facilities and sites.

In terms of degradation of landscape value and its visual perception, the impact of the Arctic LNG 2 project can be assessed as **local, permanent, medium intensity**.

Visual impact

In clear weather, the facilities will be visible from 38%of the OGCF territory. They will be clearly visible from the ISPN migration routes on watershed surfaces in central part of the Salmanovskoye (Utrenneye) OGCF. The field facilities will be directly visible from 5 out of 12 sacred sites within the field territory, i.e. visual properties of the landscapes will be affected. The littoral part of the field, particularly the well pads located north of the onshore facilities, will be clearly visible from the Ob Estuary water area. The field facilities will be also clearly visible from the field roads and TAC. The main visual dominant element will be high pressure flares of CTTP (85 m in height), and high pressure flare and telecom tower at the LNG Plant (140 m and 55 m, respectively). In dull weather conditions with limited visibility the visual impact on landscapes will be lower.

Another factor of visual impact will appear in relation to the significant sources of lighting during dark time at the Arctic LNG 2 Project facilities and other field infrastructure. The vertical flare units will also be visual dominants, due to their height (up to 140 m). On the other hand, the Project provides for gas burning in vertical flares only in emergency situations. The vertical flares will not be used during normal operation. Impact of this factor of this factor is assessed as **local, long-term, low-intensity.**

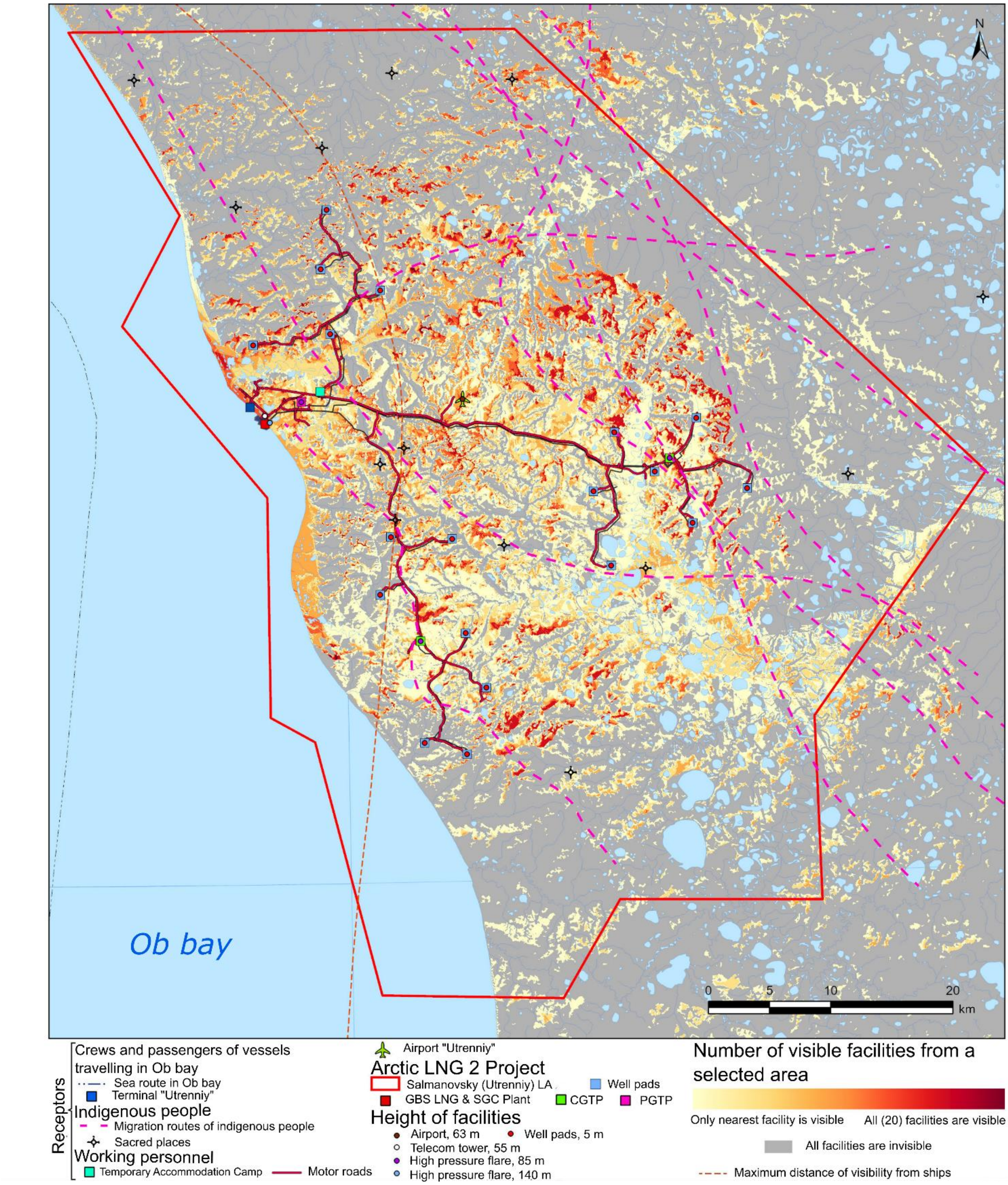

Figure 9.6.7: Schematic map of the Project facilities visibility during operation

9.6.3 Mitigation

Based on the above assessment of the landscape sensitivity and extent of its changes, the impact magnitude (refer to Chapter 3) is assessed as moderate.

To minimise the negative impact on the landscape, it is recommended to adopt the following measures during the Project construction and operation:

- Keep the earthworks strictly within the site boundaries;
- Design of roads and other linear facilities shall allow for construction of culverts, to avoid technogenic waterlogging;
- Ensure prompt reclamation of areas acquired for short term and disturbed by the construction activity;
- Prohibit off-road traffic of machinery;
- Dismantle building equipment and machinery at the end of construction;
- Adopt measures to control pollution with dust, including watering of technical roads and reinforcement of slopes of filled banks during dry periods;
- In order to minimise fire risks at all phases of the Project, strictly follow fire safety rules;
- Ensure continuous control of landscaping of the territory of the Project facilities throughout the operation period;
- Minimise flaring of gas;
- During the period of construction and operation, keep artificial lighting during dark time to the necessary minimum for safety reasons, including the use of motion sensors in outdoor lighting systems;
- Select pitch and location of lighting units to minimise spillage of light outside the territory of the license area;
- At the decommissioning stage, dismantle buildings and installations and remove equipment from the site territory;
- Arrange for landscape and vegetation monitoring with a network of permanent sites, also after the end of the Enterprise service life, to assess efficiency of reclamation activities.

It is expected that reclamation after the Project facilities decommissioning will have a positive effect on landscapes modified by the Project, with lost functions and aesthetic value.

9.6.4 Summary

Summary of the landscape impacts and mitigation measures at all phases of the Project is provided in Table 9.6.2.

Table 9.6.2: Summary of landscape and visual impacts, and mitigation measures

Impact	Receptor	Phase	Design solutions and mitigation	Residual impact
Modification/loss of resource and landscape-stabilising function	**Landscapes in the Salmanovskoye (Utrenneye) OGCF**	**Construction**	• Keep the earthworks strictly within the site boundaries; • Design of roads and other linear facilities shall allow for construction of culverts, to avoid technogenic waterlogging; • Ensure prompt reclamation of areas acquired for short term and disturbed by the construction activity; • Prohibit off-road traffic of machinery; • Dismantle building equipment and machinery at the end of construction; • Adopt measures to control pollution with dust, including reinforcement of slopes of filled banks during dry periods	**Negligible**
	Landscapes in the Salmanovskoye (Utrenneye) OGCF	**Operation**	• Prohibit off-road traffic of machinery; • In order to minimise fire risks at all phases of the Project, strictly follow fire safety rules; • Ensure continuous control of landscaping of the territory of the new Enterprise throughout the operation period; • Arrange for landscape and vegetation monitoring with a network of permanent sites, also after the end of the Project facilities service life, to assess efficiency of reclamation activities	**Negligible**
Degradation of the landscape visual properties	**Permanent population of the Gydan Peninsula; Vessel crews, Rotation shift personnel of construction contractors**	**Construction**	• Ensure prompt reclamation of areas acquired for short term and disturbed by the construction activity; • Dismantle building equipment and machinery at the end of construction; • Adopt measures to control pollution with dust, including reinforcement of slopes of filled banks during dry periods; • During the period of construction, keep artificial lighting during dark time to the necessary minimum for safety reasons, including the use of motion sensors in outdoor lighting systems; • Minimise flaring of gas	**Negligible**
	Permanent population of the Gydan Peninsula; Vessel crews, Rotation shift personnel of construction contractors	**Operation**	• Ensure continuous control of landscaping of the territory of the Project Facilitiees throughout the operation period; • During the period of construction and operation, keep artificial lighting during dark time to the necessary minimum for safety reasons, including the use of motion sensors in outdoor lighting systems; • Select pitch and location of lighting units to minimise spillage of light outside the territory of the license area; • Minimise flaring of gas; • At the decommissioning stage, dismantle buildings and installations and remove equipment from the site	**Negligible**

9.7 Industrial and Domestic Waste Management

9.7.1 Introduction

Domestic and industrial waste management at NOVATEK and its subsidiaries is based on the principle of minimization of environmental impacts through reduction of waste generation volumes and weight, recycling of certain categories of waste, and keeping landfill disposal to the minimum.

Waste shall be collected, stored, utilized and disposed in line with the environmental standards, occupational health and fire safety rules in order to avoid accidents, fires, environmental damage and harm to human health. For this purpose, adequate facilities should be provided at the work sites for segregate collection and storage of various types of waste, including dedicated collection sites, metal containers, sealed tanks, etc.

All waste management procedures shall meet both Russian regulatory requirements and IFC standards for waste management. In particular, design solutions should be focused on prevention of waste generation as far as possible, and if this is not possible - on recycling, treatment, utilization. Landfilling may be accepted only as a last resort.

Construction and operation of the Project “Arctic LNG 2” and associated facilities will result in generation of significant quantities of various wastes. This assessment covers the impact of the following facilities:

- Salmanovskoye (Utrenneye) OGCF Facilities Setup including the solid municipal, construction and industrial waste disposal site;
- 19 well pads with producing wells at the Salmanovskoye (Utrenneye) OGCF;
- Three process trains of the GBS Plant for production, storage and offloading of LNG & SGC and onshore general purpose facilities;
- Utrenniy Terminal (including associated federal property facilities and marine operations financed from the RF state budget) and its associated facilities, including harbour vessels;
- Utrenniy Airport (associated facility of the Project).

The Project area has not been used for any industrial operations before, therefore, the issues of managing historically generated waste are not considered within the scope of this assessment.

In absence of adequate precautions, the waste management processes may cause negative impact on flora and fauna, soils, ground and surface water, and also on human health. This Chapter covers the assessment of waste generation and management methods to be applied to reduce the negative impact down to acceptable level at various sites of the Project including associated facilities.

The wastes that will be generated at the sites of the planned activities at the construction and operation phases are characterized by their volumes and hazard class. The types of waste are classified in accordance with the Federal Waste Classification Catalogue (FWCC)[164]. The five hazard classes which are adopted for the FWCC classification are slightly different from the classes used in other countries, e.g. in the European Union, where wastes are commonly divided into three groups: hazardous, non-hazardous or inert[165]. Brief characteristic of hazard classes used within the FWCC versus extended typical international classification is given in Table 9.7.1.

Table 9.7.1: Waste classification applied by the FWCC

<table>
<tr><th>Hazard class used in the RF</th><th>Definition of hazard used in the RF</th><th>Examples of waste</th><th>Equivalent as per typical international classification</th></tr>
<tr><td>I</td><td>Extreme hazard</td><td>Fluorescent lamps containing mercury, activated carbon contaminated with mercury sulphide.</td><td rowspan="2">Hazardous</td></tr>
<tr><td>II</td><td>High hazard</td><td>Concentrated acids, alkalis, halogenated solvents, lead-acid batteries, dry batteries, etc.</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Moderate hazard</td><td rowspan="2">Waste oils, oily sludge, oily rags, used oil filters, non-halogenated solvents, paint waste, etc.</td><td>Hazardous</td></tr>
<tr><td>Non-hazardous</td></tr>
</table>

[164] Rosprirodnadzor Order of 22.05.2017 No.24

[165] Definition of inert waste used in the EU is extremely rigid and rules out any reactive waste, including waste ferrous materials, wood, etc. Thus, in accordance with the EU definition, very small quantity of waste produced during construction works under the Project can be classified as inert.

Hazard class used in the RF	Definition of hazard used in the RF	Examples of waste	Equivalent as per typical international classification
IV	Low hazard	Municipal waste, non-ferrous metals, certain chemicals, certain construction waste, wastewater treatment sludge, treated medical waste, water based drilling fluids, etc.	
V	Practically non-hazardous	Inert waste: plastics, ferrous metal, inert construction waste, food waste, brushwood, non-treated wood waste.	

The project design documentation provides estimation of waste generation volumes, based on the technological processes and processes that make finished articles unfit for further use, as well as specification of adequate methods and approaches for handling, transportation, temporary accumulation, treatment, recycling and disposal of wastes compliant with the applicable best practice.

The Project waste management flowchart to be implemented to prevent pollution of the environment is shown in Figure 9.7.1.

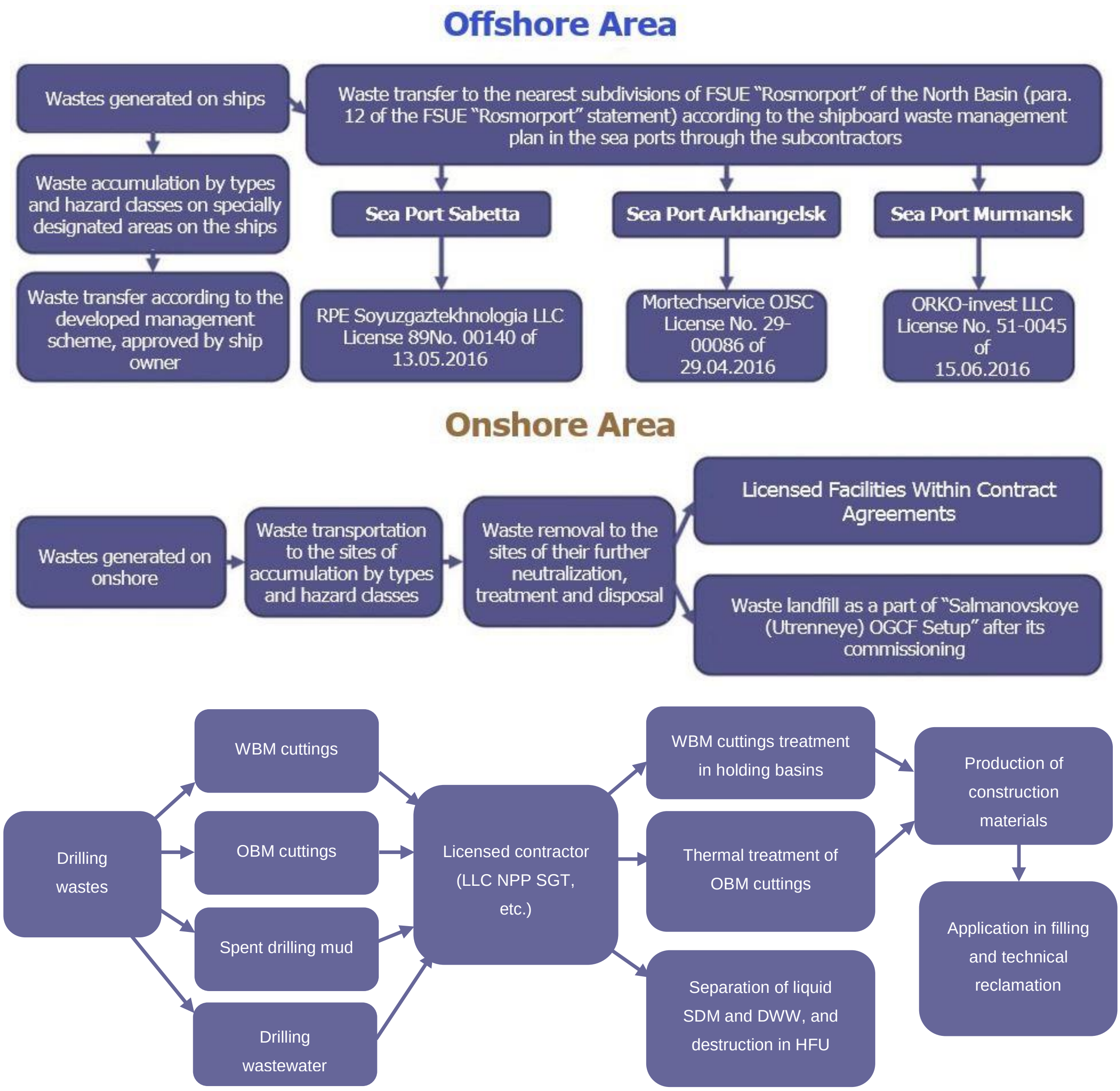

Figure 9.7.1: Waste management flowchart for construction and operation of the Project and associated facilities

Overview on the designed solid municipal, construction and industrial waste disposal site is included in Section 9.7.2. Specific details of the waste generation volumes and handling methods for each Project facility (including associated facilities) at the construction and operation stages of the Project are provided in Sections 9.7.3 and 9.7.4. Assessment of the impact from the Project's waste management is provided in Section 9.7.5, and mitigation measures are covered in Section 9.7.6. Conclusions and summary table of the impact assessment are included in Section 9.7.7.

9.7.2 Solid municipal, construction and industrial waste disposal site

Due to the lack of waste disposal facilities in the Project area, a new own solid municipal, construction and industrial waste disposal site will be developed as part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup. Solid municipal, construction and industrial waste disposal site (SMCIW DS) is intended for centralized collection, thermal treatment (incineration) and disposal of industrial and domestic wastes of hazard classes III-V generated during construction and operation of the Salmanovskoye (Utrenneye) OGCF Facilities Setup, Utrenniy Terminal, the GBS LNG & SGC Plant, Utrenniy Airport and also immediately from the operations of the SMCIW DS.

The SMCIW DS is included in the scope of Phase 2 of the Field facilities to be developed during 2020-2021 at a site located south of Power Supply Complex No.2 and PGTP No.3. Before the disposal site is commissioned, construction wastes generated by the works will be collected at dedicated equipped sites within the allocated areas, in particular, at the sorting facility within the boundaries of the designed SMCIW DS. The RF regulation allows a maximum 11 months period for accumulation of waste at dedicated equipped sites before it must be transferred for further treatment, recycling or disposal. During this period, wastes will be transferred to specialized licensed providers of waste management services, and will be removed from the Project area for neutralisation, treatment, recycling and disposal.

The following operations will be conducted at the waste disposal site:

- Reception, disposal, isolation and burial of construction and industrial wastes of hazard classes IV and V;
- Pre-treatment (crushing) of bulky wastes and compaction of packaging;
- Temporary storage (accumulation) till generation of the shippable quantity of wastes prohibited for acceptance at the waste disposal site, and valuable recyclables;
- Thermal neutralization and in the thermal treatment system (TTS) of industrial wastes of hazard class III-IV (including oily), municipal solid wastes of hazard class IV-V, and liquid wastes of hazard class III-IV.

The following facilities will be provided at the waste disposal site for the above purposes:

- Unit KTO-1000.3.V for thermal treatment of waste, comprising two process lines;
- Industrial shredder for crushing of bulky wastes;
- Vertical press for drum vessels;
- Vertical press for paper and film;
- Press for metal scrap.

The waste disposal site service life is 25 years. The waste disposal site design capacity is 161,400 tons of wastes, including

- 63,200 tons to burial,
- 96,000 tons to thermal treatment, and
- 2,170 tons to accumulation (temporary storage).

A part of the waste disposal site will be occupied by the operations area comprising the following facilities that correspond to the adopted methods of waste management:

- Waste storage zone;
- Waste preparation zone;
- Waste incineration zone;
- Waste accumulation (temporary storage) zone.

Most of the disposal site area will be occupied by the landfilling zone comprising:

- 8 equipped cells for disposal of wastes of hazard classes IV and V; and
- Isolating soil site.

The methods of waste treatment are selected to keep the amount of wastes disposed at the landfill cells to a minimum. Waste prohibited for landfill disposal shall be accumulated at the waste disposal site before transfer to third parties for treatment/recycling outside the Project area. Thermal treatment is provided to minimize the volume of waste to be disposed of.

Considering the adopted methods of waste management, and in the prospect of cost optimization, the waste streams will be source-segregated. The waste trucks and special vehicles will collect waste from the generation and collection sites at all project facilities.

Design of the waste disposal facilities provides for application of the best available technologies (BAT ITS 17-2016 Disposal of Industrial and Domestic Wastes):

- Provision of isolating membranes. The main structural element of waste disposal sites that performs the environmental protection function - protection of soils, ground and surface water from polluted industrial leachate are impermeable membranes at the bottom and sides (slopes) of landfill sections. The design provides for artificial impermeable lining of geo-synthetic isolating materials on a leveling sand blanket;
- Incoming inspection system at the waste disposal site including radiation and mercury surveillance of wastes delivered by waste trucks, and industrial wastes arriving in dump trucks and hopper trucks. Wheels of vehicles leaving the waste disposal site will be disinfected to prevent pollution of adjacent territories;
- Technical and biological preservation and reclamation at the end of landfill service life, for ultimate isolation of wastes from the environment.

Solid construction and industrial wastes of hazard class III-V, including oily wastes, as well as municipal solid wastes of hazard classes IV and V will be thermally treated in the thermal treatment system (TTS) KTO-1000.3.V meeting the requirements of BAT ITS 9-2015 Thermal waste treatment (waste incineration). The furnace is designed to ensure the required treatment capacity, mixing of generated gas with oxygen, and maintaining temperature at a level high enough for complete thermal neutralisation of wastes.

The waste disposal site design provides for a sufficient set of measures to reduce the impact of temporary storage, treatment and disposal of waste at the site, including application of the best available technologies.

Based on the review of the SMCIW DS design documentation and the technical characteristics of the thermal treatment facility (KTO-1000.3.V) for compliance with the World Bank Group EHS Guidelines for Waste Management Facilities[166], it can be concluded that the SMCIW DS and the incinerator meet most of the requirements, including measures to reduce the impact of transportation, tipping and shredding of waste, measures to collect and treat leachate, to reduce air emissions of pollutants, to ensure fire prevention and safe working conditions and health of personnel, etc. A nonconformity was identified in terms of monitoring the negative impact of landfill activities, namely, that quantitative and qualitative measurements of leachate are not included in the Industrial Environmental Monitoring Program for the operational stage; monitoring of leachate volumes is based only on calculations. To ensure full compliance with the requirements of the World Bank Group Guidelines, it is needed to measure and record the amount and chemical composition of the resulting filtrate as part of industrial environmental monitoring. Changes in the volume or composition of the filtrate that are not related to weather conditions or other external factors may indicate on changes in the insulation, filtrate collection system, or landfill shelter.

The project does not provide for the construction of its own treatment facilities for storm water treatment at the landfill. At the same time, the runoff collected from the landfill will be transported by special vehicles to the treatment facilities (CPS-3) and after cleaning it will be discharged into the surface reservoir, which minimizes the impact of potentially contaminated stormwater on the environment. This solution is an adequate alternative to building their own WWTP at the site given the climatic conditions of the area of the project, characterizing low annual rainfall and extremely uneven temporal distribution of surface runoff (up to 90% of runoff occurs during snowmelt in May-June). Under the existing conditions, compliance with the requirements of the EHS Guidelines for the reuse of treated stormwater runoff when placing waste in a landfill, for example, for dust suppression, is not technically, environmentally and economically feasible and, among other things, may lead to a violation of the water balance, so the treated wastewater should be returned to surface water bodies in the maximum possible volume.

Waste streams from major components of the Project have been examined, in order to confirm that capacity of the designed waste disposal facilities is sufficient for disposal of all wastes from the Project and associated facilities.

Table 9.7.2: Waste disposal at the solid municipal, construction and industrial waste disposal site[167]

Facility	Waste disposal		
	Construction, tons/period	Operation (25 years), tons/period	Total, tons
GBS LNG & SGC Plant	1435.475	1832.357	3267.832
Salmanovskoye (Utrenneye) OGCF Facilities Setup	5769.538	21245.1	27014.638
Utrenniy Terminal	2194.221	34.0	2228.221
SMCIW DS	49.174	29932.43	29981.604
Utrenniy Airport	334.01	13.705	347.715
TOTAL			**62840.01**

According to the design documentation for the Project facilities: Salmanovskoye (Utrenneye) OGCF Facilities Setup, GBS LNG&SGC Plant, Utrenniy Terminal, SMCIW DS and the Utrenniy Airport which is the associated facility with the design documentation providing for incineration and disposal of some kinds of wastes at the SMCIW DS (as one of the disposal options), the total quantity of wastes to be disposed (buried) at the waste disposal site during the construction and operation phases is estimated at 62,840 tons, which does not exceed the design waste disposal capacity of the SMCIW DS (63,200 tons).

It should be noted that design documentation for the Project permanent facilities specifies the largest possible generation of wastes, whereas actual quantity of wastes can be significantly smaller. Therefore, a phased approach to development of waste disposal capacities is advisable and is effectively adopted in the SMCIW DS design. New waste treatment and disposal facilities can be designed and implemented at the site as appropriate, and also wastes from the license area can be transferred to remote facilities for treatment, recycling and disposal.

9.7.3 Waste Management during Construction

9.7.3.1 Salmanovskoye (Utrenneye) OGCF Facilities Setup

The Salmanovskoye (Utrenneye) OGCF Facilities Setup will be implemented as a phased process, with gradual commissioning of components. The facilities will be developed in three areas - “domes”: Northern, Central and Southern, to be commissioned at different times. The construction activities will follow a technical process flowchart that specifies the sequence of implementation of different main, auxiliary and supporting components, water supply, utility systems and wastewater treatment facilities, power supply system, etc., which is also reflected in the implementation calendar plan. The total period of construction of the complete system of facilities and structures is 105.5 months. The maximum number of construction workforce for the Salmanovskoye (Utrenneye) OGCF Facilities Setup is 2046.

The Field facilities construction activities will generate a significant quantity of construction wastes and a smaller quantity of wastes of consumption including waste POL materials, wastes from maintenance of machinery and vehicles, mobile power generation units and compressors (filters, tires, accumulator batteries), mercury and LED lamps, oily rags, ferrous and non-ferrous scrap, waste PE and other packaging materials, food wastes, water treatment wastes, as well as solid and liquid municipal wastes.

The total of 23,227.920 tons of wastes of 56 different types and hazard classes I-V will be generated during construction of the Salmanovskoye (Utrenneye) OGCF Facilities Setup (years 2020-2026), more specifically:

- Hazard class I – 1 type, 11.983 tons/period;
- Hazard class II – 1 type, 20.731 tons/period;
- Hazard class III – 13 types, 461.728 tons/period;

[167] 120.ЮР.2017-2020-02-ИОС7.3.19.1 Обустройство Салмановского (Утреннего) нефтегазоконденсатного месторождения. Проектная документация. Раздел 5

- Hazard class IV – 23 types, 9614.955 tons/period;
- Hazard class V – 18 types Waste, 13,118.523 tons/period.

During the site preparation, all excavated soil will be used in construction - for filling of banks and in the landfill isolation layer. Therefore, this material is not considered as waste in the design documentation.

The civil and installation works will generate a typical range of construction wastes: waste cement and asbestos cement, broken concrete and RC articles; broken asphalt paving; ferrous and non-ferrous scrap; debris from construction and repair activity; packaging waste; waste rockwool, insulated wires and cables, roofing felt and bitumen, welding wastes. A crushing unit for broken concrete and RC articles will be installed at the field camp site of the Northern dome. Crushed concrete will be utilised for reinforcement of roadside slopes. Construction contractors will collect wastes generated during construction activity at dedicated outdoor sites in the work areas designated for temporary storage of building wastes and MSW. Later on the wastes will be transferred to licensed waste management contractors, or transported for treatment and disposal to the project-owned SMCIW DS.

Domestic solid waste from personnel activities (including food waste, oily rags, etc.) will be collected and stored at dedicated sites in compliance with SanPiN 42-128-4690-88 "Sanitary rules for the maintenance of territories of settlements" and subsequently transferred to the Landfill for temporary storage and neutralization (hazard class IV, V and (partially) III), and for disposal at the Landfill (hazard class IV, V).

Liquid waste from accommodation premises at the well sites will be collected and stored in tanks at dedicated sites with secondary containment bunds, and regularly transported to the CGTP STF at the Salmanovskoye (Utrenneye) OGCF by specialised contractor to be appointed at a later stage. Wastes from the wastewater treatment processes at CGTP STF, and from maintenance of the water recycling systems of the wheel-washing units at the construction sites, will be collected in metal containers on hard-paved outdoor sites, or indoors, and transferred to the SMCIW DS for thermal treatment.

Wastes of hazard classes I, II and (partially) III, as well as recyclable wastes, which are not subject to treatment and landfilling at the waste disposal site, will be accumulated at the waste collection site till generation of shippable quantity (but not longer than 11 months) before further transfer to specialized contractors for recycling, treatment and disposal.

TyumenVtorSyr'yo LLC (TVS) has been appointed for the year 2020 as an operator of all solid waste management services for the Project with the main operations base at the sorting facility at SMCIW DS site. TVS holds License No. (72) – 4724 – STOB/P dated 07.06.2019 for collection, transportation, treatment, recycling, neutralisation and disposal of wastes of hazard classes I-V. The TVS's scope of responsibility will also include transportation by sea of the wastes that are not subject to thermal treatment, and must be removed from the territory of the Salmanovskoye (Utrenneye) OGCF. TVS will subcontract other waste management service providers outside the Project area (refer to Annex 4)).

Waste streams during the construction of the Field facilities (years 2020-2026) can be described as follows:

- Wastes of hazard classes III-V to be treated at the Company's facilities – 7802.082 tons/period (34%);
- Disposal at the project-owned SMCIW DS – 1134.232 tons/period (5%);
- Transfer to specialised contractors for treatment and disposal (recycling) – 4727.733 tons/period (20%);
- Disposal at a specialised contractor's landfill (during the construction of SMCIW DS) – 238.443 tons/period (1%);
- Utilization at local sites – 9325.430 tons/period (40%).

The main types of waste that will be generated before the first phase facilities of the waste disposal site are put into operation are waste from life activities of personnel and from construction of the early development facilities. Considering the prohibition of accumulation and storage of wastes from human life activities, in particular food wastes, such wastes must be removed from temporary facilities and transferred to specialized contractors for removal and disposal at licensed waste disposal facilities outside the Project area. According to SanPiN 42-128-4690-88 "Sanitary rules for the maintenance of territories of settlements", the maximum permitted duration of food wastes storage is three days during cold season (at a temperature of minus 5°C and lower) and one day during warm season (at a temperature higher than +5°C), to avoid degradation of the material. A dedicated site is provided at the sorting facility of the designed SMCIW DS for temporary accumulation of construction wastes during a maximum period of 11 months before transportation to remote sites for recycling/disposal.

9.7.3.2 Well Pads

The total of 19 well pads with producing wells will be developed for the Project. The producing wells will be drilled and tested during the period 2020-2026.

The designed activities will generate 13 types of wastes of hazard classes I, III, IV and V. The main industrial waste from drilling of producing wells at the well pads are «drilling wastes resulting from production of crude oil, natural (associated) gas, and gas condensate» (FCCW code 2 91 100 00 00 0)[168], referred to hazard class IV, including:

- Cuttings from drilling of wells for production of crude oil, natural gas and gas condensate, using water-based clay drilling mud (WBM);
- Cuttings from drilling of wells for production of crude oil, natural gas and gas condensate, using oil-based clay drilling mud (OBM);
- Spent oil-based and water-based drilling mud (SDM) from drilling of gas and gas condensate wells, low-hazard waste;
- Drilling wastewater (DWW) from drilling for production of natural gas and gas condensate, low-hazard waste.

In the course of sequential drilling of producing wells at the well pads, these wastes will be collected in impermeable holding basins. Following natural precipitation and assisted separation through a coagulation/flocculation process, liquid drilling wastes are eliminated in HFU. Solid fraction of drilling wastes in the holding basin will be utilized for production of construction materials using a process technology approved by the State Ecological Expert Review Board. The product can be used for ground filling, paving of industrial roads, or as a soil material for reclamation of land, depleted quarries, liquidation of mud pits and temporary sludge basins. Detailed description of the process technology that will be applied for treatment and disposal of drilling wastes is provided in Chapter 5 of this Report. Emergency situations related to management of drilling wastes are covered in Section 9.8.

Drilling activities at seventeen well pads will generate cuttings in the following quantities:

- From WBM – 73,945 tons;
- From OBM – 61,425 tons.

Cuttings volume from WP No.2 and WP No.16:

- From WBM – 21.103 m^3;
- From OBM – 6.603 m^3.

Solid fraction of wastes from drilling with WBM that will be collected in the drilling wastes basin, can be utilised for production of building material using any technological process, i.e. the choice is not limited by the technologies mentioned in the design documentation. At the end of well drilling and before start of recycling of drilling wastes, physical and chemical properties of the cuttings must be tested by an accredited laboratory, and a Laboratory Testing Report must be issued with conclusions about the cuttings material compliance with the requirements to feedstock for specific technological process. The building material products can be applied as filling material for technical reclamation of drilling waste basins.

OBM cuttings are subject to thermal destruction in mobile modules Fortran (for WPs Nos. 2 and 16) or UPNSh unit (for 17 well pads). The technology will be implemented by specialised contractor NPP SGT LLC.

Neutralisation of drilling cuttings in the thermal treatment units will produce waste described as "ash and slag from incinerators and waste thermal treatment facilities". At WP No. 2 and WP No.16, this material will be stored on site for a maximum period of 11 months, and during the period winter roads availability it will be transported for disposal to the landfill of Poligon-LTD CJSC (KhMAO-Yugra, Surgut Municipal District)[169]. Generation volumes of ash and slag from incinerators and waste thermal treatment facilities:

- Well pad No.16 (row 1): 377 tons;
- Well pad No.16 (row 2): 644 tons;

[168] The Project does not provide for crude oil production. The full name of the group of wastes is given in this report - Drilling wastes resulting from production of crude oil, natural (associated) gas, and gas condensate, FCCW code 2 91 100 00 00 0

[169] 346-1-319/18/П-346-ООС Construction of well pads No.2 and No.16 at the Salmanovskoye (Utrenneye) oil, gas, and condensate field, drilling and testing period (Section 8.3.3)

- Well pad No.2: 1807 tons.

It is proposed that at 18 well pads this waste will be utilized for production of material for technical reclamation of drilling waste basins[170]. In this case, the ash is subject to physical and chemical testing to verify its suitability for utilization as a material for reclamation (particularly, its environmental safety).

Besides drilling wastes, operations at the well pads (site preparation, recycling and neutralisation of drilling wastes, reclamation) will produce other wastes of hazard classes I, III, IV and V, namely:

- Wastes of hazard class I: Mercury lamps, mercury-quartz lamps, fluorescent lamps unfit for further use;
- Wastes of hazard class III: Waste mineral motor oil;
- Wastes of hazard class IV: cleaning material contaminated with oil or petroleum products; sand contaminated with oil or petroleum products; office and domestic waste from organizations' facilities, unsorted; LED light fixtures;
- Wastes of hazard class V: waste polyethylene film and products made from the same; waste polyethylene packaging; food waste.

The total quantity of industrial and domestic wastes produced at the well pads (besides the drilling wastes and ash from incineration of drilling wastes) is 312.21 tons. Most of these wastes (including waste mineral oils, cleaning rags, and food wastes) will be transferred for treatment, and solid municipal wastes will be disposed at the SMCIW DS.

Collection of wastes at the well pads will be arranged with segregation by types and hazard classes. Designs for the site preparation activities, treatment and recycling of drilling wastes, and reclamation provide for arrangement of waste collection facilities as appropriate considering the toxic, physical and chemical properties of their components. Adequate mechanical aids will be provided at the waste collection sites, for loading the wastes on specialised vehicles for transportation to the disposal facilities.

Wastes of hazard classes III and IV shall be collected separately in metal containers, and transferred to specialised contractor for neutralisation. Mercury, mercury-quartz, fluorescent lamps unfit for further use shall be collected in tight containers at the well pad.

Collection of municipal solid wastes is arranged in metal containers, in compliance with SanPiN 42-128-4690-88. Recyclable wastes of hazard class V (waste polyethylene film and products made from the same, uncontaminated waste polypropylene packaging) will be collected in metal container. Food wastes will be collected in tight metal containers installed near the kitchen/canteen. Considering that well pads are industrial sites outside any residential units, waste removal interval of one week is adopted, with transportation by winter road in winter, or by helicopter in summer. At the end of works, containers, toilets and tanks for collection of domestic wastewater will be disinfected with 10% chlorine solution, dismantled and removed from site.

The wastes will be transferred to a specialised contractor appointed as the waste management operator for the Project, for temporary accumulation, neutralisation or disposal at the SMCIW DS being a part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup. In 2020 TVS LLC has been appointed as an operator of solid waste management services with conclusion of a one-year contract; in the future the solid waste operator will be selected on the basis of competitive bidding. Waste transportation will be arranged by the specialised contractor. Wastes of hazard classes I-III, as well as recyclable wastes, which are not subject to treatment and landfilling at the waste disposal site, will be accumulated in dedicated area at the waste disposal site and transferred to specialised contractors for further neutralisation, recycling or disposal outside the Project area (refer to Annex 4).

Before the solid municipal, construction and industrial waste disposal site being a part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup is put into operation, construction wastes will be transferred to specialised licensed operator (TVS LLC) which will engage licensed contractors for transportation, treatment and disposal at the solid construction waste landfill in Novy Urengoy (SRWDF ref. 89-00067-3-00592-250914). Municipal solid wastes will be transferred to the regional MSW operator for YNAO – Innovatsionnyje Tekhnologii LLC, for transportation and disposal at the MSW landfill of the Urengoy municipal service enterprise MUE "Urengoiskoye Gorodskoye Khozyaistvo" (SRWDF ref. 89-00042-3-00592-250914).

[170] 2018-560-НТЦ-ООС1 Construction of 18 well pads at Salmanovskoye (Utrenneye) OGCF, drilling and testing period (Section 3.7.2)

9.7.3.3 GBS LNG & SGC Plant

Construction period of the Plant facilities and structures for production, storage and offloading of liquefied natural gas and stabilised gas condensate is 65 months. After commissioning of Process Train No.1 and the onshore facilities (in QIII 2023), construction phases 2 and 3 will be implemented parallel with operation of the completed production facilities. Planned time for putting into operation of Process Train No.2 is QII 2024, Process Train No.3 - QII 2026. Maximum number of construction workforce for the Plant and onshore facilities is 5345.

Wastes during the period of construction of the onshore facilities and LNG & SGC Plant will consist of waste building materials, domestic wastes from the workforce activities, and from maintenance of equipment. In accordance with the principle of minimising site construction operations, the Plant will be constructed of package modular systems and complete Process Trains manufactured at remote specialised shipyards. This way, generation of construction wastes in the Project area will be prevented to a large extent. Given the absence of tree vegetation on site, no felling residues or stump clearance wastes will be produced.

The total quantity of wastes of hazard classes III-V (22 different types) from preparation of base for installation of the Process Trains and construction of onshore infrastructure of the LNG&SGC Plant is assessed at 8597.34 tons, namely:

- hazard class III – 0.0581 tons during the period of construction;
- hazard class IV – 5430.358 tons during the period of construction;
- hazard class V – 3166.924 tons during the period of construction.

The wastes from civil and installation works will consist of residues of construction materials: waste petroleum bitumen; waste mortar stone; cleaning rags; welding slag; waste rockwool; empty containers from paint; residues of sand and gravel mix; ferrous and non-ferrous scrap; broken concrete products; waste wires and cables; waste finishing materials of polypropylene and polystyrene; waste polyurethane film.

Wastes from personnel life activities will include: waste from cleaning mobile toilets, rubbish from offices and domestic facilities.

Wastes from the construction vehicles and machinery are not included in the estimation of total quantity of wastes at the construction site, as maintenance of these units will be provided elsewhere. All equipment and machinery used in the construction is owned by contractor, therefore, the respective wastes are included in the calculation of waste generation rates of the contractor.

The temporary waste accumulation site to be used during the period of construction will be located downwind in the construction materials storage area. The site will be equipped with 3.6 m^3 standard specialised containers (hoppers) for collection of building wastes. Segregate collection of wastes will be provided considering further disposal routes: neutralisation, recycling or burial.

Liquid domestic wastes will be collected in portable toilets and removed for treatment to CGTP STF within the Salmanovskoye (Utrenneye) OGCF Facilities Setup.

Containers for collection of solid municipal wastes will be installed on concrete slabs in the construction site area. Domestic wastes will be transferred to the regional MSW operator for treatment, recycling and disposal.

The wastes will be transferred to a specialised contractor – TVS LLC appointed as the waste management operator for the Project, for temporary accumulation, neutralisation or disposal at the SMCIW DS being a part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup. TVS LLC will also make agreements with other service providers for transportation, recycling, treatment and disposal of wastes of hazard class I-III and recyclable wastes which are not subject to treatment and landfilling at the project-owned waste disposal site (refer to Annex 4). Responsibility for removal of wastes will rest with contractor conducting construction activity on site.

Waste streams during the construction of the LNG & SGC Plant can be described as follows:

- Disposal at the project-owned SMCIW DS – 773.447 tons/period;
- Treatment at the project-owned SMCIW DS – 1018.536 tons/period;
- Local utilization – 3114.097 tons/period;
- Transfer to specialised contractors for:
    - burial – 565.618 tons/period;

- treatment – 2844.813 tons/period;
- utilisation (recycling) – 281.3521 tons/period.

Before the solid municipal, construction and industrial waste disposal site being a part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup is put into operation, wastes generated during the construction period will be transferred to specialised licensed contractor TyumenVtorSyr'yo LLC, for recycling, treatment and disposal outside the Project area

9.7.3.4 Utrenniy Terminal

The Utrenniy liquefied natural gas and stabilised gas condensate terminal (the Port) is intended to provide the marine logistics support in terms of gas carriers and tankers for offloading of LNG and SGC, reception and storage of cargoes for operations and construction. The offshore facilities of the Port will be constructed in the Ob Estuary area, in the place of existing berth structures.

Construction activities for the Terminal will take place on the shore and in the water area of the Ob Bay. Construction of the Utrenniy Terminal is planned for the end of year 2022.

The main sources of waste will include:

- Materials used in construction, including packaging;
- Construction and installation works;
- Vessels operation;
- Personnel activities and cleaning of territory.

The works will generate wastes of 33 different types, with hazard class III-V, in the total quantity of 53,076,956.75 tons/period, where excavated soil will make up a major part.

The total of 44,054,199.00 tons of soil excavated during the period of construction will be transported to a dry-excavation quarry located at a distance of 20 km, or to a temporary storage at a distance of 3 km from the site, and subsequently used for landscaping of the Terminal territory.

The Terminal construction will include dredging in the offshore area and construction of onshore facilities. Areas of the planned dredging operations are located within the boundaries of the approach channel and maneuvering area of the Port. The dredged soil will be dumped in the periphery of the above area, considering seabed relief in the Ob Estuary (refer to Chapter 5 for details). Dredged soil is not considered as a waste. The associated environmental impact is considered in thematic Section 9.3 – Impact on Surface Water.

Wastes from civil and installation works will include: mercury lamps; waste construction materials (concrete, RC articles, ceramic, cement, bitumen, PVC, etc.); building rubbish; welding wastes; metal scrap; containers contaminated with paint; cleaning material contaminated with oil; packaging materials. Washing of vehicle wheels is not planned, as no urban areas are present nearby, and building materials will not be delivered by road.

Wastes from personnel activity: municipal wastes from offices and domestic premises; liquid wastes from septic tanks; sludge from sewage treatment facilities.

Vessels operating in the sea port will generate bilge water, wastes from domestic facilities, etc. No maintenance or repair of vessels, on-board equipment and structures (or elements thereof) will be provided. These services will be provided at the home ports or at other vessels maintenance facilities.

Waste generated onshore will be source segregated by hazard class and other parameters, to facilitate recycling, neutralization and disposal. Temporary waste storage facilities will be provided during construction in the direct vicinity of the work sites, in compliance with the applicable sanitary rules and environmental standards for waste management, including hard paving and storm water drainage systems.

Dedicated metal containers with a capacity of 27 m^3 will be provided for collection of construction waste of hazard class IV-V, at a dedicated hard-paved collection site with convenient access for special vehicles.

Metal scrap (steel, welding electrode stubs) will be collected separately from other waste streams, in a container or in bulk, at a dedicated hard-paved site protected from atmospheric precipitation, for subsequent transfer for recycling.

Bilge water will be collected in holding tanks and, when accumulated in a shippable quantity, removed for treatment outside the Project area.

The waste accumulation facilities should be designed to prevent accidental falls, roll-over, spillage of wastes, and to ensure convenient access and safety of loading and transfer to licensed contractors for neutralization, recycling and disposal. Duration of temporary waste storage at dedicated equipped sites may not be longer than 11 months.

Specialised licensed service provider TyumenVtorSyr'yo LLC will also be the main waste management contractor for the Terminal. Wastes of hazard class I, II and (partially) III, as well as ferrous metal scrap will be collected with source segregation and transferred for treatment, recycling and utilization to specialised contractors. Waste of hazard class IV, V and (partially) III will be transferred for neutralization and disposal to the waste disposal site being a part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup.

Wastes from ships during the construction works can be transferred for disposal to the nearest division of FSUE "Rosmorport" in the Northern Basin area (branch divisions in Arkhangelsk and Murmansk providing services to vessels near and in the sea port areas, including collection and treatment of ballast waters, disposal of rubbish, food wastes, collection and treatment of bilge water).

Waste streams during the construction of the Port can be described as follows:

- Treatment at a licensed facility – 11.79 tons/period;
- Transfer to licensed contractor for utilization – 5508.77 tons/period;
- Burial – 44,071,433.19 tons/period, of which 17,234.19 tons/period will be disposed at a waste landfill (the rest is soil stored in a temporary bank for subsequent utilisation).

Before the solid municipal, construction and industrial waste disposal site is put into operation in 2021, all wastes will be transferred to the nearest contractors licensed for handling of wastes of hazard classes I-IV (refer to Annex 4) for treatment, recycling and disposal outside the Project area.

9.7.3.5 Utrenniy Airport

The Utrenniy Airport is designed for year-round air transportation of rotation-shift workforce and production cargoes; the Airport operator will be Sabetta International Airport LLC (established by Yamal LNG OJSC). The Airport is an associated facility of the Arctic LNG 2 Project.

The Airport site is located 15 km east of the berth structures and comprises the following facilities:

- access road with utility communications;
- aerodrome buildings and structures;
- service area comprising: passenger service buildings and facilities, cargoes transportation service buildings and facilities, auxiliary buildings and facilities.

The airport will be constructed in two phases during 45 months, with a peak number of 369 of construction workers. The available materials do not specify the planned time of the airport commissioning for operation.

The main sources of waste during the construction will include:

- building materials and packaging;
- civil and installation works;
- personnel activities and cleaning of territory;
- wastes from treatment of surface runoff water.

The works will generate wastes of 14 different types, hazard class IV and V, in the total quantity of 435.38 tons during the whole period of construction.

Wastes from civil and installation works will include: wastes of building and finishing materials (cement, asphalt, ceramic, linoleum); welding wastes; ferrous metal scrap; containers contaminated with paint and petroleum products. Wastes from personnel activity: rubbish from offices and domestic premises; food and non-food wastes from kitchens and catering facilities. Wastes from treatment of surface runoff water: sludge from mechanical treatment of oil-contaminated wastewater, nonwoven polymer filter media contaminated with petroleum products. The largest fractions of wastes are debris from offices and domestic premises, and food and non-food wastes from kitchens.

The construction wastes will be source segregated by hazard class and other parameters, to facilitate recycling, neutralization and disposal. The site area will be landscaped upon completion of the construction activity.

Containers for collection of building wastes and MSW will be installed at the construction site and TSF No. 13. Waste accumulation sites are arranged in compliance with SanPiN 2.1.7.1322-03 Hygienic Standards for disposal and neutralization of industrial and domestic waste and SanPiN 2.1.7.1287-03 Hygienic Standards of soil quality. The permissible volume of temporary accumulation of wastes is defined by the requirements of environmental safety, availability of space for temporary accumulation with unobstructed vehicle access for loading and removal to disposal facilities, and the standard intervals for removal of waste.

Intervals for removal of building wastes are defined in compliance with Federal Law No.89-FZ On industrial and domestic waste, sanitary standard SanPiN 42-128-4690-88 Sanitary rules for the maintenance of territories of settlements, based on the holding capacity of the accumulation containers and load capacity of the waste trucks. Removal of wastes by specialised vehicles to licensed facilities for recycling/disposal will be arranged upon accumulation of shippable quantity, but at least once every 11 months. MSW will be removed on a daily basis during warm season and once in two days at cold time.

Collection, transportation and treatment of a part of wastes of hazard class IV (ferrous metal containers contaminated with paint and petroleum products, asphalt, sand contaminated with petroleum products, sludge from treatment of oily wastewater and filters from cleaning of surface runoff) will be provided by Ekotekhnologii JSC or other specialised licensed contractors. Ferrous metal scrap will be transferred for recycling to a licensed company. Wastes of hazard classes IV and V (debris from offices and domestic premises, linoleum, food waste, ceramic) will be transferred for treatment and/or disposal to the SMCIW DS being a part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup. A part of wastes (non-food waste from kitchens, waste cement, welding electrodes stubs) will be transferred to the MSW landfill in Novy Urengoy operated by MUE UGKh. Before commissioning of the SMCIW DS, debris from offices and domestic premises will be transferred to the regional MSW operator for YNAO (Innovatsionnyje Tekhnologii LLC).

9.7.4 Waste Management during Operation

9.7.4.1 Salmanovskoye (Utrenneye) OGCF Facilities Setup

During operation of the Salmanovskoye (Utrenneye) OGCF Facilities, wastes will be generated by the following processes:

- Feed gas purification and treatment processes:
- Cleaning of pipelines and tanks;
- Replacement of oils and filter elements in the process equipment;
- Maintenance and repair of the main and auxiliary equipment and vehicles;
- Operation of treatment facilities: rain water, chemically contaminated wastewater, domestic wastewater treatment facilities;
- Operation of the SMCIW DS (thermal treatment of waste);
- Warehouse operations (storage of fuels and lubricants, chemicals);
- Personnel activities;
- Housekeeping and cleaning of territories and operational, office, domestic and accommodation premises.

During cleaning of infield gas pipelines, drainage vessels and separators waste products from the process of purification of natural gas from mechanical impurities will be generated.

Wastes from routine maintenance of equipment (compressors, separators, pumps, boiler house, emergency diesel power stations, gas turbine generators, transformers) will include oily rags, spent oily asbestos-graphite packings, uncontaminated ferrous metal scrap, spent mineral and synthetic oils, spent separating and air filters, oil and fuel filters, spent lead accumulators, sludge from vessels and pipelines cleaning from oil and petroleum products. Replacement of carbon filters in the methanol recovery unit will generate spent activated carbon contaminated with iron oxides and petroleum products.

Wastes from maintenance of specialised machinery and vehicles will include waste synthetic and mineral oils, cleaning rags, sand contaminated with petroleum products, ferrous and non-ferrous scrap, rubber articles, oil and fuel filters, spent air filters from vehicles, spent lead accumulators, spent brake blocks without asbestos lining, ferrous metal containers contaminated with petroleum products. Treatment of vehicles cleaning wastewater is a source of such wastes as sludge from mechanical treatment of oily wastewater, oily sludge and spent filter media contaminated with petroleum products.

Metal working and welding activities generate ferrous and non-ferrous scrap, steel electrode stubs and welding slug, abrasive dust and spent abrasive wheels, waste oils, cleaning rags.

The water treatment processes produce dewatered sludge from production of drinking water by coagulation with aluminium sulphate and flocculation with acrylamide, as well as waste filter media (sand, polypropylene, anthracite, activated carbon). Wastes from treatment of domestic wastewater and industrial storm water runoff include the following: debris from protective screens in domestic and combined sewerage systems; excess biological sludge; grit; floating petroleum products from oil separators; spent activated carbon; waste mercury-filled lamps.

Wastes from personnel life activities will be generated in offices, domestic and accommodation facilities. Waste protective clothing and footwear will be generated when worn out articles are replaced. Municipal solid wastes from cleaning of hard-paved areas will include sweepings from outdoor areas and rubbish from storage facilities. Unpacking of goods and cooking will also produce wastes such as food waste, grease from grease separators, waste PE film and PP packaging, wooden containers, waste glued paper.

Operating waste disposal site will generate waste containers, packaging, rubbish from offices and domestic premises, sweepings from outdoor territories, sand contaminated with petroleum products, cleaning rags. Thermal waste treatment in TTS will generate ash and slag from incinerators and waste thermal treatment units, broken furnace lining and equipment, vulcanized rubber hoses.

The total of 5047.341 tons of wastes of 88 different types and hazard classes I-V will be generated annually during operation of the Salmanovskoye (Utrenneye) OGCF Facilities Setup, more specifically:

- Hazard class I – 1 type, 0.006 tpa;
- Hazard class II – 1 type, 5.803 tpa;
- Hazard class III – 17 types, 318.472 tpa;
- Hazard class IV – 53 types, 4610.646 tpa;
- Hazard class V – 16 types of waste, 112.414 tpa.

Waste accumulation sites will be arranged during the construction and operation in line with the requirements of SanPiN 2.1.7.1322-03 “Hygienic Standards for disposal and neutralization of industrial and domestic waste”. Source segregation of wastes will be based on type, physical state, fire and explosion hazards, and other attributes with reference to the established class of hazard. Joint accumulation of various types of waste is allowed provided that their management procedure is similar, as well as subject to their compatibility due to physical, chemical and other properties. The temporary waste accumulation sites will be equipped with vessels and containers as appropriate for the type of wastes, their hazard class, dangerous properties, and further management.

The following waste management approach is adopted for the Field operation period:

- Low-hazard and non-hazardous wastes of hazard classes IV and V in the total quantity of 2241.596 tpa (44.2%) will be transferred for disposal at the project-owned waste disposal site;
- Wastes of hazard class III-V in the total quantity of 2614.831 tpa (52%) will be incinerated (thermally treated) in project-owned incinerators;
- The quantity of waste to be transferred to specialised contractors for treatment and utilization (recycling) is 124.99 tpa (2.5%);
- The quantity of waste to be transferred to specialised contractors for disposal is 65.923 tpa (1.3%).

For the year 2020 TyumenVtorSyr’yo LLC (TVS) has been appointed as an operator of all solid waste management services for the Project with the main operations base at the sorting site of the SMCIW DS. TVS holds License No. (72) – 4724 – STOB/P dated 07.06.2019 for collection, transportation, treatment, recycling, neutralisation and disposal of wastes of hazard classes I-V. The TVS’s scope of responsibility will also include transportation by sea of the wastes that are not subject to thermal treatment, and must be removed from the territory of the Salmanovskoye (Utrenneye) OGCF. TVS will subcontract other licensed waste management service providers outside the Project area (refer to Annex 4).

9.7.4.2 GBS LNG & SGC Plant

During the facility operation, wastes will be generated by the following sources:

- Operation of three process trains;
- Maintenance of the main and auxiliary equipment;
- Maintenance and cleaning of production premises, sites of the main and auxiliary facilities onshore;

- Operating personnel life activities.

Wastes from operation and maintenance of the process trains will include the following: waste oil-based HTF (heating oil), waste propylene glycol heat transfer media, filter paper contaminated with petroleum products, filters from treatment of ethylene glycol, spent MDEA sorbents from treatment of natural gas and gas condensate, aluminium oxide adsorbent from gas dehydration, natural aluminosilicate filter media, oil filters, waste synthetic and mineral oils and hydraulic fluids, sludge from cleaning vessels and pipelines from oil and petroleum products, wastes from treatment of natural gas for removal of mechanical impurities, fibrous PP filters, spent activated carbon, spent zeolite from gas dehydration, filter cloth.

Wastes from maintenance of the main and auxiliary equipment will include spent lead accumulators, oil, fuel and air filters from power generating and compressor units, waste anti-freeze agents, spent mineral oils, cleaning rags, water treatment PP filters, contaminated ferrous metal and polymer containers from chemicals and oils, waste heat insulation materials, welding slug, wastes from operation of process wastewater, storm water and domestic wastewater treatment facilities.

Wastes from maintenance of production premises onshore will include spent mercury-filled lamps, high-pressure sodium-vapour lamps, LED light fixtures, broken glass, timber waste, ferrous and non-ferrous scrap, wastes from cleaning of outdoor and indoor premises.

Wastes from life activities of operating personnel: garbage from offices and domestic premises, food wastes, waste protective footwear and clothes, waste PE packaging, paper and cardboard.

Generation of industrial and domestic wastes during operation of the GBS LNG & SGC Plant has been estimated using the applicable methodology and considering the design solutions. Operation of the Plant and onshore facilities will result in generation of 53 types of waste of hazard classes I-V:

- hazard class I – 0.3711 tpa;
- hazard class II – 0.1764 tpa;
- hazard class III – 15,739.81 tpa;
- hazard class IV – 957.46 tpa;
- hazard class V – 105.41 tpa.

The total annual amount of wastes during the period of operation is 16,803.22 tpa.

Wastes generated during the operation will be treated and buried at the solid municipal, construction and industrial waste disposal site within the Salmanovskoye (Utrenneye) OGCF Facilities Setup, or will be transferred to licensed contractors for recycling, treatment and disposal. Removal of wastes for treatment is subject to agreement with specialised contractors licensed for the respective activity.

Wastes generated over the entire period of operation will be disposed as follows:

- disposal at the project-owned solid municipal, construction and industrial waste disposal site – 787.563 tons, treatment at SMCIW DS – 96.17 tons;
- transfer to specialised contractors for treatment – 9394.539 tons, for utilization (recycling) – 6524.955 tons.

During the Plant operation, generated wastes will be handed over (without temporary accumulation) to the unified waste management operator licensed for handling of wastes of hazard classes I-IV and transported to the SMCIW DS being a part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup. At the disposal site the waste, depending on its hazard class, will be either thermally treated and disposed of at the landfill cells (hazard classes IV-V), or accumulated till generation of shippable quantity before further transfer to specialized contractors licensed for collection, transportation, treatment, recycling, neutralization and disposal of waste of hazard classes I-IV. Source segregation and temporary storage of wastes will be arranged considering the hazard class and aggregate state of waste. In accordance with the adopted scheme, industrial wastes of hazard classes I-V will be transferred to licensed contractor for recycling, treatment and disposal.

Temporary accumulation of municipal solid wastes will be arranged at onshore facilities and the plant. Two tight metal containers, 0.75 m^3, with lids and tray will be installed on site paved with RC slabs, with kerbs and vehicle access. The site is located at a minimum distance of 20 m from the central control building.

Sites for temporary accumulation of domestic wastes are planned considering the waste generation from the planned activity. The sites should have sufficient capacity to accommodate the generated wastes, provided that designed removal frequency is observed.

9.7.4.3 Utrenniy Terminal and auxiliary facilities

The Utrenniy Terminal operation will result in annual generation of standard quantities of industrial and domestic waste attributable to the site-specific activities. The facilities will continuously operate year-round, 24-h/7day. The main sources of waste at the operation phase are:

- Operation of harbour vessels;
- Maintenance of equipment and harbour vehicles;
- Operations of auxiliary (administrative) services;
- Area cleaning;
- Personnel activities.

Vessels operating in the sea port will generate wastes from domestic facilities. Wastes from maintenance and repair of equipment and harbour vehicles will include spent lead accumulators, waste mineral oils, oil and air filters from vehicles, sand contaminated with petroleum products, cleaning rags, used tyres, vehicle component parts. Personnel life activities and functioning of auxiliary services will generate the following wastes: municipal waste from offices and domestic premises, waste electronic appliances and office equipment. Most wastes will result from housekeeping activities on the site territories and berth structures.

Operation of the Terminal facilities will annually produce 8533.65 tons of waste of hazard classes I, III, IV and V, including:

- hazard class I – 0.02 tpa;
- hazard class III – 0.07 tpa;
- hazard class III – 0.08 tpa;
- hazard class IV – 8533.46 tpa;
- hazard class V – 0.02 tpa.

The wastes generated at the Terminal operation phase will be segregated by type, hazard class and other attributes (segregate collection), to facilitate their reuse as secondary raw materials, treatment and disposal. Temporary waste accumulation sites and access roads to them shall be paved with road slabs, to prevent pollution and damage. Considering the site location, in accordance with RD 31.06.01-79 "Instruction for collection, removal and neutralisation of sea port rubbish", containers with tight lids will be provided for collection of wastes generated during operation of the onshore facilities. Each vessel will have dedicated facilities for collection of wastes equipped in compliance with sanitary standards and environmental safety requirements for operation of vessels[171].

Wastes of high hazard classes (spent mercury-filled lamps and lead accumulators) are collected in dedicated closed premises that cannot be accessed by unauthorized personnel. Waste mineral oils are collected separately in 20 l metal vessels on metal trays that prevent accidental spillage of petroleum products, away from the maintenance work areas. Sand contaminated with petroleum products and cleaning rags are collected in metal container with a lid, away from the work area. Used vehicle tyres are stored in stacks, vehicle parts - in bulk on a fenced site, or in container in dedicated hard-paved area.

It is recommended to use special containers for collection of sludge from vessels and pipelines cleaning, and keep the containers in dedicated temporary storage facilities (on metal trays), away from other combustible materials and potential ignition sources. The sludge may be transferred to licensed contractor without intermediate storage, immediately upon cleaning of tanks.

Rubbish from offices and domestic premises, oil and air filters, worn protective clothes and footwear, waste electronic appliances and office equipment, used PPE, wastes from cleaning of berth structures and other onshore facilities of the port will be collected in metal containers with lids at a dedicated site with improved paving and convenient transport access from the port territory. Municipal wastes will be removed on a daily basis. Overfilling of containers and placing industrial wastes in containers intended for MSW is not acceptable.

Waste streams during the operation of the Port:

- Treatment at a licensed facility – 3.88 tpa;
- Transfer to licensed contractor for utilization – 2.05 tpa;
- Disposal at the project-owned SMCIW DS – 8529.76 tpa.

[171] In accordance with "Certificate of prevention of pollution from ships" approved by the Russian Maritime Register for each type of vessel

Wastes transportation to treatment and disposal sites will be provided by dedicated equipped vehicles of the licensed contractors upon accumulation of shippable quantity, but at least once every 11 months. All wastes will be transferred to the solid municipal, construction and industrial waste disposal site being a part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup for treatment, neutralization, disposal, or for further transfer to specialized licensed contractors (refer to Annex 4).

9.7.4.4 Utrenniy Airport

During operation of the Utrenniy Airport, wastes will be generated as a result of operational activities and life activities of the workforce and engineering technicians. The maximum number of rotation shift personnel at the Airport facilities is 211. The main sources of waste at the operation phase are:

- maintenance of equipment, aircraft and airport vehicles;
- de-icing of aircraft;
- operations of auxiliary (administrative) services;
- area lighting;
- treatment of surface runoff water;
- area cleaning;
- personnel activities.

The operation activities will annually produce 532.96 tons of waste of 31 different types, hazard classes II, III, IV and V.

Treatment of aircraft with de-icing fluid will be conducted during September-November and March-May at a dedicated site with artificial aerodrome paving sloping toward drainage channels for separate removal of de-icing fluid and rain water. During de-icing operations, valve is opened for collection of de-icing fluid, and wastewater flow is directed to a 5 m^3 holding tank, for collection and subsequent recycling/regeneration of de-icing fluid.

The following types of waste are generated during technical maintenance of equipment and buildings: spent accumulators, spent oils and anti-freeze agents, fuel filters, oils, air filters from vehicles, cleaning rags contaminated with oil and petroleum products, waste abrasive materials and wheels, used tyres, textile and rubber, ferrous metals scrap and chips, brake blocks. Replacement of lighting lamps results in generation of waste LED lamps unfit for further use.

Wastes from personnel activity: debris from offices and domestic premises; unsorted domestic wastes; food and non-food wastes from kitchens and catering facilities, grease from grease separators. Surface runoff treatment facilities generate wastes in the form of sludge from mechanical treatment of oily wastewater. The largest fractions of wastes are spent de-icing fluid containing ethylene glycol, debris from offices and domestic premises, domestic wastes, and food and non-food wastes from kitchens.

Wastes from the operational Airport will be source segregated by hazard class and other parameters, to facilitate recycling, neutralization and disposal. Municipal solid wastes from buildings will be collected in containers installed on a dedicated site with asphalt paving extending 1 m from the base of container on all sides. The permissible volume of temporary accumulation of wastes is defined by the requirements of environmental safety, availability of space for temporary accumulation with unobstructed vehicle access for loading and removal to disposal facilities, and the standard intervals for removal of waste.

Intervals for removal of building wastes are defined in compliance with Federal Law No.89-FZ On industrial and domestic waste, sanitary standard SanPiN 42-128-4690-88 Sanitary rules for the maintenance of territories of settlements, based on the holding capacity of the accumulation containers and load capacity of the waste trucks. Removal of wastes by specialised vehicles to licensed facilities for recycling/disposal will be arranged upon accumulation of shippable quantity, but at least once every 11 months. MSW will be removed by specialised trucks on a daily basis during warm season and once in two days at cold time.

The wastes will be transferred to specialised contractors licensed to manage wastes of hazard classes I-IV. Contracts for collection, transportation treatment and disposal of wastes will be concluded immediately before commissioning of the facilities.

Waste de-icing fluid containing ethylene glycol and spent accumulators will be collected, transported, treated and disposed of by specialised contractor NPP AREAL LLC (specified in the design documentation[172]).

[172] 375-юр/2018-ООС1.1-ТЧ Utrenniy Airport. Design documentation. Section 8. List of Environmental Protection Measures. Vol. 8.1.1, Section 3.7.1.

Collection, transportation and treatment of a part of wastes of hazard class IV (ferrous metal containers contaminated with paint and petroleum products, asphalt, sand contaminated with petroleum products, sludge from treatment of oily wastewater and filters from cleaning of surface runoff) will be provided by Ekotekhnologii JSC or other specialised licensed contractors. Ferrous metal scrap will be transferred for recycling to a licensed company. A part of wastes of hazard classes IV and V (debris from offices and domestic premises, sweepings, spent filters, food waste, abrasives) will be transferred for treatment and/or disposal to the SMCIW DS being a part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup. Debris from offices and domestic premises and other wastes similar to MSW may also be transferred to the regional MSW operator for YaNAO (Innovatsionnyje Tekhnologii LLC). A part of wastes (non-food waste from kitchens, textile and rubber, packaging waste, etc.) will be transferred to the MSW landfill in Novy Urengoy operated by MUE UGKh.

9.7.5 Waste Management Impact Assessment

Wastes generated in the process of production and consumption have a potential to produce negative impact on components of the environment. Environmental impact of wastes occurs at all steps in the waste management chain – generation, collection, accumulation, utilization, transportation, treatment, storage and burial.

The disposal stage (storage and burial) has the greatest impact on the environment. Disposal of wastes is often accompanied by acquisition of land, or, in case of violation of waste management regulations and illegal dumping – littering and degradation of land, deterioration of consumer and recreational properties of territories, degradation of aesthetic value of the natural landscapes.

The main mechanisms of harmful impact of wastes on specific components of the environment at the stage of treatment and disposal are:

- Pollution of air with:
  - Emissions of gases from incineration of wastes in the thermal treatment facilities at the SMCIW disposal site and well pads;
  - Emissions of gases due to evaporation, sublimation, chemical reactions (including spontaneous combustion);
  - Wind transport of fine particles and larger fractions of waste;
  - Operation of vehicles during transportation of wastes and disposal at landfill;
- Pollution of surface and ground water resulting from:
  - Leaks of liquid wastes;
  - Leaks of liquid fractions from wet semi-solid waste;
  - Leaching of harmful substances from solid and semi-solid waste with atmospheric precipitation at the SMCIW disposal site and temporary waste accumulation sites;
- Contamination of the surface layer of ground and soil due to:
  - Mixing of toxic wastes with surface layer material, in case of disposal on unprepared surfaces;
  - Aerogenic precipitation due to wind transport;
  - Horizontal and vertical migration of pollutants (including soluble) with surface runoff and infiltration flows from the SMCIW disposal site and temporary waste accumulation sites;
- Technogenic changes in geology due to construction of SMCIW disposal site, and development of negative physical geological processes and phenomena due to:
  - Modification of terrain by construction and grading activity, stripping of top layer, increasing load on ground;
  - Disturbance of runoff conditions, potential intensification of dangerous geological processes, etc.;
  - Modification of drainage conditions, thermal and water content patterns in the seasonally thawed and seasonally frozen layers;
- Lack of waste management capacities due to disposal of large quantities of wastes;
- Impact on customary land use by ISPN, due to obstruction of seasonal migrations of deer herds;
- Impact on human health due to:
  - Inadequate handling of hazardous wastes by personnel;
  - Effect of pollutants emitted in the work zone and environment, development of pathogens as a result of uncontrolled storage of wastes;

  - Threat to human health in case of spontaneous combustion of wastes, odours, bites by insects/animals attracted by wastes;
- Impact on flora and fauna resulting from:
  - Pollution of habitats (particular freshwater and marine environment - refer to thematic section on surface water);
  - Attraction of fauna (birds, insects, mouse-like rodents, carnivore mammals) to the food waste disposal sites, and local risk of extermination of birds, which nests are located on the ground.

Without implementation of additional measures aimed at reducing impact on human health, the level of the same can be assessed as moderate or high, considering the high sensitivity of the region's natural ecosystems. Assessment of impact on different aspects of the natural and social environment is provided in Table 9.7.3. Assessment of impact of thermal treatment of wastes on the air quality is included in Section 9.1; impact on indigenous communities is assessed in Section 10.7.

9.7.6 Mitigation measures to reduce environmental impact of wastes of production and consumption

The design documentation for the Project facilities includes technical and management measures to control the negative impact of waste generation, accumulation, treatment, disposal and recycling on the environment. Waste management during construction and operation of the designed facilities shall be compliant with:

- Process standards specified in the design;
- General and special environmental requirements and measures based on the applicable environmental and sanitary-epidemiological standards and regulations.

Implementation of the environmental measures listed below, and compliance with the sanitary regulations applicable to collection, storage, transportation, neutralization, recycling and disposal of waste will help to minimize the negative impact of waste on human health and natural environment:

- Source segregation of wastes shall be based on type, physical state, fire and explosion hazards, and other attributes with reference to the established class of hazard.
- Joint accumulation of various types of waste is allowed provided that their management procedure (treatment, recycling, neutralisation) is similar, as well as subject to their compatibility due to physical, chemical and other properties.
- The waste storage (temporary accumulation) sites shall be equipped with vessels and containers as appropriate for the type of wastes, their hazard class, dangerous properties, and further management;
- Upon completion of construction activity, the sites shall be cleared of construction waste and unused construction articles;
- Appropriate arrangements for collection of wastes and their transportation shall be selected to match their quality and quantity parameters, and hazard class;
- All vehicles that transport open storage hoppers with wastes shall be equipped with canvas covers;
- Time limit for waste accumulation at sites shall be determined for each type of waste in accordance with its properties, but in any way shall not exceed 11 months;
- Equipment of temporary waste accumulation sites at the field, plant, terminal and temporary accommodation camp in accordance with the requirements of SanPiN 2.1.7.1322-03 - Hygienic Standards for Disposal and Neutralization of Industrial and Domestic Waste (hard paving, use of suitable containers, weather protection, timely removal);
- Regular transfer of waste to the solid municipal, construction and industrial waste disposal site for further treatment, neutralization, disposal or further transfer to specialized licensed contractors;
- Minimisation of waste volumes (including recycling, compaction, thermal treatment);
- Reduction of hazardous wastes generation by appropriate selection of technological solutions;
- Use of only licensed third party waste disposal facilities included into the State Register of Waste Disposal Facilities;
- Training of personnel on waste management methods;
- Accumulation of food waste in containers with tight covers at fenced sites, and timely removal of the waste being potential food for animals from the temporary storage sites;
- Application of measures to deter animals from the food waste storage sites, canteens and food products storage facilities;
- Timely collection and removal of all wastes generated on vessels to the home port (at the construction phase);

- Temporary accumulation of wastes within the limits recommended and allowed for accumulation onboard, in accordance with "Certificate of prevention of pollution from ships" approved by the Russian Maritime Register for each type of vessel;
- Isolation of temporary onboard waste accumulation areas from domestic and communal premises;
- Transferring bilge water to the nearest division of FSUE "Rosmorport" in the Northern Basin Area: Arkhangelsk Sea Port and Murmansk Sea Port, in compliance with approved Sea Port Waste Management Plans;
- Selecting position of the SMCIW disposal site in the area with low permeability of ground, outside the water protection zones of waterbodies and protective sanitary zones of drinking water supply sources;
- Effective isolation membrane for the SMCIW disposal site;
- Site grading of the SMCIW disposal site to ensure removal of precipitation water from the territory and protection against underflooding with ground and surface water from adjacent territories;
- Implementation of a system of thermal insulation and other measures to prevent degradation of permafrost within the footprint of the solid municipal, construction and industrial waste disposal site and around it.

Requirements to temporary waste accumulation facilities:

Outdoor and indoor premises will be provided for temporary accumulation of wastes onsite. The following requirements for temporary accumulation of wastes at dedicated sites will be applied:

- Effective protection of wastes against impact of precipitation (sheds, containers with lids, etc.);
- The outdoor sites shall be located downwind and paved with a material non-degradable and impermeable by toxic substances (e.g. paving with asphalt concrete, polymer concrete, tiles, etc.);
- Curbing or bunding of the sites to the adequate height (at least 10 cm) to prevent roll off of the containers;
- Sites intended for temporary accumulation of dusty wastes shall protect the environment against entrainment of pollutants into the atmosphere;
- Sites with accumulation containers for liquid wastes shall be adequately equipped (with trays) to prevent spillage of wastes in case of accidental loss of integrity of the vessels;
- Fire fighting equipment shall be provided at temporary accumulation sites for combustible wastes;
- Access roads to the waste accumulation sites shall be lighted during dark periods;
- Provision of storm water disposal/drainage systems at the temporary waste accumulation sites.

Buildings and premises used for temporary accumulation of wastes shall meet the following requirements:

- Rooms for temporary accumulation of wastes of hazard classes I and II shall be isolated and equipped for separate storage of wastes;
- The area shall be fenced, and unauthorized access prevented by lockable doors;
- Accumulation of wastes shall be arranged in a way to prevent mixing or contact of incompatible materials, and to enable inspection of space between containers for identification of potential leakage or spillage. To this end:
  - Steel drums shall be stored on trays and can be stacked in two tiers. Trays shall be arranged in lines of two trays;
  - Trays shall be installed at a minimum distance of 1 m from walls and 0.8 m between trays;
  - For separation of incompatible wastes, different compartments shall be arranged for accumulation of drums, with concrete walls between compartments;
  - Each compartment intended for accumulation of incompatible wastes shall have an individual drainage system with a closed sump from which material is evacuated by a road tanker with a vacuum pump;
  - A secondary protective enclosure shall be provided in places intended for storage of more than 220 l of liquid wastes. Effective volume of the secondary protective enclosure shall be at least 110% of volume of the largest storage container, or 25% of the total storage capacity;
- A disinfecting shower and hand-wash station shall be provided in the waste accumulation building;
- Adequate ventilation system shall be provided to prevent pollutants concentrations reaching 30% of the MAC limit for the workplace air, at the height of 2 m from surface, in case of uncontrolled leaks or emissions from waste.

Management arrangements

In addition to the aforementioned measures, the following organizational measures shall be implemented to reduce the load on the environment during construction and operation of the facilities throughout the Project cycle:

- Timely conclusion of agreements with waste collection, treatment, neutralisation, recycling, decontamination and disposal service providers;
- At all the Project facilities, including vessels, appointing of persons responsible for waste management;
- Development of adequate job descriptions for personnel responsible for management of waste;
- Training for workers and supervising personnel with responsibility for hazardous waste management;
- Development of Waste Generation Norms and Disposal Limits (WGNDL), passports of hazard class I-IV wastes, and all other documents required for operational site in accordance with Russian waste management regulations; getting the documents approved by the state supervision authorities and obtaining waste generation norms and disposal limits;
- Initial and day-to-day record-keeping and monitoring of generation, temporary accumulation conditions, transportation of waste, control of compliance with environmental, health and safety rules during handling of wastes;
- Keeping record of all hazardous wastes generated on vessels, maintaining a log with records of operations with wastes generated during the works;
- Getting locations for temporary on-site accumulation of wastes and schedules of their removal approved by the competent environmental and community health supervision authorities;
- Obtaining the permits for the solid municipal, construction and industrial waste disposal site and incinerators, getting the waste disposal site registered in the State Register of Waste Disposal Facilities;
- Licensing of own activities related to collection, transportation, treatment, recycling, neutralization, disposal of waste of hazard classes I - IV;
- Making agreements with specialized licensed contractors for collection, transportation, neutralization, treatment, recycling and disposal of waste of hazard classes I, II and (partially) III which may not be accepted for disposal at the SMCIW disposal site of the Salmanovskoye (Utrenneye) OGCF Facilities Setup;
- Making agreements with specialized licensed contractors (capture vessels) for collection and capturing of bilge water and other waste from vessels;
- Disposal of waste only at licensed facilities listed in the State Register of Waste Disposal Facilities;
- Timely payment of pollution charges in relation to the waste disposal activities;
- Timely reporting on management of wastes to the RPN authority;
- Coordination of activities with the relevant state supervision authorities (Rosprirodnadzor, Rospotrebnadzor) in respect of all issues related to waste management safety.

In accordance with the requirement of the IFC Environmental and Social Performance Standard 1, the Project's environmental and social management system should cover the management of all identified impacts, including impacts from waste management. In this regard, an Environmental and Social Action Plan / Environmental and Social Management Plan is being developed for the entire Project, which should include a Waste Management Plan containing all proposed measures aimed at minimizing the identified risks and impacts of the Project, ensuring compliance with applicable national regulations, as well as compliance with the requirements of applicable IFC Performance Standards at all stages of the Project.

If the applicable health and waste management regulations are complied with, and the above management measures are implemented, the residual impact of waste on human health and the environment can be assessed as low or not significant.

9.7.7 Summary

Construction, operation and decommissioning of the Project Arctic LNG 2 and associated facilities will generate waste streams of hazard classes I-V. The waste management activities, including collection, storage, transportation, treatment, recycling, neutralization and disposal, will be associated with various negative environmental impacts. After the environmental measures proposed by the Consultant, significance of the impacts can be reduced to (**low or negligible**).

At the **construction** stage, major part of the works, particularly manufacturing of the process trains, will take place at remote sites; therefore, management of wastes related to this phase of the Project is left outside the scope of this ESHIA. Given that Yamal-Nenets Autonomous Okrug experiences a shortage of waste disposal and recycling facilities and that there are in fact no such facilities in the Project area, the selected approach to construction, i.e. using existing yards and other industrial sites in Russia and elsewhere, is the best choice in terms of efficient and environmentally safe management of construction wastes.

Technologies adopted for management of drilling wastes that will be generated in large quantities during construction of the producing wells prevent ingress of drilling wastes into the environment before the wastes are neutralised and recycled. Products of neutralisation and recycling of drilling wastes can be used as construction materials for the Project facilities - filling of roads, embankments, site preparation and technical reclamation of sites.

Before commissioning of the SMCIW DS, wastes from construction of the Terminal and Field facilities will be stored at a dedicated site within the area of the designed waste disposal site, and removed for neutralisation, recycling and disposal outside the Project area by specialised licensed contractors.

After commissioning of the SMCIW DS being a part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup, wastes of hazard classes III-V from the Project and associated facilities will be removed for thermal treatment and disposal at the SMCIW DS. Design of the waste disposal site provides for application of the best available technologies for disposal of industrial and domestic wastes, and for thermal treatment of wastes. A phased approach is adopted for implementation of the waste disposal facilities, as designs for the Project facilities specify the largest possible generation of wastes, whereas actual quantity of wastes to be treated and buried at the waste disposal site can be significantly smaller. The residual impact of the project-owned waste disposal site capacity is assessed as low. If circumstances require, new facilities can be designed and implemented for disposal of industrial and domestic wastes, or wastes can be transferred to remote facilities for treatment, recycling and disposal.

Wastes of high hazard classes and recyclable wastes will be accumulated in dedicated temporary storage area at the waste disposal site till generation of shippable quantity, and removed by specialised contractor for treatment, recycling and disposal at licensed facilities outside the Project area.

At the **operation** stage, most industrial wastes from the Project will be related to replacement of filtering elements and heat transfer agents at the GBS LNG & SGC Plant, cleaning of pipelines and tanks, collection of spent aircraft de-icing fluid at the Utrenniy Airport, maintenance and repair of the main and auxiliary equipment and vehicles of the Plant, Field, Terminal and Airport, and with thermal treatment of wastes in TTS units. A major part of the wastes will consist of low-hazard domestic wastes – MSW, as well as industrial wastes similar to municipal waste, wastes from housekeeping activities, and sludge from water treatment facilities. As is the case with the construction stage waste, the Project's most hazardous operations waste will be transferred to third parties, while the rest of the waste streams – classes V, IV and (partially) III, will be disposed of at the SMCIW DS.

As most wastes generated by the Project construction and operation are of low hazard category, their management is expected to produce a moderate impact on the environment. If the applicable health and waste management regulations are complied with, and the management measures proposed by the Consultant are implemented, the residual impact of waste on human health and the environment can be reduced to **low or negligible**.

Following the **decommissioning** of the Project and associated facilities, a significant amount of waste will be generated from the dismantling of buildings and structures, usually classified as low hazard classes (refer to Chapter 11 in this Report). After the closure of the project as a whole, including dismantling of buildings and structures, reclamation of land and its return to traditional use, the area under the solid municipal, construction and industrial waste disposal site and its sanitary protection zone will remain the only subject of operational environmental monitoring, also after the Landfill has stopped receiving waste.

Summary of the assessment of environmental and social impacts of waste management and proposed mitigation measures is provided in Section 9.7.3.

Table 9.7.3: Summary of waste management impact assessment

Impact	Sign	Receptor	Receptor Sensitivity	Stage	Impact magnitude	Impact significance	Mitigation	Residual impact
Use up of waste management capacities	N	Project-owned waste management facilities	M	C, O	H	H	• Disposal of wastes on landfills with finite capacity is allowed only when no other waste disposal option is available; • Neutralization / disposal of major part of waste at the the solid municipal, construction and industrial waste disposal site being a part of the Salmanovskoye (Utrenneye) OGCF Facilities Setup; • Regular collection of waste by licensed organizations or through own efforts subject to having a license for collection, transportation, treatment, recycling, neutralization, disposal of waste of I - IV hazard classes; • Segregation of hazardous waste by type; • Minimizing the waste volume (including by means of thermal treatment, compaction, recycling). • Reduction of hazardous wastes generation by appropriate selection of technological processes; • Use of only licensed own and third party facilities for waste disposal/recycling.	L
	N	Waste management facilities of third parties	L	C, O	M	L/M		N
Impact on human health and well-being (poisoning, spread of pathogens, odour emissions, animal / insect bites)	N	Construction workforce	M	C	M	M/H	• Safe temporary accumulation of waste only at dedicated facilities; prevention of theft or vandalism risks. • Regular collection of waste by licensed organizations or through own efforts subject to having a license for collection, transportation, treatment, recycling, neutralization, disposal of waste of I - IV hazard classes; • Segregation of hazardous waste by type; • Training of personnel on hazardous waste management methods; • Access roads to the waste accumulation sites shall be lighted during dark periods; • Only escorting staff shall be present at transportation, presence of unauthorized persons is prohibited; • Disposal/recycling/treatment of waste only at licensed specialized facilities. • To avoid degradation of food waste, the maximum permitted duration of food wastes storage is three days during cold season (at a temperature of minus 5°C and lower) and one day during warm season (at a temperature higher than +5°C). • Storage of food waste in containers with tight covers at fenced sites, and timely removal of the waste being potential food for animals from the temporary storage sites; • Application of measures to deter animals from the food waste storage sites, canteens and food products storage facilities; • Provision of waste collection containers at the operational sites; • Collection containers for domestic waste shall have tightly closing lids. Containers for domestic waste and sites under them shall be	L
		Operating personnel of the Project and associated facilities	M	O	M	M/H		L

Impact	Sign	Receptor	Receptor Sensitivity	Stage	Impact magnitude	Impact significance	Mitigation	Residual impact
							washed and treated with disinfectant at least once in ten days (except for winter period). • Isolation of temporary onboard waste storage facilities from domestic and communal premises; • Fire fighting equipment shall be provided at temporary storage sites for combustible wastes; • Rooms for temporary storage of wastes of hazard classes I and II shall be isolated and equipped for separate storage of wastes; The area shall be fenced, and unauthorized access prevented by lockable doors; • Mixing or contact of incompatible wastes shall be prevented; • A disinfecting shower and hand-wash station shall be provided in the waste storage building; • Adequate ventilation system shall be provided to prevent pollutants concentrations reaching 30% of the MAC limit for the workplace air, at the height of 2 m from surface, in case of uncontrolled leaks or emissions from waste.	
Contamination of soils, surface and groundwater in case of leachate leakage at the solid municipal, construction and industrial waste disposal site, waste temporary accumulation sites and during waste transportation	N	Surface waterbodies, freshwater flora and fauna	H	C, O	M	H	• Hard paving at the Project facilities waste temporary accumulation sites; • Provision of trays/ bunding of temporary accumulation sites for liquid waste to ensure secondary containment of spills; • Arrangement of access roads and passages to each waste temporary accumulation site; • For storage of liquid wastes in containers or barrels with a capacity larger than 220 l, secondary protective enclosures (trays) shall be provided to prevent spillage in case of accidental loss of integrity of the vessels. Volume of the secondary protective enclosure is at least 110% of volume of the largest storage vessel, or 25% of the total storage capacity; • Protection of wastes against impact of precipitation (sheds, containers with lids, etc.); • Equipping liquid waste accumulation sites with spill response means; • Regular inspections of spaces between containers for identification of potential leakage; • Collection of aircraft de-icing fluids during treatment of aircrafts in a metal vessel with subsequent recycling at a specialized facility • Transportation of waste only by special vehicles of waste management contractor; • Maintenance and repair of special vehicles only at dedicated equipped facilities; • Hard paving of roads with materials resistant to petroleum products; arrangement of removal of liquid waste spills during transportation; • Provision of low-permeability membrane for the solid municipal, construction and industrial waste disposal site;	L

Impact	Sign	Receptor	Receptor Sensitivity	Stage	Impact magnitude	Impact significance	Mitigation	Residual impact
							• Selecting position of the solid municipal, construction and industrial waste disposal site outside the water protection zones of waterbodies and protective sanitary zones of drinking water supply sources; • Compliance with the fire safety rules during the construction and operation of the solid municipal, construction and industrial waste disposal site; • Effective isolation membrane for the solid municipal, construction and industrial waste disposal site; • Surface grading of the solid municipal, construction and industrial waste disposal site to ensure removal of precipitation water from the territory and protection against underflooding with ground and surface water from adjacent territories; • Disinfection of vehicle wheels at the exit of the solid municipal, construction and industrial waste disposal site.	
	N	Ob Estuary water environment, marine flora and fauna	H	C	L	M	• Temporary accumulation of wastes within the limits recommended and allowed for accumulation onboard, in accordance with “Certificate of prevention of pollution from ships”; • Isolation of temporary onboard waste accumulation facilities from domestic and communal premises; • Making agreements with specialized licensed contractors (capture vessels) for collection and capturing of bilge water and other waste from vessels; • Transferring bilge water and other wastes from ships to the nearest division of FSUE “Rosmorport” in the Northern Basin Area: Arkhangelsk Sea Port and Murmansk Sea Port, in compliance with approved Sea Port Waste Management Plans. All wastes shall be transferred to licensed onshore facilities for recycling, neutralization and disposal. • Appointing with a company order of aperson responsible for waste management. The appointed personnel shall have professional skills and certification in the sphere of management of wastes. • Keeping record of all hazardous wastes generated on ship, maintaining a log with records of operations with wastes generated during the works.	N
Pollution of terrestrial habitats during temporary accumulation, transportation and disposal of wastes	N	Terrestrial flora and fauna	H	C, O	N	N/L	• Safe temporary storage of waste at dedicated facilities. Equipment of temporary waste accumulation sites in accordance with the requirements of SanPiN 2.1.7.1322-03: hard paving, use of suitable containers, weather protection, timely removal; • Upon completion of construction activity, the sites shall be cleared of construction rubbish and unused construction articles; • Outdoor temporary waste accumulation sites shall be located in downwind position;	N

Impact	Sign	Receptor	Receptor Sensitivity	Stage	Impact magnitude	Impact significance	Mitigation	Residual impact
							• Sites intended for temporary accumulation of dusty wastes shall protect the environment against entrainment of pollutants into the atmosphere; • Curbing or bunding of the sites to the adequate height (at least 10 cm) to prevent roll off of the containers; • Regular collection of waste by licensed organizations or through own efforts subject to having a license for collection, transportation, treatment, recycling, neutralization, disposal of waste of I - IV hazard classes; • Transportation of waste only by special vehicles of the company or vehicles of the waste management contractor; • All vehicles that transport open storage hoppers with wastes shall be equipped with covers.	
Increasing number of synanthropic species (plants, rodents, birds, insects) due to availability of food	N	Terrestrial flora and fauna, construction and operating personnel	H	C, O	L	M	• Elimination of the food base by the following actions: safe temporary storage of waste in containers with tight lids at dedicated fenced facilities, and timely removal from the collection sites by licensed contractors, and waste disposal/recycling at specialized licensed facilities; • Application of measures to deter animals from the food waste storage sites, canteens and food storage facilities. • Ensuring compliance with environmental protection requirements in line with the Industrial Control Program of the SMCIW DS, including the schedule and measures for sanitary control of the territory (disinfection of wheels of vehicles leaving the site, disinfection and deratisation of operational solid waste cells and household premises).	L
Violation of legal regulations in the sphere of waste management	N	Environment, biodiversity	H	C, O	M	H	• At all the Project facilities, appointing of persons responsible for waste management, having professional skills and certified to manage hazardous waste; • Inclusion of waste management responsibilities into the job descriptions or appointment orders of responsible personnel ; • Training for workers and supervising personnel with responsibility for hazardous waste management; • Development of Waste Generation and Disposal Limits (WGDL), passports of hazard class I-IV wastes, and all other documents required for operational site in accordance with Russian waste management regulations; getting the documents approved by the state supervision authorities and obtaining waste disposal limits; • Initial and day-to-day record-keeping and monitoring of generation, collection, temporary accumulation, transportation of waste, control of waste management in compliance with environmental, health and safety rules;	N

Impact	Sign	Receptor	Receptor Sensitivity	Stage	Impact magnitude	Impact significance	Mitigation	Residual impact
							• Keeping record of all hazardous wastes generated on vessels, maintaining a log with records of operations with wastes generated during the works; • Segregate collection of waste by type, hazard class and other attributes, to facilitate their reuse as secondary raw materials, treatment and disposal; • Getting locations for temporary on-site accumulation of wastes and schedules of their removal approved by the competent environmental and community health supervision authorities; • Obtaining the permits for the solid municipal, construction and industrial waste disposal site and incinerators, getting the waste disposal site registered in the State Register of Waste Disposal Facilities; • Licensing of own activities related to collection, transportation, treatment, recycling, neutralization, disposal of waste of hazard classes I - IV; • Timely appointment of specialized licensed contractors for transportation, neutralization, treatment and disposal of waste, including those of hazard classes I-III, which may not be accepted for disposal at the solid municipal, construction and industrial waste disposal site at the Salmanovskoye (Utrenneye) OGCF Facilities Setup, and for collection and capturing of bilge water and other waste from vessels; • Disposal of waste only at licensed third party facilities listed in the State Register of Waste Disposal Facilities. • Transportation of hazardous waste only subject to having a hazardous waste certificate, by vehicles specially equipped and provided with special signs, subject to observing safety requirements for transportation of dangerous materials. • Timely reporting on management of wastes to the RPN authority; • Timely payment of the environmental pollution charges in relation to disposal of wastes.	

9.8 Emergency Impact and Natural Hazardous Processes

9.8.1 Construction

Construction of all Project facilities will have inherent emergency risks related to various events of which the highest likelihood has been identified for the following:

- Spills and leaks of liquid hydrocarbons, POL and other process liquids (particularly flammable);
- LOC of pressure vessels, failure of air compressors;
- LOC and mechanical damage of fuel and process liquids storage vessels;
- Man-induced fires;
- Explosions of gas-air and fuel-air mixtures, particularly in case of LOC or damage of equipment;
- Escape of gas and potential inflammation during wells drilling activity;
- Disturbance of lifting devices operation associated with falling of loads and elevated parts of heavylift equipment;
- All kinds of incidents related to handling operations (impact shocks, collision of machinery, falls of people or cargoes);
- Collapse or displacement of soil in undermining area, spill of sludge or unclarified seepage water outside the fill sites, during development of soil-based construction materials quarries;
- Collapse of the soil mass of formed bank, concrete or other structure as a result of external physical impacts, during construction of hydraulic structures and underwater technical operations;
- Collisions of vehicles (including vessels) and construction machinery.

In general, potential consequences of emergency situations during construction may include the following:

- Contamination of soil and vegetation and Ob Estuary water area with liquid agents (different mixes of liquid hydrocarbons, including petroleum products);
- Disturbance of soil and vegetation by fires;
- Pollution of the Ob Estuary area with products of incomplete combustion fuel;
- Air pollution with combustion products and suspended particles, injuries of personnel;
- Injuries of personnel at collisions with construction machinery, collapse of heavylift equipment, falling objects.

Emergency leaks of hydrocarbons, POL and other HFL are probable in relation to construction of *all components of the Project*. Leakage is possible through untight joints of equipment, or may result from damage or loss of integrity of tanks, pipelines, during fuelling and maintenance of vehicles and machinery. Liquid hydrocarbons may be spilled during temporary storage and transportation of wastes.

The most probable emergency is spillage of diesel fuel during fuelling. When filling the fuel tank, fuel may overflow or spill from damaged hose. Leaks are also possible if fuel storage tanks are damaged or untight.

Accidents during movement of refuelling tankers may result in **LOC of the road tanker** and release of 10 m^3 of the transported material onto the site surface. Probability of road tanker LOC is 5.0×10^{-6}; probability of petroleum products overflow through the fill opening of the vehicle fuel tank, due to the failure of automatic control system, is 5.0×10^{-5}.

The extent of air pollution resulting from an emergency spill depends on the quantity of volatile low-molecular hydrocarbons that evaporate from the surfaces covered by spilled petroleum products.

Estimated quantity of pollutants that can be released to the air as a result of spillage of diesel fuel varies from 4.2 kg to 47.13 kg depending on the incident circumstances.

At the construction phase, potential emergency situation will be related to **spillage of diesel fuel at refuelling of machinery**, as a result of overflow from the vehicle/machinery fuel tank, or spill through damaged hose.

During operation of the Utrenniy Terminal, diesel fuel and methanol are pumped from vessels to the fuel depot facilities built during phase 12 of the tarly development facilities at the Salmanovskoye (Utrenneye) OGCF. Risk analysis of accidental oil spills has shown that petroleum products can be spilled in the following situations:

- Loss of integrity of the loading arms during fuel unloading to the berth;
- Loss of integrity of pipeline or fittings at the process pumping station;
- Loss of integrity of process pipelines.

The emergency risk analysis concluded that the highest environmental risks are related to potential loss of integrity of a pipeline on the discharge side of the process pumping station, in which case 46 tons of diesel fuel can be spilled in the area of 6900 m².

Immediate consequences of emergency leakages include direct pollution of soil, vegetation and waterbodies, as well as their contamination by runoff from the construction sites. Habitats may be exposed to major impacts with consequences as severe as complete loss of the habitat food resources and shelter functions. POL ingress into waterbodies can result in loss of ichthyofauna, due to increased pollution of the aquatic environment.

Considering the scale of the activity and the severe climate, emergency risks related to leaks of hazardous liquids can be assessed as medium.

The diesel fuel spill response operations will produce the following main types of wastes:

- Sand contaminated with oil or petroleum products (petroleum products content of 15% and higher), hazard class III[173];
- Synthetic sorbents contaminated with oil or petroleum products (petroleum products content of 15% and higher), hazard class III;
- Oily rags from hands wiping of personnel involved in emergency response operations – this waste is described as "cleaning material contaminated with oil or petroleum products (petroleum products content of 15% and higher)", hazard class III;
- Soil contaminated with oil or petroleum products (petroleum products content less than 15%), hazard class IV.

Accidents during **underwater technical operations** (dredging, building and reinforcement of ALP, installation of GBS and construction of berth structures) are possible in case of oil spills, collapse of the soil mass of formed bank and building structures under mechanical impacts.

Activities in the internal marine waters will be conducted using a minimum number of high-capacity dredging and other machinery units resistant to wave impacts. The main source of potential oil spills in the water area during the work activities is LOC of dredging vessel hull in case of navigation accidents or emergency situations at mooring.

9.8.2 Operation

GBS LNG & SGC Plant

During a 60-year period of its existence, the LNG industry has proved to have a low accident rate - much less accidents and fatalities have occurred at its facilities as compared to those of the oil industry[174]. Accidents at LNG plants which occurred in the XX century, in general, were caused by design shortcomings (use of fragile materials, lack of gas detectors), non-production activity (violation of safety rules during maintenance) and ageing of equipment. Lessons learned from these accidents along with more than 60 years of experience in LNG production, contributed to establishment of reliable and effective codes of practice and safety systems that are currently in effect for construction and operation of new structures[175].

Potential sources and contributing factors of occurrence and development of emergencies at the Plant are as follows[176]:

- Accidents occurrence:
  - Specific properties of materials used (combustibility, capacity to form FAM[177] with oxygen from air);
  - The applied turn-key factory-fabricated technical equipment - Process Trains 1, 2 and 3, and technological processes inside them;
  - Pipelines of various diameters and lengths;
  - Specific design features of the turn-key factory-fabricated technical equipment - Process Trains 1, 2 and 3;

[173] In Russian regulations on management of wastes, terms "oil" and "petroleum products" designate liquid hydrocarbons of virtually any composition, therefore, sand contaminated with diesel fuel is categorized as "sand contaminated with oil and petroleum products".
[174] A. P. Yanchushka, A. M. Sayfutdinov, G. E. Korobkov Liquefied Natural Gas Facilities Safety Review // Materials of III International Scientific and Practical Conference "Problems and Achievements in Science and Technology". 2016. pp. 78-81.
[175] D. Wood, S. Mokhatab, Is the LNG Supply Chain Safe and Environmentally Friendly? // ROGTEC. 2007. pp. 96-105.
[176] GBS LNG & SGC Plant. Design documentation. Section 12, Sub-section 1, Book 1. Industrial Safety Declaration, Vol. 12.1.1, LNG NOVAENGINEERING LLC, M., 2019
[177] FAM - fuel-air mixture

    - External factors (significant thermal, snow, wave, ice and wind loads).

- Development of emergencies:
    - Time spent for accident detection and response;
    - Specific properties materials used (type of emergency scenario);
    - Quantity of hazardous substance circulating in an equipment unit, and the material flow rate in the pipelines;
    - Location and nature of the equipment damage;
    - Compactness of the layout of the process equipment;
    - Weather conditions.

The most likely accidents at operation are:

- Failures/malfunction of the turn-key factory-fabricated technical equipment - Process Trains 1, 2 and 3, and pipelines due to various factors, such as
    - Wear, corrosion, erosion, mechanical damage, thermal deformation;
    - Disruption of utility supply;
    - Causes related to typical processes.
- Human errors:
    - Lack of control over specified process parameters;
    - Inadequate interpretation of information;
    - Untimely emergency response;
    - Errors at startup and shutdown, repair, preventive maintenance and other works with unstable process conditions.
- External natural and man-caused impacts:
    - Lightning or static electrical discharges;
    - Tornado, windstorm, etc.;
    - Snowdrifting, temperatures and ice load values beyond the design range;
    - Subversive activity.

Summary of the most likely emergency scenarios for the Plant[178], with most severe potential consequences is provided in Table 9.8.1.

Table 9.8.1: Emergency scenarios summary

Most hazardous scenario	Most likely scenario
Turn-key factory-fabricated technical equipment - Process Trains 1, 2 and 3	
Loss of integrity of the turn-key factory-fabricated technical equipment - Process Train - resulting in SGC spill, intensive evaporation from the spill surface, build-up and dispersal of FAM cloud (in open site - drift in the windfield), inflammation of the FAM cloud from ignition source (faulty electrical equipment or open fire) and its deflagration combustion with development of compression wave and fire in congested space (affecting factors - physical impact of fragments of fractured equipment, baric impact, thermal impact of open flame or heat radiation, toxic impact of combustion products).	LOC of the turn-key factory-fabricated technical equipment - Process Train - with emission (release) of hazardous materials, inflammation of the released material and development of jet flame or fire in congested space (affecting factors - physical impact of fragments of fractured equipment or impact pressure of the released jet, baric impact, thermal impact of open flame or heat radiation, toxic impact of combustion products).
Fuel gas system	
Loss of integrity of a pipeline and emission (release) of hazardous materials, dispersion, build-up of FAM cloud, followed by inflammation and deflagration combustion of FAM cloud (affecting factors - physical impact of fragments of fractured equipment, baric impact, thermal impact of open flame or heat radiation, toxic impact of combustion products).	LOC of pipeline and emission (release) of hazardous materials, dispersion, build-up of FAM cloud, followed by inflammation and deflagration combustion of FAM cloud (affecting factors - physical impact of fragments of fractured equipment, baric impact, thermal impact of open flame or heat radiation, toxic impact of combustion products).

[178] GBS LNG & SGC Plant. Design documentation. Section 12, Sub-section 1, Book 1. Industrial Safety Declaration, Vol. 12.1.1, LNG NOVAENGINEERING LLC, M., 2019

Most hazardous scenario	Most likely scenario
Flare system	
Loss of integrity of separator resulting in spill, intensive evaporation from the spill surface, build-up and dispersal of FAM cloud (in open site - drift in the windfield), inflammation of the FAM cloud from ignition source (faulty electrical equipment or open fire) and its deflagration combustion with development of compression wave and fire in congested space (affecting factors - physical impact of fragments of fractured equipment, baric impact, thermal impact of open flame or heat radiation, toxic impact of combustion products).	LOC of pipeline resulting in spill, intensive evaporation from the spill surface, build-up and dispersal of FAM cloud (in open site - drift in the windfield), inflammation of the FAM cloud from ignition source (faulty electrical equipment or open fire) and its deflagration combustion with development of compression wave and fire in congested space (affecting factors - physical impact of fragments of fractured equipment, baric impact, thermal impact of open flame or heat radiation, toxic impact of combustion products).
Inter-site pipelines	
Loss of integrity of a pipeline resulting in spill, intensive evaporation from the spill surface, build-up and dispersal of FAM cloud (in open site - drift in the windfield), inflammation of the FAM cloud from ignition source (faulty electrical equipment or open fire) and its deflagration combustion with development of compression wave and fire in congested space (affecting factors - physical impact of fragments of fractured equipment, baric impact, thermal impact of open flame or heat radiation, toxic impact of combustion products).	LOC of pipeline resulting in spill, intensive evaporation from the spill surface, build-up and dispersal of FAM cloud (in open site - drift in the windfield), inflammation of the FAM cloud from ignition source (faulty electrical equipment or open fire) and its deflagration combustion with development of compression wave and fire in congested space (affecting factors - physical impact of fragments of fractured equipment, baric impact, thermal impact of open flame or heat radiation, toxic impact of combustion products).

Maximum possible number of affected persons is 128 at Stage 1[179], 134 at Stage 2, and 65 at Stage 3.

The assessment of accident risks to operators of HPF GBS LNG & SGC Plant is based on the following parameters of human exposure:

- Potential spatial risk;
- Individual risk;
- Collective risk;
- Social risk.

The highest risks are related to potential failures of process equipment and pipelines during the operation and transportation of products with high media parameters.

The most hazardous component is the turn-key factory-fabricated technical equipment - Process Train 2[180].

In relation to this component, the risk parameters for HPF GBS LNG & SGC Plant are as follows:

- Accidents occurrence rate – $4.24 \cdot 10^{-3}$ year^{-1};
- Collective risk – up to $4.66 \cdot 10^{-2}$ man/year;
- Individual risk corrected for the shift pattern – up to $5.25 \cdot 10^{-5}$ year^{-1}.

Therefore, maximum individual lethal risk to personnel in case of accident is within 7.12·10-5 year^{-1}, i.e. below the statistically average (background) man-caused risk parameters (over past 5 years) related to industrial activity and everyday life in Russia.

Leakages of hazardous liquids (methanol, MDEA[181], aromatic hydrocarbons, wastewater, glycol, diesel fuel, etc.) and SGC[182] on soil and vegetation cover may lead to impact of high significance. Considering the

[179] Stages 1, 2 and 3 correspond to the commissioning of Process Trains Nos. 1, 2 and 3
[180] 2017-423-M-02-ДПБ1. GBS LNG & SGC Plant. Section 12. Subsection 1. Book 1. Industrial Safety Declaration. Vol. 12.1.1. M. 2019
[181] MDEA – Methyl diethanolamine
[182] Stabilised gas condensate produced at the Salmanovskoye (Utrenneye) OGCF - at the first stage of the field development, SGC consists of hydrocarbon fractions with boiling temperatures ranging from 45 to 610 degrees, and isopentanes. According to the hydrocarbon classification, fraction with boiling temperatures 30-200 degrees is described as benzenes, with boiling temperatures 200-300 degrees - as kerosenes. Therefore, gas condensate produced at the Salmanovskoye (Utrenneye) OGCF is a mixture of benzene (50%) and kerosene (10%) fractions of petroleum products, which also contains isopentanes (20%) and heavier fractions of hydrocarbons (10%).

low probability of leakages (based on international experience), the risk can be assessed as medium in magnitude.

Similar impact and risks are characteristic of hazardous liquids and SGC ingress into the ecosystem of the Ob Estuary and inland waterbodies. Gas condensate spills represent the biggest environmental hazard in the site-specific circumstances due to storage and transfer of large volumes of SGC, toxicity of its components for marine biota, possibility of condensate rapid spread, and limited spill response measures[183].

Scenarios of potential technical accidents and volumes of resulting SGC spills are summarised in Table 9.8.2.

Table 9.8.2: Technical accident scenarios at the Plant

Scenario characteristics		Spill characteristics		
Source	**Dispersion boundaries**	**Mass, t**	**Duration, h**	**Development**
Maximum design spill: Through loss of containment of SGC tank wall	Whole water area Port water area with booms	7342	81	Even
Credible spill: Crack in side wall surface of SGC tank	Whole water area Port water area with booms	6026	56	Even

Consideration has been given to the conservative scenario of accident at SGC storage facilities, where loss of containment occurs in the lower part of storage tank with a typical size (diameter) of 220 mm, and condensate escapes under action of hydrostatic pressure of the condensate column in the full tank. It is assumed that detection of leak will trigger stoppage of condensate supply to storage and automatic evacuation of condensate from the failed tanks.

Furthermore, spills of hydrocarbons in volumes smaller than the maximum design volume have been identified as possible in the following situations:

- Accident on pipeline supplying SGC for offloading to tankers – 1230 t;
- Accident at diesel fuel storage – 1.34 t;
- Accident at storage of oil used as heat transfer media in the technological process – 1.68 t.

Stabilised gas condensate is a liquid with specific gravity of 723.6 kg/m^3 and medium molecular weight of 96.57 g/mole, with prevailing C5 fraction and cleared off propane-butane fractions.

The Ob Estuary features a complex structure of currents. In the north, the main influencing factors of current velocities and directions are winds and tidal effects. In the southern section, surface currents are mainly shaped by the discharging rivers - Ob and Nadym in the Ob Estuary, and Taz and Pur in the Taz Estuary - the influence of which is also notable in the northern section (time-averaged), however, here it is not as important as the influence of tides and wind-induced currents. Prolonged action of the north or north-west winds which prevail in the northern section of the Ob Estuary in summer induces a current directed to the south. Position of the interface boundary of the wind-induced current and the constant discharge current (which is directed to the north) depends on the force and duration of wind, and actual river flow conditions.

The maximum quantity of condensate on surface in case of uncontained spill of specified volume is expected at calm weather and makes up about 600 tons in constant no-wind conditions, 81 hours after the release begins.

Spill behaviour in all conditions is characterized by intensive evaporation of gas condensate, mainly in the area where it reaches the sea surface, and depends on the spill area size (Table 9.8.3).

Table 9.8.3: Condensate spill areas

Time, h	Area, km^2				
	Calm	**3 m/s**	**5 m/s**	**7 m/s**	**10 m/s**
Maximum design spill					
1	0.05	0.07	0.09	0.10	0.13
2	0.09	0.07	0.09	0.10	0.28

[183] Safety data sheet 730370. ConocoPhillips, 2012. 13 p.

Time, h	Area, km²				
	Calm	3 m/s	5 m/s	7 m/s	10 m/s
4	0.09	0.25	0.31	0.36	0.28
6	0.17	0.46	0.58	0.66	0.61
8	0.25	0.69	0.86	0.98	0.96
12	0.41	1.19	1.47	1.67	1.71
24	0.86	2.82	3.51	3.96	4.22
48	1.57	6.55	8.04	8.91	8.74
72	2.29	6.73	8.27	9.13	12.19
81	2.56	7.35	9.06	9.97	12.68
96	3.02	6.89	8.46	9.36	4.69
120	3.62	7.06	8.65	9.58	0.20

Notes: 81 hours is the time when condensate release from the source ceases. The maximum design spill is estimated as 7432 t of condensate released from the source during 81 hours.

With the total spilled quantity of 7342 t, maximum possible contamination of water surface after 24 hours is 289.5 t (average 258 t), after two days – 352.4 t (average 308.9 t), immediately after condensate release from source has stopped - 423.7 t (average 367.5 t). After 5 days, remaining quantity of condensate on sea surface is estimated at 41.2-172.5 t (average 96 t), after 10 days - 128.2 t maximum (average 10.5 t). After release is stopped (81 h), the maximum quantity is 423.7 t (average 367.5 t).

On the other hand, if weather conditions support extensive removal of spilled material from the sea surface, only 186 t out of spilled 7342 t will remain on the surface at the end of release.

Dispersion may be a complex process, depending on the spill thickness on surface, wave height, depth to which detached droplets pass in water, and size distribution of the droplets. Larger droplets are fast to rise to the surface and rejoin the spill. Potential pollution of sea water depends on the proportion and mass of smaller droplets that remain in water and are transported by currents.

The maximum pollution of water at the surface will be caused by dispersion of 278.2 tons of spilled condensate (total spill spilled quantity 700 t) at the wind speed of 8.1 m/s during 180 hours in the area of 18.3 km^2. The primary pollution effect of dispersion is estimated at 10.4 mg/l at the depth down to 1.4 m. Then the spilled material is further diluted and transported by currents in the Ob Estuary, with assumed constant (flow) velocity of 0.1 m/s and depth of 10 m.

Potential impact on the Ob Estuary water is characterised by the following estimated levels of pollution:

- at 0.05 mg/l (hydrocarbons MAC for fishery water bodies) or higher - about 5.0 km^3;
- 0.1 mg/l (2 MAC) or higher – 2.72 km^3;
- 0.5 mg/l (5 MAC) or higher – 0.54 km^3;
- 5.0 mg/l (10 MAC) or higher – 0.05 km^3;
- 10.4 mg/l (maximum) – 0.026 km^3.

The above assessment is conservative, as it is made for dispersion of thin films of 1 μm, whereas MAC-level pollution of surface water layer of 1.4 m would produce a film of about 70 μm.

With a mixing depth of 1.4 m and seabed gradient of 0.005 near shore, potential settling of heavy residues on the seabed is conservatively expected within the 280 m strip along the shoreline. The quantity of settled hydrocarbons depends on the conditions in which spills approach the shore, and local littoral conditions.

Assessment of impact of potential condensate spills on atmospheric air

Potential spills of condensate may result in maximum daily evaporation of 2014.8 t of condensate to air (average - 1961.1 t, or 88.3% of the spilled quantity during the period); maximum evaporation during two days is 4177.7 t (average - 4115.4 t, or 92.6%).

Evaporation during the reference period is 95.6% to 98.1% of the total spilled quantity. The following findings are reported:

- A relatively weak dependence of evaporation on wind speed;
- Virtually constant intensity of evaporation in time indicates that intensity increment with spread of spill is offset by the reduction of evaporation intensity as a function of duration of spilled material presence on surface;
- Rapid drop of evaporation intensity by the time of cessation of the material release indicates that most evaporation takes place immediately at the source;

- Evaporation intensity nears zero in about 16 hours from cessation of leak (96 hours after the start), and further increment of evaporation due to the increasing surface area is offset by the decline in intensity as the reserve of light fractions is depleted.

The impact on air of pollution emissions from SGC spills has been assessed by pollution dispersion simulation for evaporation of diesel fuel in ground-level air.

The simulation assumed a fugitive emission source with the minimum spill area of 0.13 km^2, as the worst case scenario for the dispersion analysis. The analysis is based on pentane - the predominant component in SGC.

The maximum radius where 1.0 MACo.t. is reached during SGC spill is 12.3 km from plume edge, radius of the area of influence (0.05 MACo.t.) is 46.5 km.

The predicted impact is local in scale (considering the estimated spill volume and size of polluted area) and will not persist longer than the period of response operations.

In case of accidents, emergency release will be arranged through the flare system. One of the worst potential emergency scenarios is diversion to cold flare in case of failure of cooler control valve. With this scenario, the rate of gas flow diverted to flare will be 1,953,000 kg/h.

Characteristics of pollutants emitted to air are listed in Table 9.8.4.

Table 9.8.4: Pollution emissions due to emergency flaring

Pollutant	MACo.t., mg/m^3	Pollutants quantity	
		g/s	t/year
Nitrogen (IV) oxide (nitrogen dioxide)	0.200	257.93793	0.9286
Nitrogen (II) oxide (nitrogen oxide)	0.400	41.914914	0.1509
Carbon oxide	5.000	2149.482752	7.7382
Methane	50.00	53.737067	0.1935
Total		**2503.07267**	**9.0112**

The impact on air of pollution emissions resulting from this emergency scenario has been assessed by the analysis of dispersion of the combustion products in ground-level air.

GLC levels of pollutants in the reference points in case of potential accident are listed in Table 9.8.5.

Table 9.8.5: Ground level pollutant concentrations in the reference points during the emergency

Pollutant	Pollutant concentrations in reference points, proportion of MACo.t.		Area of influence (0.05*MPC), m
	TAC boundary	Nearest residential area boundary	
	RT1	RT2	
Nitrogen dioxide (nitrogen (IV) oxide)	0.26	0.01	22,300 m from the industrial site
Nitrogen (II) oxide (nitrogen oxide)	0.02	9.97E-04	nil
Carbon oxide	0.01	1.43E-03	nil
Benz/a/pyrene (3,4-benzpyrene)	4.45E-04	1.96E-05	nil

Outputs of the dispersions analysis demonstrated that concentrations of all pollutants emitted due to the accident will stay within the permissible limits applicable in residential areas, and the requirements will be met.

Assessment of potential impact on shores

Impact of spills on shores are characterized by

- Time and probability of potential approach of spill to the shore;
- Mass of spill that approaches the shore and causes the threat of pollution in specific local conditions (wind direction to the shore, tidal current phase, beach terrain in the approach zone);
- Extent of pollution brought by sea.

Average mass of pollution spread on shore is 1440 t, and maximum quantity may be 2407.4 t.

The available data demonstrate that:

- The release to shore stops growing at the time when condensate leak from the source ceases: by 81 h the maximum release quantity is 2384 t, and after that the magnitude of potential afflux to the shore is measured in dozens of tons;
- significant raise in release to the shore takes place in the time intervals 24-48 h and 48-72 h (520 t and 433 t, respectively, compared to 380 t during the time interval 0-24 h), as parts of spill that previously moved off the shore return again.

In certain weather conditions, condensate spills with pollution intensity higher than 10 μm can reach the western shore of the Ob Estuary about three days from beginning of spillage.

With the specified shore gradients, flooding and retreat of water is possible within 10-20 m strip of coastline.

Extrapolating these data to the eastern shore of the Ob Estuary, it can be conservatively assumed that condensate that reaches the shore will be spread within a 20 m coastline strip.

Considering the possibility of spread of spills along the coastline, the affected coastline may be as long as 50 km (about 35 km to the north and 15 km to the south of the facility location point).

The Ob Estuary has low sandy shores that are heavily waterlogged during the spill release. There is information that indicates oil sorption capacity[184] of sandy soil with a water content of 60-80 % being about 0.12-0.06 m^3/m^3.

If decontamination of such polluted area will be found reasonable, this will generate 0.39 to 0.64 m^3 of wastes per 1 m of decontaminated coastline (Arctic Council data).

The above assessment is conservative, since complete flooding of dewatered areas in summer is unlikely as water table at this time is low (summer low-water period), and wind surges at the eastern shore are hardly expected, due to the predominance of winds of north-eastern direction.

The variety of possible scenarios of ***spill dispersion in ice*** is very broad.

It is assumed that in typical conditions of the ice season ice cover in the port area will be partially broken by moving vessels, and an ice channel will be maintained on the western access route of the port.

Gas condensate can be spilled on open water near the GBS walls, or on ice and then drain to water.

By the time spillage stops, the sea surface is contaminated with 1119 tons of condensate which covers the whole area of the channel with a layer about 1 mm. After 120 hours, the quantity of condensate slightly decreases, and the spilled material concentrates in the section of some 300 m that can be described as end of channel, with the film thickness increasing to 20 mm.

Development of this situation has the following characteristic features:

- Spill that starts at the Process Train is pushed by eastern wind to the southern side of the ice barrier and approaches the port exit area within 3-4 hours from the beginning;
- The spill further spreads through the ice channel with a time-proportional growth in area size, and after 12 hours reaches the tentative "border" of the channel;
- In about 15 hours, spilled material fills the whole channel and starts accumulating in the end section - this process continues till spill release is stopped;
- Spill evaporation rate is even throughout the period of condensate spillage, but it nears zero as soon as spillage is stopped, i.e. most material is evaporated during the spill spreading in the port water area;
- During the period between cessation of release till about 96 hours, the spill area rapidly shrinks and concentrates at the channel end section.

The spill development pattern may differ from the above description. Western and north-western winds and blocked outlet from the port water area may lock most part of spilled material in the port. Ice cake in the port water area and ice channel will reduce the spill plume size roughly proportionally to the ice

[184] The notion of oil sorption capacity is applied to substrates and sorbents irrespective of the composition of concerned liquid hydrocarbons. In particular, it applies to ground and sorbent capacity to retain gas condensate (N. V. Chukhareva, L. V. Shishmina. Comparison of sorption properties of top and bottom peat in relation to commercial crude oil and stabilised gas condensate // Vegetable feed chemistry. 2012. No. 4. pp. 193-200).

concentration, and evaporation will decrease accordingly. With different dimensions of the ice channels, the spill front may stop closer to the facility or move further to the west.

Salmanovskoye (Utrenneye) OGCF Facilities Setup

The main causes of accidents at the Salmanovskoye (Utrenneye) OGCF Facilities Setup can be classified into three groups[185]:

- Loss of integrity (loss of containment) of process equipment, pipelines and fittings, and failures of safety systems;
- Human errors, late response or omissions in normal and abnormal situations, unauthorized actions of personnel; and
- External natural and man-caused impacts.

The main causes of breakdown and failures of equipment, pipelines and safety systems are:

- Structural failures of process equipment and pipelines;
- External mechanical damage of equipment and pipelines;
- Causes related to typical processes;
- Disruption of utility (power) supply.

Causes related to human errors, late response or omissions in normal and abnormal situations, unauthorized actions of personnel are:

- Infringement of job descriptions and process operation instructions;
- Erroneous actions during repair activity;
- Late decision making on activation of the right level of the safety system;
- Lack of response or erroneous response in abnormal situation;
- Conducting continuous or short-term hot works without special consent;
- Unauthorised resumption of works stopped by Rostekhnadzor;
- Instructions or directives issued by officers that force their subordinates to break the workplace health and safety rules;
- Operation of equipment and pipelines at the parameters outside the specified range;
- Tampering (damage), deactivation of the equipment explosion suppression systems, electric equipment automation and safety systems;
- Non-observance of fire safety rules.

The level of process automation imposes stringent requirements for personnel qualification and extra care. The highest hazards are related to errors at startup and shutdown, repair, preventive maintenance and other works with unstable process conditions, emptying and filling equipment and vessels with hazardous materials. Human errors may result in loss of containment and accidents.

External natural and man-caused impacts include:

- Lightning and static electrical discharges;
- Snowdrifting and abnormal drops (raises) of air temperature;
- Equipment exposure to affecting factors of accidents at neighbour facilities;
- Wilful acts (subversive activity).

The main contributing factors of occurrence and development of potential emergencies at CGTP and PGTP process facilities are:

- Large quantities of flammable and explosive materials (natural gas, gas condensate, methanol) circulating in the facilities;
- High process parameters resulting in significant mass fluxes of gas and condensate emissions from failed communication lines and untight equipment;
- Complex spatial orientation of the process pipelines;
- Congested installation of equipment in limited space, resulting in a high chance of accident cascading.

[185] Vol. 12.2.1. Part 2. Southern dome. Book 1. Industrial Safety Declaration of Hazardous Production Facilities. Salmanovskoye (Utrenneye) OGCF Facilities Setup. NIPIgaspererabotka JSC, Moscow, 2019

Specific types of potential accidents at the inlet facilities, and resulting impacts on the environment depend on circulating hazardous substances, their physical and chemical properties, technological processes, characteristics of the process equipment and devices, and their layout configuration.

Based on review of the original causes and factors defining the outcome of accident, and considering particular features of the applied process technologies, properties and distribution of hazardous substances, the following typical emergency scenarios can be defined for the gas pre-treatment site:

- Scenario 1 – release of hazardous substances without inflammation;
- Scenario 2 – fire of spilled combustible liquids on open site;
- Scenario 3 – outdoor explosion of FAM;
- Scenario 4 – indoor fire;
- Scenario 5 – explosion of FAM in confined space;
- Scenario 6 – burning gas "column" plume.

The main contributing factors of occurrence and development of potential emergencies at the well sites are:

- Explosive and flammable properties of produced gas;
- Significant quantity of flanged and welded joints resulting in frequent leaks of gas;
- Potential build up of combustible and explosive media in case of leaks, loss of containment and failures of process sections, which, in presence of ignition sources, may result in accidents with catastrophic consequences;
- High process parameters of gas extraction meaning that significant quantity of natural gas may be involved in accidents, which in turn determines the high energy potential, density and rate of energy release, explosion overpressure, and other shock wave parameters;
- Need to conduct gas-hazardous works;
- Need to provide maintenance of the wells equipment in adverse weather conditions, for the continuous technological process;
- Difficulty of containing an accident, possibility of uncontrolled open flowing during long time.

The main contributing factors of occurrence and development of potential emergencies in the field pipeline system are:

- Large quantities of flammable and explosive materials circulating in the facilities;
- High capacity of this mode of hydrocarbons' transport;
- High process parameters of the gas transportation system;
- Above-ground installation of pipelines (potential mechanical damage and significant range of action of the affecting factors of accidents);
- Significant length of pipelines;
- Poor transport access to the pipelines route;
- Extreme temperature conditions for the pipelines' operation;
- Nonsteady gas transportation process.

At the CGTP and PGTP sites, the most significant factors of accidents occurrence are:

- Significant gas mass flows resulting in high mass fluxes of emissions from failed communication lines;
- Concentration of hazardous substances in single process unit;
- Congested installation of equipment in limited territory;
- Complex spatial orientation of the external pipelines;
- Large quantity of locking, measuring and control fittings.

According to the available statistical data, up to 50% of gas line failure accidents (including field pipelines) are accompanied by inflammation of gas.

The most dangerous period is at the beginning of gas release and burning, when the rate of gas release and flame are maximal, and people have no time to evacuate from the hazard area.

Based on the estimation analysis, potential complete rupture of a flow-line is likely to affect 1 or 2 persons, maximum. The most likely (average) number of affected persons, considering the actual locations of workplaces and shift pattern of work at specific site, is 1 person. At the level of individual components of the hazardous production facility, the most likely emergency scenario is C6 - gas jet fire.

The most hazardous emergency scenarios are explosions of gas at the pig receivers and separation unit: Scenario C3 (death of 1-2 persons, with total number of affected persons up to 2).

Social risk to CGTP personnel (total annual occurrence rate of events with lethal outcome for 10 or more persons) per one rotation shift is estimated at 9.31×10^{-9} year^{-1}.

At other facilities, accidents with lethal outcome for ten and more persons are practically impossible, therefore, in accordance with the established terminology, it can be concluded that no social risk is present there.

Potential risk to the facility under the identified scenarios is $2,44\cdot10^{-5}$-$3,99\cdot10^{-4}$.

No residential units will be exposed to affecting factors of accidents at the declared facilities, even in case of the worst-case emergency scenarios.

Human exposure in case of potential accidents at the sites of Salmanovskoye (Utrenneye) OGCF Facilities Setup does not exceed the average individual risk at hazardous production facilities (average individual lethal risk to personnel in case of accident at HPF is $1.0x10^{-4}$…$1.0x10^{-5}$ 1/year).

The above level of risk to personnel of the designed facility is recognised as acceptable.

The lethal risk to third parties in case of accidents at the Salmanovskoye (Utrenneye) OGCF Facilities Setup is zero.

Terminal "Utrenny"

During the development of the project documentation186, the most dangerous scenarios associated with ship accidents in the port water area were identified:

• Collision of a vessel with an obstacle, grounding;

• Damage to the vessel in the operating water area with the release of oil products into the water body. The first scenario involves damage to the bottom of the vessel as a result of a decrease in navigation depth at the terminal, which could lead to the outflow of oil products from the fuel tank. The probability of this accident is estimated at 2.5 * 10-3 1 / year.

The second scenario takes into account the collision of the ship with the terminal as a result of difficult hydrometeorological conditions or violations of the rules for navigation of ships, damage to the ship's hull and the outflow of oil products from the fuel tank into the water area. The probability of this accident is estimated at 3.0 * 10-3 1 / year.

During the operation of the Utrenny Terminal, emergencies related to the bulk of ships on the CDP are also likely. For the analysis of emergency scenarios, various probable scenarios187 were considered, taking into account the participation in emergency situations of various types of ships, including:

• passing vessels (powered or drifting);

• LNG / condensate transport vessels (powered or drifting);

• harbor icebreaker (powered or drifting);

• tugs (with a working power plant or drifting)

Analysis of the likely scenarios revealed that:

• The frequency of the event (the bulk on the GBS of a passing vessel with a working power plant is negligible due to the fact that ships rarely pass by the GBS, and the foundations themselves are protected by a breakwater;

• It is highly unlikely that a tug-operated LNG / condensate carrier underway will be able to approach the berth at a speed sufficient to cause serious damage. It is also unlikely that a collision with a second cargo ship at the adjacent GBS could occur because when sailing, cargo ships move under the control of four tugs;

[186] 018-ЮР/2018(4742)-ДБГ3.1. Терминал «Утренний», Раздел 12, Подраздел 3, Декларация промбезопасности гидротехнических сооружений. Часть 1. Объекты инвестора, Том 12.3.1, - АО «ЛЕНМОРНИИПРОЕКТ», 2019.

[187] 3000-F-NE-000-HS-REP-1006-00, Ship collision study,-__ TechnipFMC, 2018

• The bulk of the port icebreaker on the GBS is most dangerous on the short side of the GBS. On the short side of the GBS, there are already cantilever structures. They can be severely damaged when the icebreaker crashes, but they do not have a significant effect on the integrity of the hull and are able to absorb some of the icebreaker's energy and reduce damage to the GBS from the short side. Thus, the risk from this scenario is negligible;

• The harbor tug is likely to cause less damage than the harbor icebreaker. Stacking frequency at high speed is considered extremely low as the tug will always operate under tight control. Due to the specifics of their work, tugs most often do not have any sharp hull elements. Typically, the bow of the tug is rounded to distribute the load and reduce damage. Thus, the risk of damage to the GBS body is very low.

Based on the analysis performed, the following conclusions were drawn:

• No additional analysis is required to assess the risks associated with the bulk of vessels moving around Arctic LNG gravity bases.

• The identified risks are negligible either due to the remoteness and security of the GBS facilities, or due to the very low impact speed and insignificant consequences due to the fact that the movements of a cargo ship near the CDP are controlled by several tugs.

9.8.3 *Potential nature of negative environmental consequences of accidents*

Impacts on the soils and vegetation

The facilities operation may cause negative impacts on ***soil*** in the adjacent areas, e.g. in case of spills of liquid hydrocarbons and methanol, diesel fuel, POL. Contamination of soil is possible during excavation activities and dismantling of temporary facilities at all construction sites.

Potential causes of such contamination are:

- Disregard of storage rules for POL, bulk materials and chemicals;
- Accidental spills of POL and chemicals to ground;
- Pollution emissions from operating vehicles and machinery;
- Unauthorized dumping of rubbish and wastes during the facilities' construction and operation.

Accidents with severest consequences are POL spills, as volatile aromatic hydrocarbons are readily degradable and dissipate from soil. Diesel fuel is very slow to degrade - the processes of destruction of certain compounds are inhibited by other compounds, some components transform into forms resistant to oxidation, etc.

Soil is cleaned by high-pressure water jetting to remove liquid hydrocarbons, or by collecting them with manual mop skimmers. Hydrocarbons washed-off to a water area contained with booms are then collected using low-capacity skimmers.

The hydrocarbon spill response tactics is focused to make sure that hydrocarbons are collected in water area, as much as possible, to prevent pollution of the coastline. Soil contaminated with liquid hydrocarbons must be removed (excavated(and transported for disposal offsite.

The impact of liquid hydrocarbons on local ***plants*** may last from several weeks to few years, depending on the composition of spilled product, on specific circumstances of its dispersion, and on the affected species. Plants living in large space of water are quicker to restore to the original (pre-spillage) state than those in smaller waterbodies.

Potential oil spill onshore will have cause a short-term and local negative impact within the construction site, without affecting soils and vegetation in the adjacent territories.

Impact on fauna

Potential explosions vapor-air mixtures may affect animals in the concerned territory directly (death, contusion, etc.) and indirectly (scaring off the breeding, hatching, feeding grounds, etc.).

Small mammals are receptors of the highest impacts of potential fires, which, if happen during the hatching season, may also cause loss of eggs and chicks, and other young animals. Animal habitats will be exposed to severe impact which may fully destroy their functions (food sources, shelter, etc.).

Liquid hydrocarbons may have **external effect on birds,** internal impact via digestive tract, contaminate eggs in nests as a result of indirect contact, and modify the living environment.

The direct impact on birds includes their internal and external contamination, contamination of nests with eggs and chicks (without lethal outcome), or contamination (poisoning, hypothermia, loss of immunity) with lethal outcome (loss of birds, chicks, eggs). Feather coat of sea birds is water-repellent, and if contaminated, it looses this protective function. Hydrocarbons permeate into feathers, stick to them and entangle their structure. In case of minor contamination, water fills the spaces in bird's feather coat which would normally be filled with air, which undermines thermal insulation and buoyancy. Bird affected by major contamination becomes physically heavier, its swimming movements become constrained, and flight impossible. Even with slight contamination of feathers, birds, if possible, rush to the shore where they continuously clean themselves with beak. This results in further damage of the feather coat structure. At the same time, some hydrocarbons get into the organism and the bird stops feeding. It is known that contamination of eggs in nest with liquid hydrocarbons may affect the chicks.

Hydrocarbon mixes in adult organism inhibit the reproductive instinct. Indirect impact on birds is caused by pollution of (all types of) soil, water, air, vegetation and animals (prey of birds), as well as complete or partial destruction of habitat by contamination with hydrocarbons. Another factor of indirect impact on birds is the deterioration of their forage base due to pollution and transformation of the environment. Contamination of territories and water areas with liquid hydrocarbons has the following negative effects on birds:

- Disturbance of natural habitats of birds, including protected rare species;
- Changes in the forage base productivity entail reduction of populations of nesting species and foreclose nesting of some of them, decline in nesting populations' productivity, including those of protected rare species;
- Any forms of contamination of the environment with hydrocarbons affect living conditions of birds, undermine forage productivity of biotopes for nesting, nomadic and migrating birds, and are particularly dangerous to mass gatherings of birds for rest, feeding, molting and nesting.

The birds' response to the above negative impacts is diverse. Rare and threatened species, and nesting birds during breeding season are exposed to the highest danger.

The populations' recovery after the impact depends on reproductive capability of those who survive, and on their ability to migrate from the area affected by spill. Since the designed facility is intended for offloading light petroleum products, their impact will be expressed mostly in respiratory and mucous membrane irritation, and in poisoning - i.e. toxic impact. Therefore, given that birds use the open water area for feeding or seasonal migrations, the indirect impact on birds may be expressed in depression of forage base, or in alteration of rest places during migration. Birds feature sufficient mobility to leave the affected area before irreversible stress conditions develop and start using alternative grounds for forage and rest.

The most vulnerable to contamination with petroleum products and other liquid hydrocarbons are birds that spend most time on water. Many of them migrate in flocks, which increases the risk of simultaneous contamination of multiple units. Slightly less vulnerable are black-backed gulls which spend most time on flight and often tend to avoid water areas with oil stains.

It should be noted that no mass nesting grounds of colonial birds have been found in the area of direct and indirect impact of the designed facility, and different species use water area of the Ob Estuary to a varying extent for their seasonal migrations. Therefore, potential hydrocarbons spill may affect feeding birds and cause temporary loss of some of their foraging grounds.

In case of hydrocarbon spills during the ice season, ice will serve as a natural barrier to protect marine biota from the harmful effects of direct pollution of water with petroleum products and gas condensate. It should be noted that in winter, fauna in the Ob Estuary is far scarcer than in warm season. The highest impact on birds is possible during ice-free period.

Impacts of hydrocarbon spills **on marine mammals** include direct negative effects of immediate contact with spilled materials or inhalation of fumes of toxic substances, and indirect influence via the food resources. The direct influence on marine mammals is related to internal and external contamination with components of hydrocarbon mixes (without lethal outcome) or contamination (poisoning, hypothermia, loss of immunity) with lethal outcome. The indirect influence on marine mammals is expressed in complete or partial disturbance of their habitat by petroleum contamination, and deterioration of forage base. Pollution of water area with liquid hydrocarbons has the following negative effects on marine mammals:

- Potential disturbance of natural habitat;

- All forms of nuisance (e.g. during the spill response operations) may (fully or partially) disturb feeding and increase mortality;
- Changes in the forage base productivity entail reduction of populations and decline in productivity of populations of marine mammals;
- Potential deterioration of living conditions for marine mammals, decline in forage productivity of biotopes, increased risks for concentrations for marine mammals, due to contamination of the environment.

Isolated encounters of single individuals of pinnipeds are reported in the coastal and water area within the zone of direct and indirect influence of the designed facilities. No mass haul-out sites and other concentrations of pinniped mammals are present in the examined area.

Potential accidents during construction of the planned facilities will be local and unlikely to cause any significant impact on fauna.

Invertebrates can be good indicators of hydrocarbon contamination, due to their limited mobility. Duration of impact of a spill of petroleum products and condensate on invertebrates may vary from a week to several months. It depends on the composition of spilled product, on specific circumstances of its dispersion, and on the influence of polluting substances on the organisms. Invertebrates colonies (zooplankton) in large space of water are quicker to restore to the original (pre-spillage) state than those in smaller waterbodies. This is due to higher dilution of spilled material in water, and higher chance of exposure of zooplankton in nearby waters.

Fish are affected by hydrocarbon spills through consumption of contaminated food and direct contact of spawn with the spill plume. Normally, fish (except young) would not be killed by a major spill of hydrocarbons. No mass death of adult fish is expected as a result of potential spills, however, petroleum products and condensate have diverse toxic effects on different fish species. Long-term or acute exposure may have a lethal or metabolic effect on heart function, it inhibits breathing, slows down growth, damages fins, causes negative biological and cellular alterations, and ultimately affects behaviour of fish in stress condition. Fish eggs and larvae which are often present at water surface and shallow waters are most vulnerable to the impact: besides the initial spill, they are also affected by hydrocarbons that accumulate in bottom sediments.

In the given conditions, suffocation (mass dying of hydrobionts due to lack of oxygen) is not a likely consequence of potential spills of liquid hydrocarbons. On the other hand, dispersion of spill will kill pelagic eggs and fish larvae in direct contract with hydrocarbons. The severest consequences for hydrobionts can be expected in relation to major spills of hydrocarbons[188]. For adult pelagic fish, the risk is not as high, due to the lower chance of contact with hydrocarbons, higher mobility and, possibly, ability to avoid contact with hydrocarbon film.

Accidents on pipelines and gas mains are related to potential loss of integrity with a release of energy content in the form of compressed natural gas. Failures of pressurized gas mains result in shock waves of expanding released product, and dispersion zones of flying debris and fragments of equipment. Failure of pipelines filled with combustible and highly flammable liquids results in spills of such liquids, and potential inflammation and development of compression waves due to expansion of combustion products.

Potential causes of accidents on pipelines may include external corrosion of metal pipes, stress-corrosion cracking; mechanical damage; poor quality installation; defective pipes and equipment; disregard of operation rules; natural disasters.

If gas is not ignited at the time of release from the pipeline, it is dispersed in the atmosphere, and gas hazard zones develop with boundaries defined by the lower flammability limit of methane in air (5% vol.).

The main factor that defines the size of gas hazard zones, their shape and potential movements of explosive cloud, is the intensity of gas leakage, as high-velocity jet release of gas is diluted with air to reach the lower explosive limit (5% vol.) at the jet velocity higher than wind speed; therefore, dependence on weather conditions is weak. Significance of impact on air can be assessed as low.

[188] SGC produced at the Salmanovskoye (Utrenneye) OGCF is a mixture of benzene and kerosene fractions (60%), isopentanes (20%) and heavier fractions of hydrocarbons (10%). The mechanism of impact of SGC on marine ecosystems are in many ways similar to the impact of light oil. In terms of the toxic impact on hydrobionts, condensate is comparable to light oils, but in some cases it has a "quicker action", due to its better solubility, even though it does not produce a stable film with comparable thickness.

Ruptures of pipes may result in significant damage to soils, vegetation, geological environment, and inland waterbodies. Underground installation is adopted for infield pipelines (condensate pipeline and methanol pipeline) which are installed in a common trench. Failure of these facilities may modify the terrain (appearance of pit in the place of rupture) and cause thermal impact on permafrost (fire in pit). The extent of such impact can be few hundred meters, maximum. The impact of this sort can be assessed as high.

Potential impact on geology is reduced by installing gas flow-lines at the minimum height of 0.5 m above ground surface.

Leakages of cryogenic media (possible at the GBS LNG & SGC Plant) result in embrittlement and subsequent collapse of structures. This may damage health of personnel, and emergency leakage and emissions of hazardous liquids and gases that pollute air, water and soils with detrimental effects on fauna, particularly marine animals. The global experience shows a low likelihood of such impact, therefore, the risks should be considered as medium.

Waste management

At the operation stage, potential accidents can be caused by loss of containment of pipelines due to mechanical damage, corrosion, poor quality installation, defective pipes and equipment, disregard of operation rules, natural disasters.

The accident response operations will produce the following main types of wastes:

- Construction and repair waste (debris);
- Welding slag;
- Scrap and waste containing uncontaminated ferrous metals in the form of products and pieces, unsorted;
- Oily rags (spent PPE of personnel involved in accident response operations).

The waste management functions include waste minimisation strategies, as well as temporary storage, transportation, decontamination, utilisation and disposal of all types of wastes generated by the accident response operations.

All produced wastes must be collected and removed from the work site to dedicated temporary storage facilities, before treatment, utilization and disposal.

The temporary storage facilities shall meet the following requirements:

- Prevention of secondary pollution of the environment;
- Monitoring of the state of wastes;
- Access to wastes for collection and loading for transportation.

Selection of hydrocarbon spill response method should be guided by the following principles:

- All activities must be completed within shortest time;
- Environmental damage from the oil spill response activities should not be greater that damage caused by the spill itself.

Emergency impact on DCA

There are no designated conservation areas within the Project area. DCAs nearest of the designed facilities are Gydan Nature Reserve of federal significance (113 km to the north-east of the PLANT site), and Messo-Yakhinskiy State Wildlife Sanctuary of regional significance (340 km to the south-east of the designed construction site). Other DCAs and Important Bird Areas (IBAs) are located far from the planned area of construction of the Plant and associated facilities.

Considering that potential accidents with combustible natural gas (mostly methane) are local in scale and limited in duration (few dozens of minutes, maximum), no impact on DCA is expected. Most part of damage is due to the heat radiation from burning released gas that can affect a limited area and cannot affect the DCAs located at a significant distance from the Project facilities.

9.8.4 Hazardous Natural Processes and Phenomena

This Section describes certain hazardous natural processes that may cause accidents.

Seismicity. The maximum magnitude of potential earthquakes in the area of the planned activities is 5. The Project facilities are designed to withstand this seismic impact. Such earthquakes will not lead to significant material damage, and will only be felt by people outside the buildings.

Thawing of permafrost in the area of the planned activities may be caused by the influence of heat radiation of flare units, heating and summer temperatures, and may lead to structural instability. Degradation of permafrost can entail outbursts of interpermafrost brines (cryopegs) and gases accumulated underground - the latter may lead to a short-term hazard of explosion and fire near the offloading site.

Another part of hazardous natural processes that can lead to accidents at buildings and structures is related to weather conditions in the area of the planned activities.

Extremely cold temperatures, snow cover and icing are common for the Arctic region and may lead to failure of outdoor and indoor equipment, flare unit blocking, increased load on the buildings and structures roofs, freezing and rupture of pipelines, icing of hard surfaces and wires, hinder emergency evacuation.

Thick fog may lead to collisions between vessels and collisions of vessels with the Process Trains, onshore road accidents, aircraft accidents, malfunctions of fire / gas detectors and hinder emergency evacuation.

Strong wind is common for the Arctic region and may lead to degradation of communication quality, destruction of structures and hinder emergency evacuation.

The third group of hazardous natural processes in the area of the planned activities is related to hydrological, hydrochemical and ice conditions of the Ob Estuary water area.

Drifting ice can have a destructive mechanical effect on hydraulic structures and onshore facilities.

High-salinity environment in the Ob Estuary accelerates corrosion.

Wave action and water level rise (e.g. due to wind surge combined with tide) may lead to delayed vessel loading and damage of onshore facilities.

9.8.5 Mitigation of Emergency Risks and Minimisation of Impacts

9.8.5.1 Designed mitigations for construction emergency risks

Emergency risks at the Project construction phase will be mitigated by a system of management and technical measures, including:

- Performance of all works in line with the process procedure, meeting the occupational health, explosion safety, electrical safety, industrial and fire safety requirements.
- Equipping construction sites with standard containers for domestic and building wastes.
- Prevention of discharge of waste lubricants, fuel, oil, industrial and domestic waste, and other pollutants into water and adjacent territory (use of protective casings, trays and drain tanks).
- Collection and removal of highly contaminated soil surface layer to a safe location, in case of accidental spill of hydrocarbons on soil or snow/ice surface.
- Development of the Shipboard Marine Pollution Emergency Plan for Noxious Liquid Substances (According to MARPOL 73/78).
- Development of the Oil Spill Prevention and Response Plan (OSPRP).
- Involving a specialised contractor for detection and tracing, prevention, identification and elimination of hydrocarbon spills in the Ob Estuary;
- Creation of a hydrocarbon spill response facility for storage and maintenance of machinery, oil spill response equipment (oil skimmers, sorbents, containment booms, buoyancy tanks, etc.).
- Compliance with all navigation-related safety regulations.
- Making sure that vessels hold adequate navigation patents.
- Coordination of routes, navigating zones and anchoring berths in the area of the planned activities.
- Approval of navigation aids specifications by the RF MoD General Directorate of Navigation and Oceanography.
- Performance of operations using seaworthy vessels and with complete crew.
- Using of double-hulled vessels.
- Equipping seagoing ships in accordance with the requirements of the International Association of Lighthouse Authorities.

- Equipping vessels with signal lights, flags and sound signalling systems.
- Provision of navigation waterways signs.
- Servicing of vessels by special ships for waste and wastewater collection and for bunkering assistance.

9.8.5.2 Designed mitigations for operation emergency risks

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Prevention of accidents and mitigation of their potential impacts will be achieved by means of[189]:

- Integrated Control and Safety System (ICSS) for automatic monitoring of technological processes, automatic and automated on-line process control, ensuring safety and controllability during normal operation, and in the transition and pre-fault conditions, and for protection and safety shut-down in case of accident threat. All ICSS data and signals are communicated to the operator workstations (OWS) in the central control room (CCR) via a human-machine interface (HMI);
- All main and auxiliary production facilities are controlled from OWSs in the Central Control Room (CCR) in the central control building (CCB). CCR provides centralized coordination at the Plant-wide level during normal operation and in emergency mode. Operator workstations Nos. 1-9 serve the turn-key factory-fabricated technical equipment - Process Trains No.1, No.2 and No.3, operator workstation No.10 serves the onshore facilities. The Main Equipment Room (MER) with non-operational equipment of the control systems is also located in CCB. The CCB building features an explosion-proof design to withstand a minimum shock wave overpressure of 5 kPa. CCB is located outside the explosion hazard zone, as per EIC. The building fire rating is II;
- The ICSS system includes a Safety Instrumented System (SIS) comprising emergency shutdown (ESD), fire detection (FDS), and gas (detection) system (GDS). SIS prevents occurrence of emergency situations in case of nonconforming process parameters that define explosion hazard of the process, and in case of abnormal drop or instrument air pressure, loss of facility power supply, fire, abnormal gas concentrations in air production zones, and ensures safe shutdown or transition of technological process to a safe mode in accordance with preset sequence;
- The gas (detection) system (GDS) is a part of the safety systems. Its function is to mitigate effects of any gas emissions for protection of personnel, environment and property. GDS continuously monitors the facilities and initiates protection measures and shutdown operations (via ESD) in accordance with the system's causal relationships;
- The fire detection system (FDS) is a part of the safety systems. Its function is to mitigate effects of fire. FDS continuously monitors the facilities and initiates protection measures and shutdown operations (via ESD) in accordance with the system's causal relationships. FDS interacts with the addressable fire detection system (FAS) being a sub-system of FDS. FAS is responsible for detection of fires in buildings and controls addressable devices (e.g. smoke and heat detectors, manual alarm calls) within multiloop systems;
- The emergency shutdown (ESD) system is a part of the safety instrumented system. Its main function is shutdown of the processes and equipment in the Plant in accordance with preset shutdown level, and their transition to safe mode in emergency situations. ESD carries out emergency shutdown in accordance with the causal relationships process schemes and description of the interlocks;
- For safety, the Plant is divided into fire areas (sectors) to limit the size of hazard zones, and accordingly the scale of effects of potential dangerous situations within the sectors. Fire area is isolated by closing emergency shutoff valves (ESV) at the systems' boundary, for all flows of highly flammable or combustible media to and from the respective area;
- Shutoff devices with remote control are provided on all process pipelines with explosive and flammable media, including feed natural gas, and at the inlet/outlet of each turn-key factory-fabricated technical equipment (Process Trains No.1, No.2, No.3);
- A fast-acting magnetic shutoff valve is provided on each gas inlet of the boiler house;
- To prevent backflow of pumped liquid, a check valve is provided on discharge side of each pump;
- Equipment, fittings, pipelines are selected for dimensioning pressure equal or higher than corresponding source pressure, and safety valves are provided as appropriate, with blowdowns directed to a closed flare system;

[189]Vol. 12.1.1. GBS LNG & SGC Plant. Section 12. Subsection 1. Book 1. Industrial Safety Declaration. LNG NOVAENGINEERING LLC, M., 2019

- Groups of apparatus and equipment where spillage of product is possible, are arranged on impermeable platforms with a continuous perimeter curb to a minimum height of 0.15 m;
- Aircraft flights (including helicopters) over the Plant are prohibited;
- Pipelines and equipment are adequately insulated to prevent freezing of products and condensation of humidity from air on pipelines' and equipment surfaces;
- The design provides for electric trace heating of pipelines and process tanks, to prevent freezing;
- The flare system will be continuously purged with fuel gas. If fuel gas is not available, nitrogen will be used as a backup fuel;
- The gas check valve is designed to prevent ingress of air into the flare system through the flare stack face, and minimise purge gas consumption;
- The height of flares at maximum release of gas, and their layout positions are defined by heat flux density calculation;
- Structures of the modular boiler house building and other buildings of category A include blast-relief elements (explosion window units) at the minimum rate of 0.05m2 per 1m3 of airspace in the boiler room.
- The fire endurance requirements for the main bearing structures of stack frames, modules, production premises are met;
- The fire protection agents applied on surface of steel structures within the zone of potential spills of cryogenic liquids are resistant to impact of such liquids and ensure the required fire endurance of the structures after such impact;
- The design provides for lightning protection and protection against static electrical discharges;
- The premises will have a continuously operating mechanically-induced combined extract and input ventilation system that will maintained a guaranteed space air overpressure;
- Cabling and process piping with detachable (flanged) joints installed on common racks will be divided by means of a horizontal fire-proof membrane;
- The design provides for a fire public address and evacuation management system (PAES);
- Automatic gas fire extinguishing systems (GFES) will be provided for extinguishing of class A, B, C fires, and of burning live electrical installations;
- Two fire water tanks each with nominal capacity of 600 m^3 are provided for the fire water stock; A fire water pumping station is provided. Fire hydrants will be installed on the external fire water supply system;
- Design and material of the process pipelines are designed to meet the strength requirements within the working range of temperatures and pressures of the circulating media, and to withstand corrosive action of the media. Strength and corrosion resistance of the pipelines at operation are ensured by the correct selection of material, wall thickness, and corrosion allowance;
- Cryogenic pipelines are designed considering potential thermal deformations due to temperature differences between the upper and lower parts of the pipeline; the short-term dynamic loads at actuation of safety valves, build-up of liquid plugs in gas flow, and pressure surges;
- 100% of flare systems and cryogenic systems are subject to nondestructive ultrasonic/X-ray testing;
- The pipeline diameters are selected in compliance with allowable product flow velocities recommended in applicable codes and standards, considering explosive nature of the products and their physical and chemical properties;
- The number of flanges in the pipeline systems is minimised. Flanges are in most cases intended for connection of equipment, integrated flanged elements and valves, to facilitate maintenance and inspection;
- Welded connections will be used for installation of fittings on process pipelines transporting cryogenic media, with the exception of fittings requiring regular inspection, testing and maintenance, e.g. check valves, safety valves, control valves;
- Corrosion protection of the pipelines is designed to prevent corrosion of their inner and outer surfaces. External corrosion protection is achieved by applying high-quality paint coat on all equipment and pipelines in the onshore area;
- The active cathodic protection is provided by cathodic protection stations (CPS) with remote control capability including remote adjustment of output parameters;
- The design provides for obstruction lights on flare unit;
- Pipeline sections overpassing the roads may not include any fittings, drainage devices and detachable connections. Pipelines installation height is compliant with the regulatory requirement for a minimum height of 5 m above the road surface.

The following fire safety engineering systems are provided for the Plant facilities[190]:

- Automatic fire alarm systems;
- Public address and evacuation management systems;
- Automatic fire extinguishing units;
- Water extinguishing units.

The site fire detection system designed for the main and auxiliary elements within the Process Trains, is a distinct element of the integrated facility management and safety system. The fire detection system performs the function of automatic fire alarm unit.

Automatic fire alarm systems are provided at all premises with explosive or flammable zones, irrespective of their size.

The fire detection system (FDS) provides the following levels of control and management:

- Field level (lower) comprising annunciators of primary fire factors, manual alarm calls, actuators;
- Medium level including certified industrial programmable logic controllers (PLC) of the fire detection system, and fire alarm control panels;
- Operator (upper) level with a workstation of the operator of the integrated automated control and safety system (IACSS).

The lower level of FDS is represented by field fire detection equipment. The designed field fire detection equipment (automatic and manual fire detectors) is installed at the process platforms and outdoor installations.

Depending on the type of protected premises, the following fire detectors are provided:

- Flame detectors;
- Smoke detectors;
- Heat fire detectors.

Also, the design provides for manual fire alarm calls.

The public address and evacuation management system (PAES) is intended to alert personnel in case of fire in closed or open spaces of the designed facilities, and in the buildings.

The integrated PAES will include the following equipment in the protected buildings and installations: Type 1 (audible) for single-floor production buildings, Type 2 (light and audible) and Type 3 (public address devices for playing pre-recorded messages, or direct verbal announcements) for administrative and public premises, and the dormitory.

The design provides for installation of automatic fire-extinguishing units (drenchers) in some buildings, installations and process units (modules).

Drencher curtains will be provided along the whole length of mooring zone, to protect the GBS from fire on a vessel. Separate drencher systems are designed for each module.

Water sprinkling is designed to protect structures and installations by reducing heat flows in case of fire. The drencher systems are designed in a way to prevent direct contact of water jets with spilled LNG, to avoid enhancing the product evaporation.

Process facilities with HIL and FL[191] will be equipped with automatic foam fire-fighting drencher units intended to extinguish the sit of fire, distribute and release fire suppressant.

Automatic foam fire-fighting drencher units will be provided at:

- Acid gas unit module;
- Coolant system module;
- Coolant system module (heating oil) and ventilation chamber;
- Coolant pumps module;
- Coolant system module (water/glycol) and ventilation chamber;
- AGRU solvent makeup pumps module;

[190] Fire-fighting plan. GBS LNG & SGC Plant. 01/19-ПТП, Novy Urengoy, 2019.
[191] HIL and FL – highly inflammable and flammable liquids

- Boil-off gas compressor station;
- Gas condensate custody transfer metering facility.

The automatic gas fire extinguishing system (GFES) represents a system of fixed equipment for extinguishing of fire seats by automatic release of fire-extinguishing gas, which are installed in permanently manned premises. Automatic release of a designed quantity of fire-extinguishing medium is triggered by operation by at least two fire annunciators in the protected rooms and spaces. Magnetic contact detectors are provided at the entrance doors, so that automatic start of the unit can be blocked if people are present in the protected premises.

At the end of GFES operation, gas and products of burning are removed from the protected zone by a gas extraction system.

Fire fighting system of the GBS LNG & SGC Plant is designed to provide fire water flows as required for the LNG Plant facilities. This system features a self-sustained design, due to the large flows of fire water, more stringent requirements to the water quality and pressure. Furthermore, each of the GBS Process Train is provided with a separate fire water supply system with dedicated pumping stations at the lower levels in GBS. The water source is GBS ballast water taken from the Ob Estuary.

In Arctic and marine conditions, all equipment of active fire protection will be properly protected against the impact of low temperatures and corrosion. The personnel will pass a fire safety training: basic fire safety and fire safety briefings.

Fire guard for the facilities located in the "North" zone (including the Plant) will be provided with the fire station combined with the gas rescue service (GRS) under the Emergency Rescue Centre (ERC).

The following fire-fighting vehicles will be available at the fire station[192]:

- fire tank truck (ATs 6.0-150) – 4 units;
- fire-fighting distributor truck (PNS-150) – 1 unit;
- fire-fighting hose tender (AR-2) – 1 unit;
- foam fire-fighting truck (APT-7-100) – 1 unit;
- foam tower truck (PPP-37) – 2 units;
- fire emergency rescue vehicle (ASA) – 1 unit.

Auxiliary fire-fighting equipment (towed water/foam monitor (UKTP-150)) – 2 units.

Estimated time of arrival from the fire station to the Plant is less than 10 minutes.

A duty (day) shift personnel at the Fire Station includes 32 fire fighters and 3 fire prevention officers. The total number of shift personnel is 62. Total number of staff of the Fire Station is 124.

In compliance with the sea pollution control requirements, all emergency response vessels shall have adequate design and equipment for collection and disposal of water contaminated with liquid hydrocarbons, as well as equipment for prevention of spillage and leakage of POL and other hydrocarbons in line with the rules of the Russian Maritime Register of Shipping. Tanks used for collection of contaminated water shall have sufficient capacity as determined for the specific area of navigation and nature of vessels operation, including terms of their maintenance in ports.

All emergency response vessels used for liquidation of accidental spills of hydrocarbons shall be adequately certified by the Russian Maritime Register of Shipping, including seaworthiness certificate, certificate of class, certificate of prevention of pollution with hydrocarbons, wastewater and solid waste.

Wastewater will be collected by means of standard hook-up devices. Reception of liquid wastes shall be arranged in a way to prevent spillage on the water area or the port territory. Accepted quantity of liquid wastes is defined by on-board measurements in tanks of the vessel transferring the wastes, and in the receiving vessels of the shipboard wastes collector. All waste flows will be transported by dedicated pipelines and hoses, to avoid their mixing. All operations for transfer of wastewater contaminated with hydrocarbons and other wastewaters are recorded in special log book (Sewage Record Book). All types of wastewater and refuse generated during performance of the works are transferred to waste collection vessel equipped with adequate containers. All types of solid and liquid wastes generated during hydrocarbon spill response operations are transferred to licensed companies.

[192] GBS LNG & SGC Plant. Section 9. Fire safety measures. Vol. 9.2.1. M., 2019.

Utrenniy Terminal and berth structures

Accidents will be prevented and impacts minimized by means of[193]:

- Observance of Russian regulations defining the principles of buildings safe operation, ensuring fire safety, development of civil defence and emergency prevention measures;
- Automation of handling operations in order to prevent leakages and spills;
- Equipping the fuel berth with automatic petroleum products transfer system (cranes with emergency prevention system in case of uncontrolled gas carrier movement);
- Monitoring of the process equipment operation mode, verification of adherence to transfer technology for bulk fuel and lubricants (diesel fuel), timely preventive maintenance of loading arms, joints and diesel fuel transport pipelines;
- Development of the Shipboard Marine Pollution Emergency Plan for Noxious Liquid Substances (According to MARPOL 73/78);
- Developing the Oil Spill Prevention and Response Plan (OSPRP[194]);
- Adhering to the "Rules of recording of operations with oil, oil products and other substances dangerous for human health or marine bioresources, as well as their mixtures produced on ships and other watercraft";
- Involving a specialised contractor for detection and tracing, prevention, identification and elimination of oil spills in the Ob Estuary;
- Storage and maintenance of machinery, oil spill response equipment (oil skimmers, sorbents, containment booms, buoyancy tanks, etc.).

The management and technical measures are defined in the Oil Spill Prevention and Response Plan (OSPRP)[195].

The following technical measures are planned:

- Most process equipment is installed outdoors, and pumps are located in dedicated indoor premises;
- Stationary automatic detectors of pre-explosive concentrations are provided at the outdoor site and indoors;
- Increase of the lower ignition concentration limit (LICL) in air in the production premises will actuate emergency ventilation, and outdoor audible and light alarms at the entrance doors. The gas contamination alarms are communicated to the control room and actuate light and audible alarm;
- Increase of the lower ignition concentration limit (LEL) in workplace air in the outdoor sites will actuate an alarm signal;
- Adequate automatic interlocks are provided to protect equipment and personnel and prevent occurrence of accident in case of nonconforming main process parameters, abnormal operation of equipment due to unplanned disruption of supply of feedstock, fuel, power, instrument air;
- Indication of parameters that characterise safe running of the process is provided;
- Technological processes are divided into individual process units, and energy level and explosion hazard category is defined for each unit;
- Division of the process schemes is determined in a way to minimise explosion hazard of the process units;
- Pipelines transporting combustible and explosive media between the units are provided with shut-off valves for emergency isolation of each process unit;
- During preparation for maintenance, liquid petroleum products are drained from equipment and pipelines via drainage valves to drainage vessel (road tanker) and further to charging stock tanks;
- Version of the electrical equipment is selected considering the properties of media circulating in the process;
- Inert gas is used for process system purging.

The following measures are intended to insure navigation safety in the water area of the Terminal:

- Compliance with all navigation-related safety regulations;

[193] 89.03.14.8.061-OTP. Vol. 3.1. Utrenniy liquefied natural gas and stabilised gas condensate terminal

[194] The title refers to the definition of an Oil Spill Prevention and Response Plan. Here and in all other similar contexts, word "oil" is used as a synonym of liquid hydrocarbons of any composition, including crude and commercial oil, petroleum products, gas condensate. The Project does not provide for production or use of oil, however standard names of documents and activities to be considered or implemented in relation to the Project do include word "oil" and "petroleum products". No special requirements for prevention of gas condensate spills have been adopted in Russia.

[195] Section 12. Book 5. Oil Spill Prevention and Response Plan (OSPRP) Activities. Utrenniy liquefied natural gas and stabilised gas condensate terminal. Vol. 12.5. JSC LENMORNIIPROEKT, StPb, 2019

- Making sure that vessels hold adequate navigation patents;
- Coordination of routes, navigating zones and anchoring berths in the area of the planned activities;
- Approval of navigation aids specifications by the RF MoD General Directorate of Navigation and Oceanography;
- Performance of operations using seaworthy vessels and with complete crew;
- Using of double-hulled vessels;
- Equipping seagoing ships in accordance with the requirements of the International Association of Lighthouse Authorities;
- Equipping vessels with signal lights, flags and sound signalling systems;
- Provision of navigation waterways signs;
- Servicing of vessels by special ships for waste and wastewater collection and for bunkering assistance.

Power supply facilities to support construction, hydraulic filling and drilling operations at the Salmanovskoye (Utrenneye) OGCF (PIR-1)

Accident prevention and minimisation of impact on various components of the environment in relation to the power supply facilities for the construction, hydraulic filling and drilling operations will be achieved by the following measures[196]:

- Application of process equipment, shutoff, control and safety valves, pipes that comply with the applicable health and safety requirements, technical specifications of the manufacturers in Russia, and climatic conditions in the area of construction;
- Provision of control, automation, safety devices on the process units, to ensure safe and reliable operation;
- Preference is given to welding joints for gas lines and pipelines transporting flammable and toxic media;
- Quality control of welded joints of pipes by non-destructive methods (ultrasonic testing with subsequent X-ray examination of defective sections);
- Provision of fire-suppression system for the process units;
- Monitoring process parameters and communication of nonconformity signals to the Plant operators, alarm signals of elevated levels of process parameters, and automatic interlocks for safe operation;
- Provision of automatic accident-prevention system designed to ensure explosion and fire safety, prevent occurrence of accidents, their containment at all modes of operation, safe shutdown or transition of technological process to a safe mode triggered by automatic alarm signal (gas, fire, etc.) or on remote signals (commands) from operator;
- Automatic or remote isolation of accident section, ensuring explosion and fire safety, prevention of escalation of industrial accidents;
- Materials and design of vessels and pipelines are selected to ensure robustness and safe operation within the whole range of working pressures and temperature;
- Vessels walls thickness is defined considering the design service life and the adverse impacts (corrosion) with contacting internal and external media;
- Outer surfaces of equipment and pipelines are covered with corrosion protective coating;
- Protection against mechanical impacts, hydrate blockage, erosion wear of equipment and pipelines;
- Provision of stationary continuously functioning detectors of pre-explosive concentrations in the indoor premises and outdoor sites where process units are installed;
- In the explosion-hazardous production premises, emergency extraction ventilators are interlocked with gas detectors, so that ventilators automatically start on the warning signal from detectors of pre-explosive concentrations;
- Emergency ventilation system is provided in premises where spontaneous release of large quantities of noxious or combustible gases and fumes is possible. Emergency ventilation systems will start automatically on signal from gas detectors when noxious substances levels raise above MAC, and concentrations of combustible substances in indoor air raise above 10% of the lower concentration limit of flame propagation (LCFP) of gas-air and vapor-air mixture, and on remote signal from the common push-button located outdoors at the main evacuation exit;

[196] Salmanovskoye (Utrenneye) OGCF Facilities Setup. Gas supply for the power supply facilities to support construction, hydraulic filling and drilling operations. Design documentation. - YUZNIIGIPROGAS INSTITUTE LLC, 2019

- In the premises equipped with automatic fire extinguishing units or automatic fire alarms, the above systems will be interlocked with ventilation systems which will be shut down automatically (except for the air supply to airlock rooms in premises of category A);
- Input ventilation units for the explosion and fire-hazardous premises will be installed in separate rooms – ventilation chambers.

The following main measures are planned to protect personnel in potential emergency situations:

- Proactive planning of personnel protection measures in case of potential accidents;
- Training of personnel on possible hazards, including emergency drills and practical training on the use of respiratory protective equipment.

Salmanovskoye (Utrenneye) OGCF Facilities Setup

The following management measures are designed to mitigate impact of potential accidents during operation of the Field facilities:

- Ensuring preparedness of the emergency response forces and equipment at all times;
- Provision and storage of a set of emergency tools and equipment for emergency response;
- Training of operator's personnel on emergency response skills, development of Emergency Response Plan for the declared facility;
- Thorough control of the state of equipment and pipelines;
- Timely diagnostic checks of the state of equipment and pipelines.

The main measures to be taken in case of threatened or actual industrial accident, emergency or natural disaster:

- Notification of command centre, emergency response resources, operator's personnel;
- Activation and deployment of command centre and emergency response resources;
- Enabling activities of the resources involved for emergency response operations;
- Managing interaction between command centre and resources involved in emergency response operations;
- Conducting rescue and other urgent operations (ROUO).

Training of the operator's personnel on emergency response skills in case of natural and man-caused emergency situations, and training of the Outsourced Accident Rescue Group (OARG) will be provided in accordance with the approved programmes.

Technical measures for prevention of emergency situations and mitigation of their risks at the PIR-5 facilities of the Salmanovskoye (Utrenneye) OGCF Facilities Setup are listed below:

- Construction of dams, embankments, membranes, drainage channels and accumulation sites to prevent contamination of soils and ground water;
- Construction of open drainage systems for collection of rain, fire and wash water, and leaked hazardous and non-hazardous liquids from the modules' floors;
- Isolation of equipment containing potential pollutants, by bunding and kerbs;
- Installation of tanks for collection of industrial wastewater and runoff below the modules' floor level;
- Provision of anti-spill kerb of concrete foundation wall blocks to the height of 0.15 m above hard paved surface of the sites, to prevent spread of spilled material from the diesel fuel site at GTPP;
- Provision of impermeable membrane of bentonite mats 'Bentomat', to prevent seepage of spilled process liquid into soil;
- Hard paving of the sate inner territory;
- Skirt of compacted soil with crushed stone on the outer side of the site anti-spill kerb;
- Waterproof membranes under tank bottoms at the POL and methanol storage sites (minimum thickness 50 mm under tank bottom centre, and at least 20 mm at the perimeter);
- Stormwater drains connected to the site drainage system, in the territory of each compartment for collection and disposal of process liquids in case of accidentals spillage;
- Sealing of technological process;
- Full automation of technological process;
- Strict observance of process regulations;
- Protection of equipment and pipelines against impact of static electrical discharges;
- Lightning protection;

- Timely checks and repair of pipelines and fittings;
- Light and acoustic alarms of the most dangerous process deviations;
- System of distributed sensors and continuous monitoring of gas levels in the territory (for explosive and flammable media);
- Remote group shutdown of electrical equipment.

The Emergency Response Plans provide for the following:

- Prompt emergency response by the operator's personnel;
- Ways and methods of liquidation of emergencies and their consequences;
- Sequence of actions to prevent (minimise) potential fires and explosions, mitigate potential consequences of accident;
- Evacuation of personnel not involved in liquidation of consequences of emergency from the hazard area.

For the purpose of emergency prevention and response at the designed facilities, and to protect the Company's personnel and property from potential natural or man-caused emergency situations, an *Emergency Rescue Center* will be established comprising a Fire Station and a Gas Rescue Station.

The following equipment will be provided for the Emergency Rescue Center:

- Fire tank trucks;
- Foam extinguishing road tanker;
- Communication and lighting vehicle;
- Equipment and materials for liquidation of emergency hydrocarbon spills.

Fire protection of the facilities located at the sites of the GBS LNG & SGC Plant, temporary accommodation camp, administrative area, field camp will be provided by Fire Station of category III with six vehicles.

Involvement of the emergency rescue services in the rescue and other urgent operations (ROUO) will be managed in compliance with the civil defence and community safety plans, emergency prevention and response plans, and also based on decisions of officers in charge of ROUO and emergency response in specific territory or facility.

A training facility will be provided at the Fire Station, for firefighters and rescuers from the Gas Rescue Service, for training on the skills needed for joint activities during emergency rescue operations on the outdoor equipment, and on working under close-to-real extreme conditions.

9.8.5.3 Mitigation of impact of hazardous natural processes

The design documentation includes the following measures to mitigate the impact/risk of hazardous natural processes:

- Construction of foundation and bearing structures considering the potential loads, to minimise mechanical affecting factor of earthquakes and subsidence of soil;
- Provision of thermal stabilization system;
- Thermal insulation in the building structures, floor air gap;
- Earthing ad lightning protection of equipment and premises;
- Selection of equipment with due account of the low ambient temperature (the lowest temperature is -52°C);
- Building structures designed to withstand snow loads;
- Ice barriers.

The main measures to be taken in case of threatened or actual industrial accident, emergency or natural disaster:

- Notification of command centre, emergency response resources, operator's personnel;
- Activation and deployment of command centre and emergency response resources;
- Enabling activities of the resources involved in emergency response operations;
- Managing interaction between command centre and resources involved in emergency response operations;
- Conducting rescue and other urgent operations (ROUO).

9.8.6 Assessment of Residual Impact and Risks

Construction

Significance of impact on environmental components at spills, leakages of POL and other process liquids may be reduced to low. Impact of explosions, fire, heavylift equipment destruction, vehicles and vessels collisions may be characterized by both moderate and high significance. The Consultant identifies the risks for the aforementioned impacts as medium/low.

Operation

Impact of hazardous liquids/LNG leakages on soil and vegetation, aquatic ecosystems may be reduced to moderate/low, subject to compliance with all design and recommended solutions/measures. Prompt application of PPE will reduce the high impact of toxic and inert gases leakages, blowouts on workers down to moderate/low.

Impact of explosions and fire may be characterized by both moderate and high significance. Leakages, spills, blowouts, explosions, fire risks will be reduced to negligible and low. Risk of explosion and fire during SGC transportation is identified by the Consultant as medium/low.

Subject to compliance with all designed and recommended solutions/measures to mitigate the impact of hazardous natural processes and phenomena, the impact significance and risk will be reduced to moderate-low and medium-low, respectively.

9.9 Climate Change Mitigation

9.9.1 Climate change risk assessment approach

Since year 2017, the weather and climate risks appear at the top line in the global risk list presented by the World Economic Forum[197]. In the WEF Report 2019, the top two risks in the list were presented by "failure of climate-change mitigation and adaptation" and "extreme weather events"[198].

Considering the Equator Principles 4 (Section 2.4.1) for the Project Category A, the assessment of climate change risks is to be provided for two categories of risks: physical and transition, in accordance with the Recommendations of the Task Force on Climate-related Financial Disclosures (TCFD)[199]. This section examines changes in the global and regional climate, global trends in the greenhouse gas (GHG) emissions policies and regulation tools, provides assessment of the Project GHG emissions, and proposes sustainability and adaptation measures for the Project.

The global climate changes and their manifestation in the Russian Federation are confirmed by studies and expressed in the form of extreme weather events and long-term changes of climate conditions[200]. The associated risks and benefits must be identified and assessed in time to take the necessary management steps and adopt adequate design solutions to minimise the risks and increase sustainability of the technology-intensive Project in the medium and long term, and to prevent potential disruptions or damage to the Project's structures, infrastructure and associated facilities, personnel and local communities.

The climate baseline and trends have been considered using the key climate variables in the region, as well as available publications with analysis of long-term existing and predicted climate trends.

As a baseline, the observational climate data were considered using the information from international and Russian data bases for the medium-term periods 1969-1991 and 2005-2019 recorded at the Seyakha weather monitoring station[201], for which the greatest amount of information is available. The main climatic characteristics of the Arctic LNG 2 Project area, as well as a description of the choice of the weather station are given in Section 7.1 above. Schematic map showing the locations of the Project, the Seyakha weather monitoring station, and the seasonally thawed layer monitoring stations is provided in Figure 9.9.1.

The following limitations must be taken into account when using the results of this review:

- **The baseline information and observation records** have been reviewed using the medium-term data on air temperature (annual average and extreme minimum and maximum), precipitation and wind velocity, extreme climate events at the selected weather station during the selected time period. The long-term trends (normalized for 1961-1990) are based on the climate change analysis in the reports of the Federal Service for Hydrometeorology and Environmental Monitoring of the Russian Federation (Roshydromet) dated 2014-2019 and research publications. In this way, overall trends of climate changes have been identified.
- **The future projections** review considered the Roshydromet report on climate risks 2017[202] and climate conditions 2019, and recent research publications, as well as simulations of future climate based on likely economic development scenarios and assumptions using the climate models. Therefore, the model outputs should be treated as projection options rather than factual values. They are generated as series of internally consistent probability-based climate characteristics which can be achieved in response to a range of potential forcing scenarios.
- **Minimizing the climate change risks**: Considering the fairly high uncertainty of the climate projections, the Consultant's recommendations for mitigation of the risks were guided by average predicted values and regional trends of potential climate changes as far as possible. Accordingly, any further research, data analysis or decision-making should take account of the climate projections and consider the available up-to-date observations data, research materials and additional studies.

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[197] http://reports.weforum.org/global-risks-2017/

[198] World Economic Forum, 2019: The Global Risks Report, 14th edition. Geneva, 107 pp. http://www3.weforum.org/docs/WEF_Global_Risks_Report_2019.pdf

[199] https://www.fsb-tcfd.org/wp-content/uploads/2017/12/FINAL-TCFD-Annex-Amended-121517.pdf

[200] Report on the climate specifics in the territory of the Russian Federation 2019 Roshydromet. - Moscow, 2020. - 97 pp.

[201] Seyakha weather data archive. Weather station (WMO ID) 20967 // Online publication at the website of LLC "Raspisaniye Pogody", https://rp5.ru

[202] Report on climate risks in the territory of the Russian Federation. Roshydromet. – Saint Petersburg, 2017.

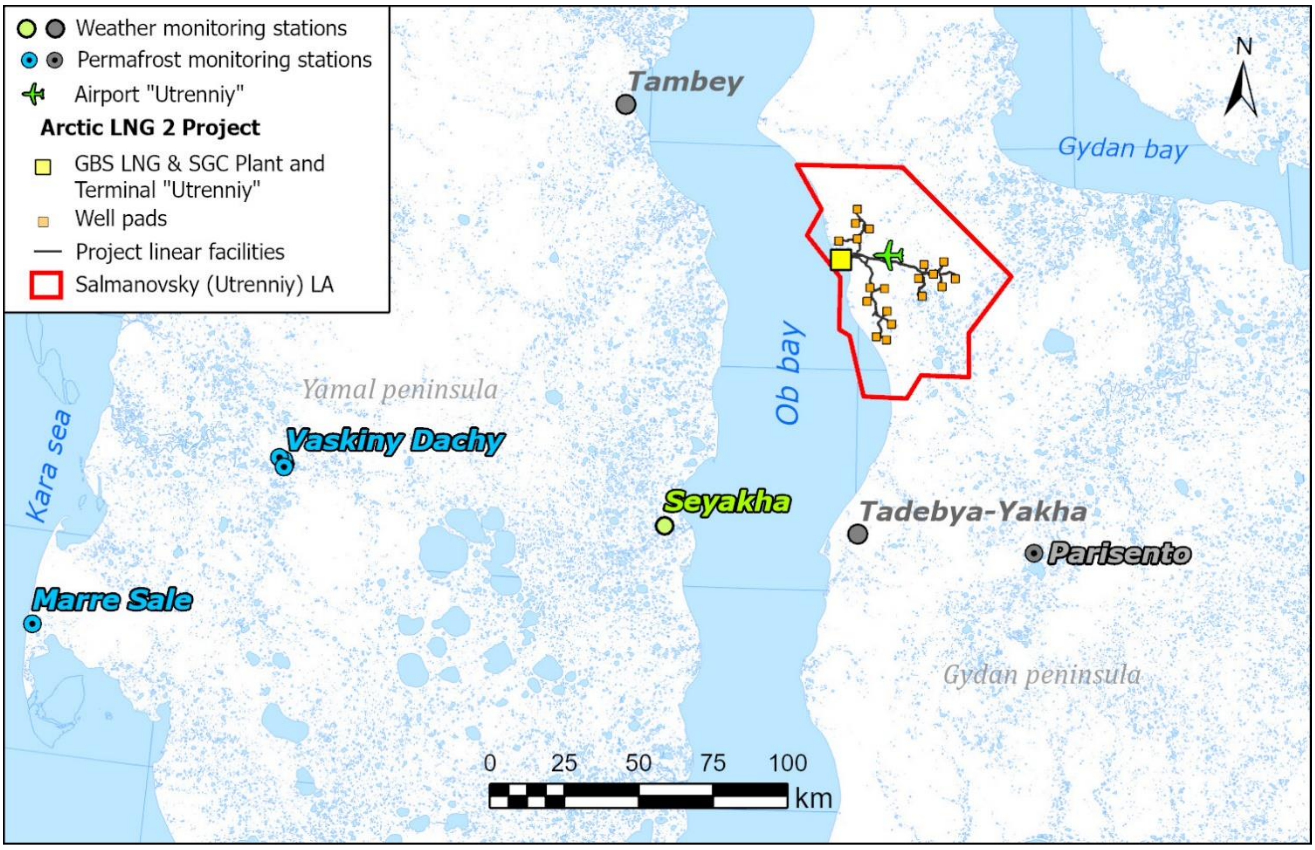

Figure 9.9.1: Weather and permafrost monitoring stations near the Project area

9.9.2 Climate change overview

9.9.2.1 Temperature

The climate warming (annual and during specific seasons) has been reported in Russia over the past decades, with few exceptions in winter and summer seasons in certain several regions. According to the Roshydromet and RAS Institute of Global Climate and Ecology, the average growth rate of air annual mean temperature in the territory of Russia during the period 1976-2018 was 0.47°C / 10 years. Such pace is by 2.5 times faster than global temperature growth over the same period: 0.7-0.18°C / 10 years, and by more than 1.5 times faster than average warming rate of ground level air temperature in the terrestrial parts of the globe, i.e. 0.28°C / 10 years (estimations based on data from the Hadley Centre and the East Anglia University).

The temperature of the Northern Polar Region (NPR) increased at the fastest pace, particularly for the last three decades ("Arctic acceleration" of warming): by data of the FSUE Arctic and Antarctic Research Institute (FSUE AANII), during the last 30 years (1990-2019), the annual average temperature rise here was 0.81°C/10 years, i.e. 2.43°C for 30 years. At the same time, different weather monitoring stations on shores of the Arctic seas of Russia reported the increase in the average annual temperature of 1.0°C/10 years.[203]

Climate surface air monitoring in the NPR is carried out both region-wide and for its individual parts, using the constantly updated base of surface meteorological data for polar regions[204].

Generally, across the West Siberian region (whereto the Gydan Peninsula belongs), a significant rise was registered in the annual average temperature growth rate (by more than 2.2 times when comparing observation periods of 1936-2019 and 1990-2019, and also during the recent years: +2.25°C over 30 years between 1988 and 2017, and +2.43°C over 30 years from 1990 to 2019). The highest growth rate is reported in the Kara sea region: about 1.59°C / 10 years. This significant change may result from

[203] Thus sub-section is prepared on the basis of the Report on climate conditions in the Russian Federation over the period 2014-2019 (Roshydromet, 2015-2019) and the Analytical Review "Key Weather and Climate Conditions in the Northern Hemisphere" (Roshydromet, 2020).
[204] http://www.aari.nw.ru

a totality of general global climate change trends and gradual migration of warm currents in the northern hemisphere (the Barents Sea).

Year 2019 was the fourth warmest year in Russia since 1936, with average air temperature anomaly of +2.07°C in the RF territory. Major positive anomalies of average annual temperatures (more than +3-4°) developed in 2019 in the polar areas, particularly in the eastern sector of the Arctic region.

In the Arctic region, year 2019 was the second warmest year since 1936. The spatially averaged air temperature anomaly of +2.8°C was recorded in the Northern Hemisphere in 2019. In the West Siberian observation area, departure from the norm made up +3.1°C, in the area of Gydan Peninsula - +3.5°C.

According to observations at the Seyakha weather station the annual average temperature for the period 1969-2019 varied from -10.2° C (in 1974) to -5.4° C (in 2016) (Figure 9.9.2).

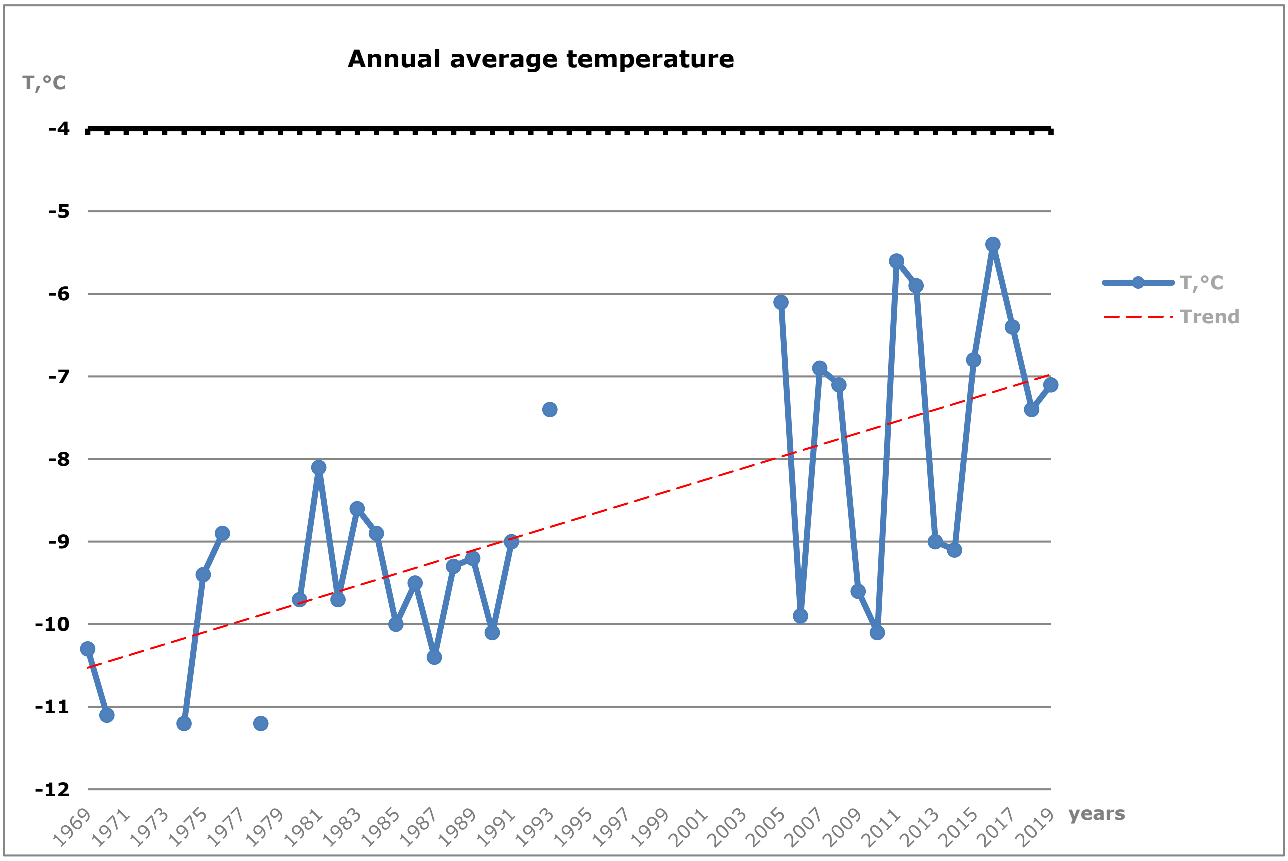

Figure 9.9.2: Annual average temperatures, Seyakha weather station data for 1969-2019

The extreme maximum temperatures during 2005-2019 varied from 20.3°C in 2015 to 28.1°C in 2016, the extreme minimum temperatures – from -47.7°C in 2007 to -35.2°C in 2012 (Figures 9.9.3 and 9.9.4, respectively).

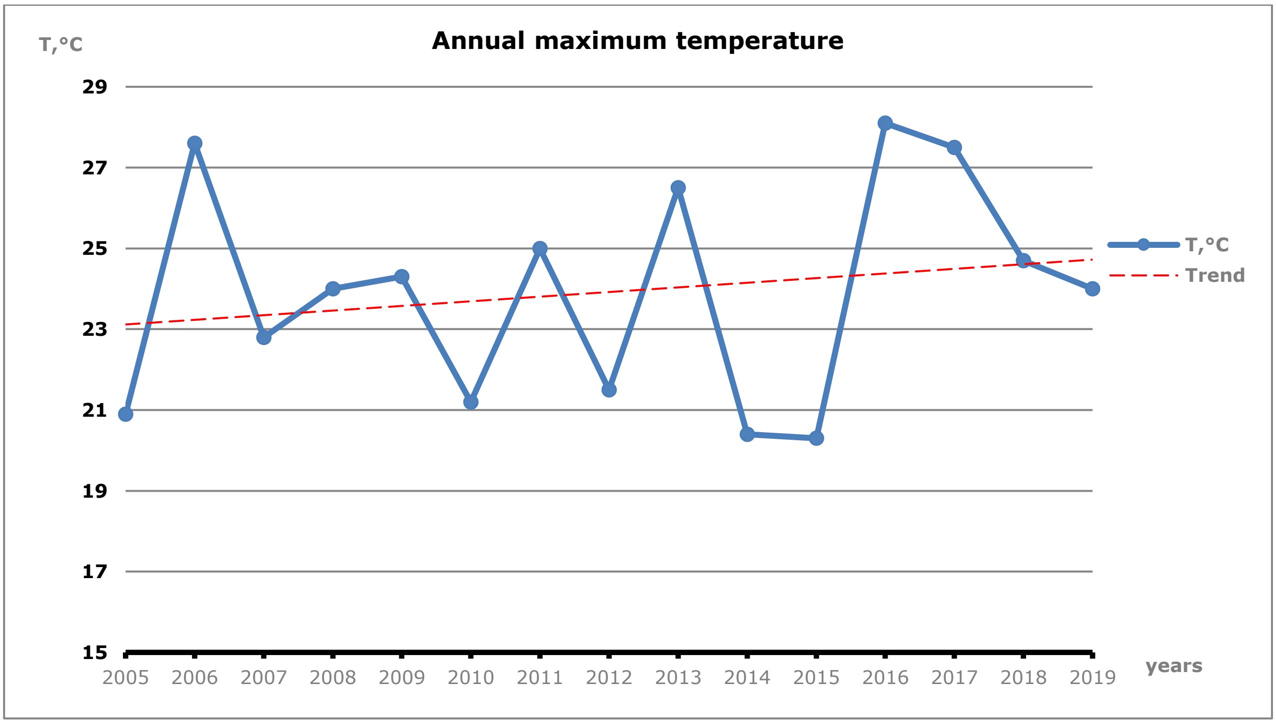

Figure 9.9.3: Maximum (extreme) temperatures, Seyakha weather station data for 2005-2019

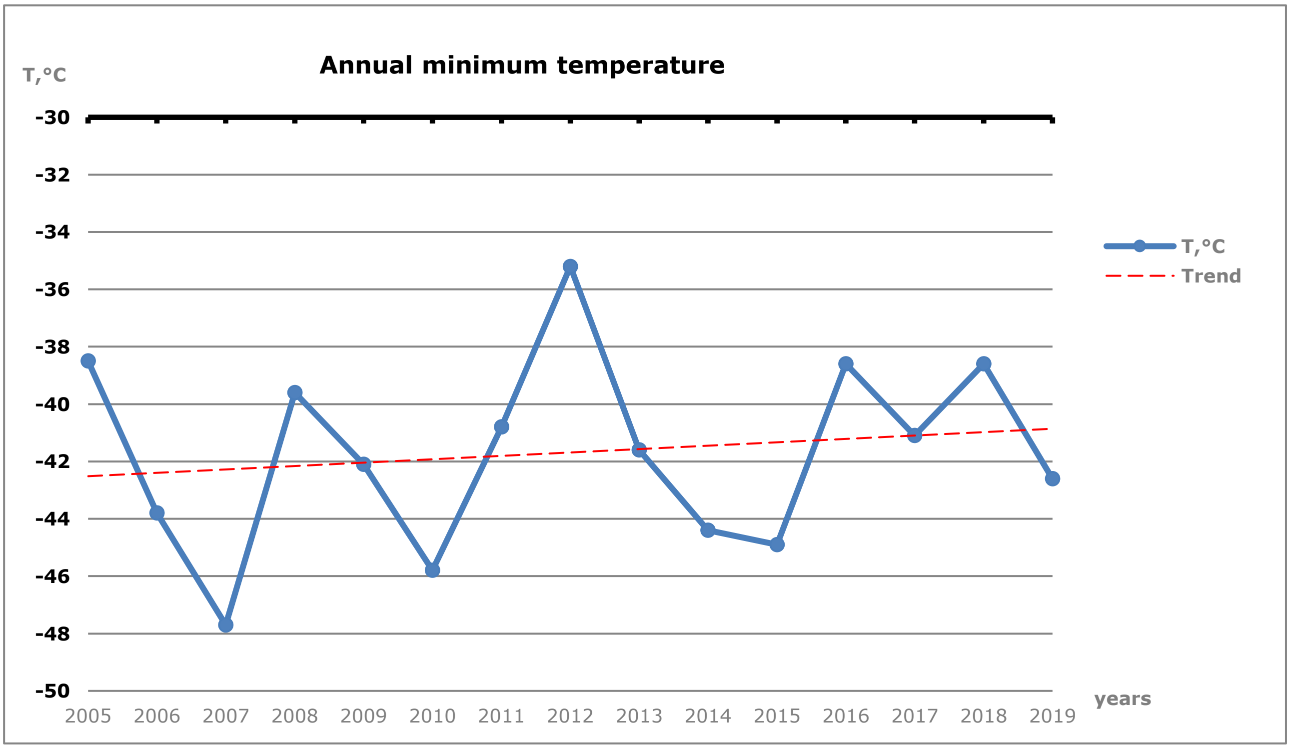

Figure 9.9.4: Minimum (extreme) temperatures, Seyakha weather station data for 2005-2019

In the recent decades, a rising trend was registered in annual average temperature growth rate across the NPR region (by more than 2.2 times when comparing observation periods of 1936-2019 and 1990-2019), and a rise in extreme minimum air temperature values (~+1.5-1.8°C over the period 2005-2019). *In the Northern Polar Region, and particularly in the West Siberian observation area, there is a noticeable trend towards an overall increase in the average annual temperature, which exceeds both the all-Russian trends and the global trend.*

9.9.2.2 Precipitation

The changes also affected annual precipitation: the average growth rate in the whole territory of Russia during the period 1976-2019 is 2.2% / 10 years. The increase in precipitation is observed in all seasons, with the most significant growth in seasonal precipitation quantity reported in spring (5.7% / 10 years). In year 2019 reported annual precipitation in Russia was 108% of the normal quantity.

Assessment of trends in seasonal and annual precipitation changes from 1936 to 2019 for the NPR allows a conclusion on a long-term trend of their statistically meaningful slow increase at an average rate of about 3 mm/10 years.

In 2018-2019, annual precipitation amount across NPR was at the normal level, however, in the West Siberian observation area precipitation amount of 120.3% of the normal level over the period 1961-1990 was reported.

According to observations at the Seyakha weather station, annual precipitation varied from 142 mm (2006) to 506 mm (1989) (Figure 9.9.5). Precipitation distribution throughout a year has top (in the cold period) and bottom maxima. Also, annual precipitation varies considerably from year to year.

The overall trend reported by the Seyakha weather monitoring station demonstrates a decline in annual precipitation, however it can't be considered as representative due to the multiple gaps in the observation data series. *In general, the Kara Sea region is characterised by a decline in annual precipitation during 1936-1990 and a slight increase between years 1990 and 2019.*

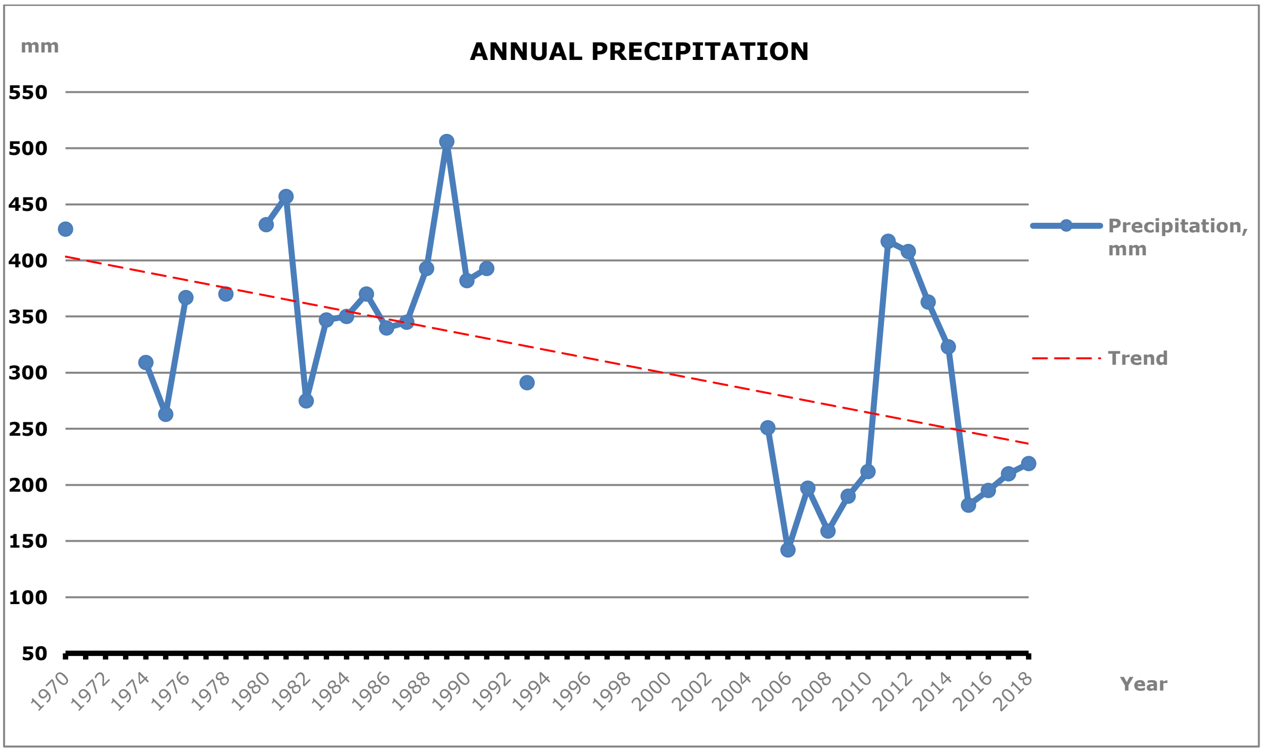

Figure 9.9.5: Annual precipitation, Seyakha weather station data for 1970-2019

9.9.2.3 Changes in the Northern Sea Route area

Changes in average winter and summer air temperatures in waters of the Arctic seas, by which the Northern Sea Route (NSR) passes, are largely similar to the general regional trends. The rapid drop of the sea ice area in the Arctic Ocean since the mid-1990s was associated with the Arctic warming, particularly in the seas on the Northern Sea Route.

The reduction in ice area in September closely correlates with the growth of summer air temperatures in the Arctic sea areas (with a correlation factor of -0.92 over the period 1979-2019). In the NSR area, warming of the marine Arctic commenced in the summer of 1996 and in the winter of 1998. The maximum temperature was registered in 2018 in winter and in 2016 in summer.

By year 2005, the ice area of SMR in September decreased to 200-300 thousand sq.km, i.e. 4-5 times compared to the values reported in 1980-s; in 2019 the ice area was about 100,000 sq.km – the second lowest value since 2012, the record year for the area when there was hardly any ice at all.

Thus, climate change is likely to be responsible for an increase in the number of navigation days in the Northern Sea Route, which has been generally confirmed by observations since 2011. However, during this period, the ice conditions were challenging for free navigation in some NSR sections. The duration of end-to-end ice-free navigation by the NSR is around 50 days.

According to observations, in recent years, the number of icebergs has increased in the Barents, Kara and Laptev seas in proximity to the outflow glaciers on the islands of archipelagos Svalbard, Frantz Josef Land, Novaya Zemlya, and Severnaya Zemlya.

Wind-wave conditions on the Arctic shelf turned out to be less severe than expected due to the displacement of cyclone trajectories north of the Arctic coast.

Generally, the changes in the hydrometeorological situation on the North Sea Route and on the shelf in 2011-2016 did not entail deterioration of the conditions for shipping and offshore activities[205].

9.9.2.4 Permafrost conditions

Depth of the seasonally thawed layer (STL) is an indicator of the permafrost state reflecting the meteorological conditions of individual years. Since 1990, STL depth measurements have been conducted using a standardized methodology as part of the International Circumpolar Active-Layer Monitoring (CALM) Program, in which dozens of countries, including Russia, are involved.

The Program has been run since 1990 with 68 monitoring sites selected in the RF territory. The number of sites from which STL data is reported varies between years, depending on other survey activities near the sites. In 2019, data was reported from 11 sites in the West Siberia, some of which are located close by the Project: the nearest site – Parisento (R4), 5 sites Vaskiny Dachy (R5, R5A-D) (refer to the schematic map in Figure 9.9.1), and Marre-Sale site (R3) on the western shore of the Yamal Peninsula. No observations are conducted at the nearest site Parisento. The longest series of monitoring data are available from sites R3 and R5; these are shown in Figure 9.9.6.

[205] Assessment of the strategic projection of climate change in the Russian Federation for the period of 2010-2015 and its influence on the sectors of Russian economy, Roshydromet. – Saint Petersburg, 2017.

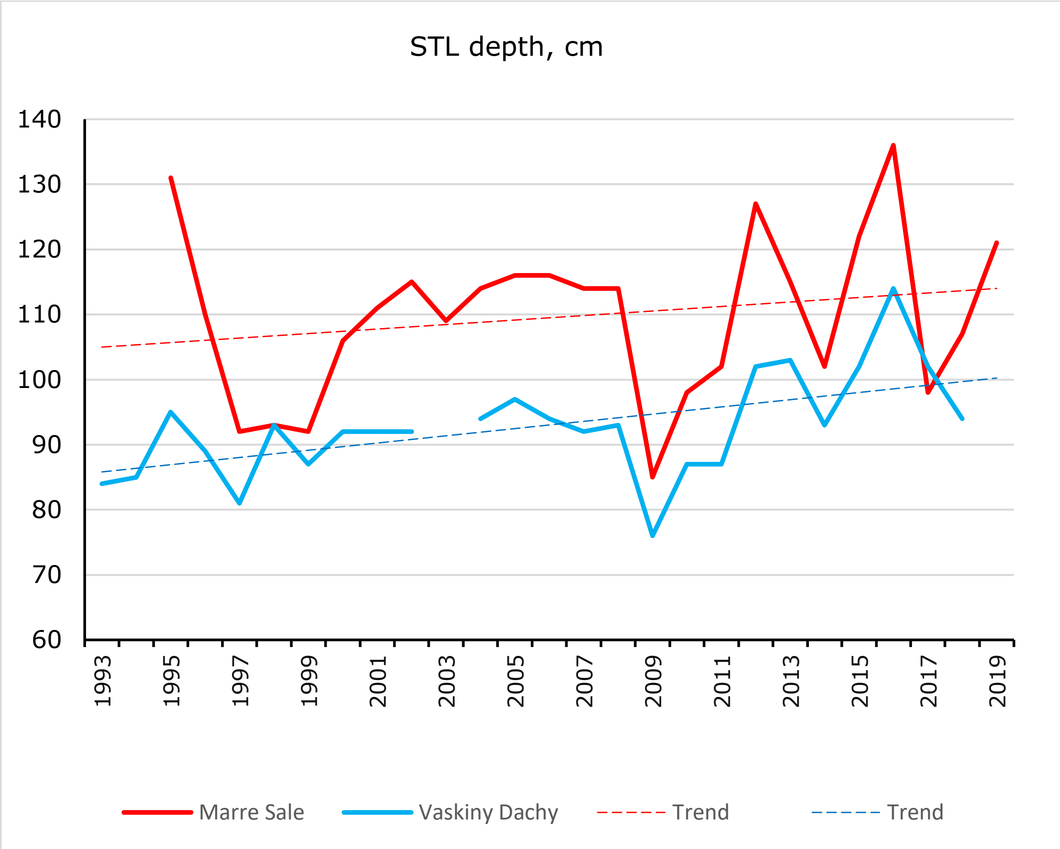

Figure 9.9.6: STL depth at monitoring sites R3 and R5, 1993-2019[206]

An increase in average depth of STL over the entire area of West Siberian region was observed in 2019. Records from sites R3 and R5 over last 15 years demonstrate slight but steady growth trends in STL depth at the rate of 3 mm and 6 mm per 10 years, respectively.

Assessment of the impacts associated with the ground conditions is provided in Section 9.4 above.

9.9.2.5 Hazardous climate events and wind conditions

The observation data demonstrate the global growth of damage caused by dangerous weather and climate events where 90% of most severe economic losses are due to extreme hydrometeorological events like floods, highwater, strong wind, rainstorms, hailstorms, droughts.

According to Roshydromet, during the period 1990-2000[207] Russia reported 150-200 damaging extreme hydrometeorological events every year. Then the number increased to 250-300 events per year, and starting from 2007 more than 400 such extreme events have been reported every second year, on average. Besides that, the extreme events reported during two past decades were more intensive and destructive than ever.

The total number of extreme weather events (EWEs) has been monitored in Russia since 2008. According to Roshydromet, the total number of EWEs reported in Russia in 2019 is 903 (including agrometeorological and hydrological), i.e. by 137 events less than in 2018 (refer to Table 9.9.1 below). 346 of all EWEs reported in 2019 (including 16 EWES in the Ural Federal District) caused significant damage to economy and communities. No EWEs were reported in the Project area.

Table 9.9.1: Annual numbers of EWEs, 2008-2019

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total EWE number	1090	923	972	760	987	963	898	973	988	907	1040	903

[206] http://www.permafrost.su/search/type/dataset
[207] Report on climate risks in the territory of the Russian Federation. Roshydromet. – Saint Petersburg, 2017.

According to observation data from the Seyakha weather station, the wind velocity over the period 1969-2019 varied between 5.5 and 6.1 m/s, with an overall minor declining trend at ~0.9 m/s during the 50-years monitoring period (Figure 9.9.7). In 2019, no abnormal deviations from the mean annual wind velocity were observed in the Project area. The overall small number of days with extreme winds is due to the unique location of the territory in the Ob Bay.

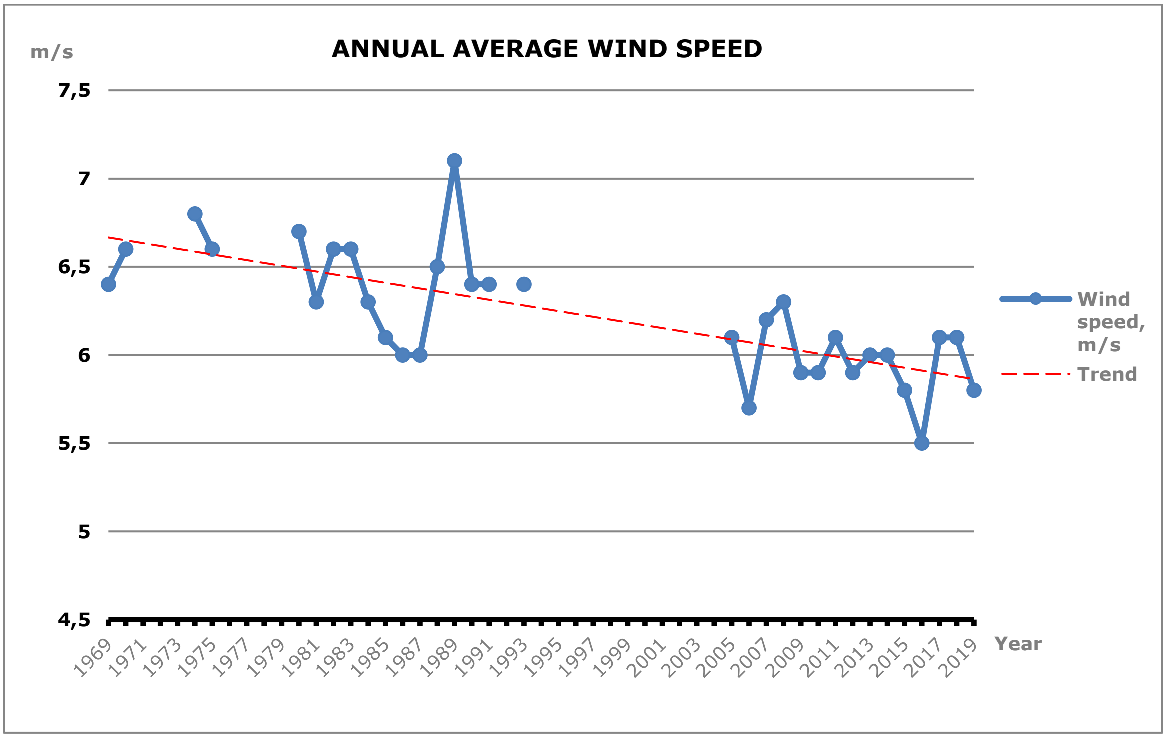

Figure 9.9.7: Average annual wind speeds in 1969-2019, Seyakha weather station

9.9.3 *Expected climate changes*

In terms of further climate changes in 21st century, IPCC[208] projections indicate temperature growth under all scenarios, considering the solar radiation and increasing greenhouse gas concentration in the atmosphere. With various man-caused impact scenarios (from a significant reduction in GHG emissions to keep global warming within 2°C, to the "business as usual"), the most likely estimated global temperature rise in 2081–2100 is within the range from + (0.2–1.8)°C to + (2.6–4.8)°C in 5–95 % of all models, compared to the level 1986–2005. The differences between precipitation quantities in wet and dry regions, and between wet and dry seasons will increase, although some exceptions are possible in few regions. The Atlantic meridional circulation will most probably diminish, however it is unlikely to change abruptly or cease. The world ocean level is predicted to increase by 0.26-0.55 m to 0.45–0.82 m in 2018-2011 compared to the end of 20th century, and its acidification will continue.

The latest climate models predict climate warming in Russia in 21st century at a significantly higher rate than global average warming. The greatest rise in surface level air temperature is projected in winter, with the rates increasing from south to north and peaking in Arctic. The summer temperature rise will hardly demonstrate any distinct zone-specific patterns. Early in the 21st century climate warming in most regions of Russia already exceeded the standard deviation that describes the range of outputs from different models. The quantitative differences between the warming scenarios rapidly grow starting from the middle of 21st century[209].

By the middle of 21st century, the average summer temperature in Russia is expected to rise by 2–3ºC to 3–4ºC compared to the end of 20th century, depending on scenario. The inter-scenario variations significantly increase by the end of 21st century: the predicted temperature rise is from 3-4ºC to 6-7ºC. The predicted temperature rise and variations between scenarios for winter period are significantly greater. In the middle of 21st century, the rapid growth of winter temperatures will affect major part of Russia's

[208] Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 p. http://ipcc.ch/report/ar5/wg1/.
[209] Report on climate risks in the territory of the Russian Federation. Roshydromet. – Saint Petersburg, 2017.

territory, with the increasing rate of change towards the Arctic coast where the temperature rise of about 5–6ºC is predicted. Based on the minimum scenario, by the end of century winter temperatures will increase by 3–4ºC in the south and by 6-7 ºC in the north of Russia. According to "business as usual" scenario, the predicted range of temperatures at the end of 21st century is from 5-8ºC in the south to 10-12 ºC or higher in the north.

It is expected that total precipitation in Russia will increase during 21st century, with more prominent growing trend in winter period. The changes in winter and summer precipitation will significantly vary between geographic areas. Precipitation increased slightly at the beginning of the 21st century and will be growing until its middle. The increase in summer precipitation is of greater significance, especially in the north and east of Russia.

The global warming may result in changes in the occurrence number and intensity of extreme weather events. A growth of annual maximum and minimum air temperatures is reported in most parts of Russia; the number of days with abnormally high air temperatures tends to increase while the number of events with extremely low night-time air temperature is diminishing.

For the 21st century and the whole area of Russia, the projections show increasing intensity of precipitation events in the form of showers or snowfalls, increase in the number of severe flooding and high water events, wind storms, varying weather conditions with consecutive series of cold and warm periods. The Project area is not prone to extreme weather events; however, it may be exposed to warm and cold weather waves, extreme temperatures, thunderstorms, and intensity of precipitation in autumn and winter.

With regard to future changes in the area and depth of sea ice in the Arctic, the modern model estimates are in good agreement, but their results dispersion is very significant. As of today, assessments under "harsh" human-caused impact scenarios may suggest the disappearance of perennial sea ice by the middle of the 21st century.

The chance that near-surface permafrost will persist is different under various scenarios: from *low* probability that the intermittent permafrost zone is preserved within its current boundaries, to the option that permafrost-supporting conditions in Russia will remain only in the Arctic region and on the East Siberian Plateau. The predicted climatic changes will also trigger an increase in the temperature of permafrost, thickening of the active layer and a decrease in the bearing capacity of soils.

According to one of the simulated projections based on standard GHG emissions scenarios, it is possible that the greatest increase of STL (by 30 ± 14 cm) will occur in the north of the West Siberian region – in the Yamal-Nenets Autonomous Okrug.[210]

The increasing depth of STL will result in a higher risk of deformation and failure of facilities and infrastructure, however, the discrepancy in the climate change assumptions imparts a high uncertainty to modelling of bearing capacity changes.

The most conservative forecast estimates the decrease in the bearing capacity of soils throughout the permafrost zone due to the climate change at <25% by the middle of 21st century. Those changes are not likely to affect prudently designed engineering facilities and buildings. On the other hand, the maximum forecast based on the aggregate of six models is 75-95% decrease in the bearing capacity of soils by year 2050. If such a forecast comes true, it will mean a high probability of deformation and failure of structures in the permafrost areas[211].

The studies also indicate shortening of the winter roads availability period due to global warming, which complicates access to various facilities and structures. In particular, in YNAO this period has decreased by 5-10 days between 1965-1975 and 1995-2005; in the Project area the reduction has exceeded 10 days. The acceleration of warming may speed up this process. In the whole territory of Russia, winter roads availability is predicted to decrease by 13% by the middle of 21st century.[212]

The Arctic acceleration of warming, heat waves and increase of STL depth may also activate anthrax foci in permafrost which are known since the end of 19th - early 20th century, and such event occurred in YNAO in 2016 last time (refer to Sections 8.12 and 9.4). However, considering the observed slow pace of STL

[210] O. A. Anisimov, V. A. Kokorev. Modeling of seasonally thawed layer thickness considering the climate change and vegetation: projection for mid-21st century and analysis of uncertainties. - Earth Cryosphere, 2017, vol. XXI, № 2, pp. 3–10

[211] Climate change and stability of urban infrastructure in Russian permafrost regions: prognostic assessment based on GCM Climate Projections. Shiklomanov, N.I., Streletskiy, D.A., Swales, T.B., Kokorev, V.A. - Geographical Review 1–18, 2016. – American Geographical Society of New York

[212] Summary report Impacts of Changing Climate in Permafrost Regions: the Russian Perspective. State Hydrological Institute of Roshydromet (SHI of Roshydromet), 2017

increase and remote location of known areas of this kind, the likelihood of occurrence of such event in the Project area during the operation period is assessed as negligible.

9.9.4 Impact and risk assessment, adaptation measures

In the context of this assessment, the climate change risk is defined as potential negative consequences of climate change effects for human life, livelihood and health, for status of ecosystems and biological resources, structures, infrastructure and services (in terms of IPCC recommendations). The climate change risks are ranked considering the likelihood of occurrence of hazardous event / trend, and magnitude of impact or effects in case of hazardous event / trend occurrence (considering the impact duration and time of occurrence).

In accordance with the Recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), both *physical* risks and *transition* risks are considered. Physical risks are caused by physical changes of climate and may be acute (due to a short-term extreme event) or chronic (due to slowly developing climate changes). Transition risks are business and financial risks arising in the course of global transition to low carbon economy.

Physical Risks

Analysis of the observation data and climate projections indicate that the changes in climate conditions in the area under consideration is higher, by certain parameters, than Russia's average trends. The predicted growth of annual average temperature may increase the depth of seasonally thawed layer and degradation of bearing capacity of permafrost, as potentially the intensity and occurrence rate of weather conditions, adverse in respect to the Project. The above factors may disrupt technological processes, decrease reliability or integrity of structures of the Project and associated facilities and their supporting infrastructure, disrupt feedstock supply, offloading and transportation of products, and affect personnel health and safety. Summary of the assessment of risks and impacts is provided in Table 9.9.2 below, along with the appropriate adaptation measures.

It has been established that for the Project, in the long term, the expected increase in average annual temperatures, as well as increase in the number and intensity of extreme events fall within the scope of **moderate** risk factors.

The likely direct *long-term* effects of such risks may include degradation of bearing capacity of permafrost and extreme physical ambient impacts on the Project facilities (uneven and "stress" loads, sharp temperature changes, etc.), which may cause deformations and loss of stability and integrity of the facilities and infrastructure. Such risks can be minimized by adopting design solutions that take account of these factors and provide for an increased safety margin for the bearing capacity of foundations and structures, and by selecting appropriate construction materials. The above adaptation measures have been considered in the design, and after their implementation the risk will be reduced to **low**.

As was mentioned above, increasing STL depth triggered by climate warming in Arctic may increase the risk of secondary mobilization of severe disease agents contained in permafrost. Even though all known areas of this kind are remote from the Project sites, it is still possible that new such areas can be found in the Project area of influence. Considering the immunization of reindeer in Tazovskiy Municipal District against anthrax, the risk of the disease spread is reduced to **low**. Nevertheless, the management plans should consider the risk of epidemic outbreaks (if anthrax cases are detected in the district – high alert and preventive measures; if animal burial sites / epizootic areas are found – suspension of works, fencing, immediate reporting to local office of Rospotrebnadzor, etc.).

In the harsh conditions of the Arctic, any increase in the extremity of any weather events or their occurrence rate will have a **cumulative** aggravating effect in terms of the impact on health and safety of the projects' personnel. The risk and magnitude of this impact are estimated in the range of **medium** to **high**; however, the impact on the health of the Project personnel will be reduced to a **low** level if the current weather conditions are duly considered when choosing work clothes and PPE, planning of outdoor works and heat supply arrangements, and if adequate response procedures are developed and implemented to address the challenges posed by weather hazards.

The impact of climate factors connected with the Project on the local communities is possible only in an indirect way – in the event of emergencies (through impact on ecosystems and subsequent reduction of biodiversity with a decline in the ecosystems' ability to meet the local population's needs for natural resources), but is considered unlikely and insignificant if the appropriate protective measures are introduced in the design, because of the Project facilities' location far from the local communities.

Contribution of the Project-related GHG emissions to climate change is considered in Section 9.8.5.

Assessment of cumulative effects as part of the analysis of the Project impact on livelihood of indigenous small-numbered peoples of the North should also consider the changes in the environment and ecosystems induced by climate change that affect ISPN livelihood in many ways: modification of natural zones' configuration, changes in the surface relief, changes in habitats and migration of game animals and commercial fish, increase in incidence of infection in animals, floods, etc.

Table 9.9.2: Climate change physical risks assessment and Project adaptation measures

Climate factor	Receptor	Impact	Sign	Receptor Sensitivity	Stage	Impact magnitude	Risk	Project adaptation measures	Residual risk
Rise of average annual and extreme maximum and minimum temperatures Increased intensity of extreme weather events and frequency of adverse conditions	Personnel	In severe climate of the Arctic and in the medium term - better working conditions due to higher average annual minimum and extreme temperatures	P	M	O	L	-	Developing procedures and instructions for emergency response in the event of extreme weather events (heavy snow, thunderstorm, fog, cold wave, etc.).	-
		Deterioration of working conditions, higher injury and health risks	N	H	O	M	M	Making personnel and contractors aware of procedures to be followed in such events. Training. Consideration of the current weather conditions when choosing work clothing and PPE, developing outdoor work schedules (C), selecting the heat supply mode (O) First aid provisions	Mr
		Appearance of foci of infectious diseases due to the increase of STL depth	N	H	O	M	M-Mr	Development and implementation of response procedures in the event of detection of foci or infection cases in the area	Mr-I
	Resources: natural gas, electricity	Reduction of power consumption due to lower heat demand	P	M	O	N	-	Introduction of automatic heat supply control system and provision of central generation capacities to serve the changing heat and electric power demand. Cogeneration	-
	Facilities and infrastructure	Shorter period of winter roads availability	N	M	O	L	Mr	Development of work schedules considering the winter roads availability	Mr-I
		Stress loads, deformation, poorer condition and reliability of main equipment, infrastructure facilities and other installations due to change in bearing capacity of permafrost and adverse weather	N	M	O	H	M	Designing facilities, pipelines, fasteners, heat sinks for foundations and isolation under equipment with heat emissions, adoption of other design solutions and technical characteristics allowing for the predicted climate changes during the whole period of Project operation	Mr
	Customers	Delays in product shipments due to weather and ice conditions on NSR	N	M	O	M-L	M	Minimisation or avoidance of contractual penalties in the event of delays in product shipments due to weather	Mr

Transition Risks

Considering the scientifically proven link between anthropogenic emissions of greenhouse gases and observed changes of climate, and simulated forecasts of climate changes by the end of 21st century for the scenario when the existing pattern of economic development persists, the global community is facing the challenge of reducing GHG emissions rapidly enough, and the need for transition to low carbon economy. According to the current scientific understanding, the available global budget of GHG emissions, i.e. the *aggregate of all future emissions of GHG* is defined by the set limit of warming and probability not to exceed this limit. Climate models in the IPCC Fifth Assessment Report indicate that the remaining budget of GHG emissions for 50% probability of non-exceedance of global temperature by +1.5 C is only 580 GtCO2[213].

To facilitate the GHG emissions reduction efforts, the Paris Climate Agreement was prepared at the end of year 2015 which regulates the measures applied since year 2020 to decrease carbon dioxide levels in atmospheric air. Most countries including Russia signed the Agreement in 2016. The Paris Agreement was ratified in Russia by the Government Resolution of 21.09.2019 No.1228.

Transition to low carbon economy can be implemented as a gradual process if initiated globally in the near future, and business will have enough time to get prepared and identify their transition strategies and mitigation measures. This way, the risk of materialisation of most adverse climate change scenarios will be *lower*, i.e. physical risks will be minimised. A late transition to low carbon scenario in global economy may be sharp and ineffective, in terms of mitigation of climate change, which would entail moderate and high physical risks and transition risks, and may trigger economic crisis in certain countries and regions. Failure to take effective measures to reduce the emissions may result in high and critical geopolitical and physical risks, global economic crisis in the middle and long term, in which case further development of humanity in its existing setup would be impossible.

Basically, it is expected that the use of fossil fuel for power generation will be phased out in a long term, therefore, the business most likely to be exposed to immediate effects of the transition period are those engaged with production and processing of coal, oil and natural gas (listed in the descending order of sensitivity to the change), and those using the above resources in their production processes. Furthermore, the physical and transition risks will affect most sectors of economy and industry in one way or another, e.g. by changing energy prices. In 2015, the study evaluated the totality of assets exposed to risks due to the climate change during the period from present time till the end of century at 4.2 to 43 trillion USD[214]. Decline in growth rates and return on investments was identified as the main impact.

Even though reduction of GHG is a complex issue in the context of economic development objectives, many countries and individual major cities have adopted low carbon strategies, and are implementing measures and technologies that will help to reduce GHG emissions to a significant degree. So far, the efforts have resulted in a notable and rapid decline in prices for renewable energy, development of carbon-free technologies for cold and heat supply, and changes in habits and consumption levels in a number of local communities throughout the globe. This trend is a driving force for introduction of new standards and requirements for products and their manufacturing processes, including tax on GHG emissions.

It is very likely that future development strategies of countries and regions will use a system of government regulation tools for GHG emissions control in terms of quantity and costs, in order to minimise carbon-intensive energy sources (e.g. carbon tax, carbon trade, legal restrictions). In 2015, 12% of global GHG emissions were covered by the emission charging system (50% in the EU)[215].

Russia occupies the fourth place among all countries, by quantity of GHG emissions; at the same time, the RF economy is to a large extent reliant on fossil fuels, and its GHG emissions meet the requirements of the Paris Agreement (as a consequence of multiple economic crises during last decade). Therefore, it is likely that the country’s internal transition risks will be smoothed out in short term, and potentially in medium term. However, these risks are still present, as consumers of the Project products are located in other

[213] IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. In Press.

[214] The Economist Intelligence Unit, “The Cost of Inaction: Recognising the Value at Risk from Climate Change,” 2015.

[215] Too late, too sudden: Transition to a low-carbon economy and systemic risk. Reports of the Advisory Scientific Committee of the European Systemic Risk Board. No.6, February 2016.

countries. In terms of carbon intensity (volume of carbon dioxide emissions), natural gas is the most viable fuel and, apparently, less exposed to the risk of falling demand than coal.

Quantitative assessment of probability of any specific development scenario is impossible, due to the high uncertainty about further movement of different countries toward low carbon economy, therefore, expert assessment of the risk is employed. The risk assessment below is high level and should not be considered as final. To prepare an adequate base for its business strategy, the Company should make a detailed assessment using the financial, and commercial and other data on its own activities, and update it regularly and as required.

The risks are examined by categories, in accordance with TCFD recommendations: Policy and Legal, Reputation, Market and Technology. Further breakdown is based on phases of the project life cycle: short term risks during the period 2020-2035, medium term – 2035-2050 (operation of the Phase 1 facilities), and long term - 2050-2065 (operation of the Phase 2 facilities).

The high-level assessment of the transition risks and Project adaptation potential in accordance with recommendations of TCFD is provided in Table 9.9.3 below.

Table 9.9.3: Climate change transition risks assessment and Project adaptation measures

Risk	Impact	Probability during specific periods 2020-2030	2030-2050	2050-2065	Risk rank	Project adaptation measures	Residual risk
Policy and legal							
High tax on GHG emissions	Increased operational costs Increased insurance costs Increased LNG production costs Falling demand for LNG Decline in the Company's revenues GHG reporting preparation, verification and disclosure requirements	L-M	H	H	M-H	Make an allowance for potential increase of GHG tax and insurance costs, and for falling demand, in the financial models for the investment efficiency estimation and planning of costs. Timely identification of changes in regulatory requirements already at the stage of their preparation. Strategic planning and adequate control of GHG emissions at all stages of the Project (using all reasonable tools). Regular preparation, verification and disclosure of GHG emission reports.	M
Potential legal suits for high GHG emissions		L	M	M-H	M-H		M
Regulation and distribution of feedstock and products		L	M	M	M		Mr
Reporting obligations		H	H	H	Mr		Mr
Technology							
Falling demand for LNG due to preference of other products and other energy sources with lower GHG emissions	Declining market value of the Company The installed equipment is getting obsolete rapidly Capital costs of transition to technologies with lower GHG emissions Process optimisation costs R&D costs	L	L-M	M-H	M-H	Phased implementation of the Project. Design for the use of best available solutions and techniques (implemented). Regular market studies for identification of emerging new LNG production technologies or consumer preferences for different energy sources and products. Building multifactor financial models for effective management of costs. Effective production management with control of improvement opportunities. Consideration of research results in the Company management and planning. R&D with preliminary assessment of costs and risks.	M
New LNG production and storage technologies		L	L-M	M	L-M		Mr
Need for transition to technologies with lower GHG emissions		L	M	M	M		Mr-M
Failed investments in new technologies		L	M	M	M		Mr

Risk	Impact	Probability during specific periods			Risk rank	Project adaptation measures	Residual risk
		2020-2030	2030-2050	2050-2065			
Market							
Uncertainty about market trends	Poor management efficiency due to inaccurate prediction of demand for LNG	H	M	L	M-H	Regular market studies for identification of emerging new LNG production technologies or consumer preferences for different energy sources and products.	M
Changes in consumers' energy and services use behaviour	Falling demand for LNG Decline in the Company's revenues	L	M	M	M		M
Reputation							
Negative attitude of stakeholders at unchanged level of GHG emissions	Tough requirements for disclosure of the Company's GHG management reporting Limited access to external investments Increased requirements for GHG emissions if external investments are involved	L-M	M	M-H	M	Planning and assessment of effective external investments Strategic planning and adequate control of GHG emissions (using all reasonable tools). Regular preparation, verification and disclosure of GHG reports.	M-Mr
Negative public perception of oil and gas industry	Boycott and protest acts	H	H	H	M		M
	Difficulties in recruiting personnel	L	L-M	M	M-Mr		Mr

9.9.5 Greenhouse gas emissions

9.9.5.1 International Requirements for Assessment of GHG Emissions

In 1987-1988 the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) established a dedicated international scientific organization – Intergovernmental Panel on Climate Change (IPCC) – that provides information on changes of climate, their impact on natural and economic systems, human health, and on the ways the impact on climate can be mitigated.[216] Results of the IPCC work are issued as scientific reports. The Fifth Assessment Report was published in 2013-2014.

The IPCC Task Force on national greenhouse gas inventories develops methodology guidance for the national inventories of GHG sources and sinks. The IPCC Guidelines for National Greenhouse Gas Inventories were published in 2006[217] to facilitate preparation of the national GHG inventories by the member countries. The Guidelines provide default values of various parameters and emission factors for various sectors of industry, to enable estimation of GHG emissions using the national economic data. Also, the countries are free to use more detailed methodologies, provided that data reported by different countries are compatible, comparable and consistent.

On August 5, 2019, IPCC issued updated version of the methodology[218]. The 2019 Refinement provide more methods to be used for evaluation of GHG emission sources and sinks. It further considers the identified scientific gaps, new technologies, processes, sources and sinks that were not covered by the IPCC 2006 Guidelines.

9.9.5.2 Requirements of the International Financial Institutions

The international financial institutions (IFI) fully recognise the importance of minimising GHG emissions. Therefore, their covenants for project loan funding include requirements to apply best available techniques, as well GHG assessment and open reporting requirements (Equator Principles 4, 2020; IFC Policy on Environmental and Social Sustainability, 2012).

For projects that currently produce, or are expected to produce post-investment more than 25,000 tonnes of CO_2-equivalent annually, the client will quantify direct emissions from the facilities owned or controlled within the physical Project boundary, as well as indirect emissions associated with the off-site production of energy used by the Project. Quantification of GHG emissions shall be conducted annually in accordance with internationally recognised methodologies and good practice[219].

In accordance with Equator Principles 4 (2020), possible alternatives must be examined for projects with direct and indirect GHG emissions over 100,000 t CO_2-equivalent per year, to reduce the emissions, and open reporting must be published on GHG emissions Scope 1 and Scope 2, as well as unit emissions, if applicable.

9.9.5.3 Regulation of Greenhouse Gas Emissions in the Russian Federation

The Russian Federation pursues a state policy in the field of reduction of greenhouse gas (GHG) emissions and increasing energy efficiency in various sectors of economy. The RF regularly provides national reports on GHG emissions inventories, based on assessment of man-induced emissions and GHG removal by sinks. Such assessment is conducted by Roshydromet in accordance with the RF Government Instruction of 01.03.2006 # 278-R[220], in line with the commitments assumed by Russia under the UN Framework Convention on Climate Change.

According to the international reports, Russian economy appears in the top five group of countries with the highest emissions of carbon dioxide and occupies the fourth line in the list (4.6%). On the other hand, the conducted assessment shows that recently Russia reported on 70% GHG emissions level compared to year 1990. The GHG emissions target of 75% of the level 1990 to be achieved by 2020 was set in the Decree of the RF President of 30.09.2013 No.752"On the reduction of greenhouse gas emissions".

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[216] http://www.meteorf.ru/activity/international/mgeik/

[217] IPCC 2006 Guidelines for National Greenhouse Gas Inventories. Prepared by the Task Force on National Greenhouse Gas Inventories of the IPCC. Edited by Simon Eggleston, Leandro Buendia, Kyoko Miwa, Todd Ngara and Kiyoto Tanabe. Published by IGES, Japan

[218] 2019 Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories

[219] IFC Policy on Environmental and Social Sustainability, 2012

[220] RF Government Instruction of 01.03.2006 #278-r (as amended on 05.04.2019) "On the institution of the Russian system for assessment of man-induced emissions from sources and removal by sinks of greenhouse gases not regulated by the Montreal Protocol on Substances that Deplete the Ozone Layer adopted in Montreal on September 16, 1987"

At present this target is met despite a slight increase in emissions volume last year: 2,818,171,345 tons of CO2 equivalent in 2017 against 2,947,855,077 tons of CO2 equivalent in 2018 (i.e. 4.4%), which is within the permissible range in compliance with the Decree of the President and the international commitments. In terms of structure, the GHG emissions from economic activities in Russia consist of 63.1% of carbon dioxide an 32.4% of methane.

In accordance with the "Concept of the system of GHG emissions monitoring, reporting and verification in the Russian Federation"[221] adopted in 2015, the assessment of anthropogenic emissions of greenhouse gases refers to the following substances: carbon dioxide, methane, nitrogen oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride, nitrogen trifluoride.

The state regulation of GHG emissions described in sub-section 2.2.1.5 is based on the principle of voluntary emissions inventory to be prepared by the constituent entities of the Russian Federation. No specific requirements for the inventory, timeframe and reporting format have been developed by present.

9.9.5.4 Corporate GHG Policy

LLC "Arctic LNG 2" is aware of possible consequences of climate change in the global context, and especially in the Arctic region, and the need to focus on minimising and effective management of GHG emissions.

The corporate HSE and Social Responsibility Policy approved by the order of LLC "Arctic LNG 2" of 24.05.2019 No.109-PR includes commitments to minimise the negative environmental impacts and use the natural resources in a reasonable manner.

In 2017 PJSC "NOVATEK" developed and adopted a corporate Greenhouse Gas Emission Management System compliant with ISO 14064-1:2007, the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the RF Government Resolution 02.04.2014 No. 504-R, and the Guideline Methodology for GHG emissions assessment approved by the RF MNR Order 30.06.2015 No.300. Description of the GHG management system is provided in the corporate standard SK ISU-0-012 ("the Standard") that establishes a unified procedure for registration of sources and estimation GHG emissions of the controlled entities including LLC "Arctic LNG 2". Further documents are included in the Appendixes to the Standard:

- Guidance for preparation of register and monitoring of GHG emissions;
- Guidance for quantitative estimation of GHG emissions.

The Standard includes a description of the Climate Policy which principles and provisions are an integral part of the NOVATEK Environmental, Industrial Safety and Occupational Health Policy (2016). The Policy declares the intention to "consider risks and provide assessments of the climate change impact on operations of the Company and its controlled entities, regularly carry out cryological monitoring, develop a system of reporting on greenhouse gas emissions, apply innovative technologies to reduce greenhouse gas emissions".

The approaches to accounting, assessment, reduction, monitoring and control of GHG emissions approved by the above regulations are equally applicable to the Project.

The following approaches and principles of energy efficiency and reasonable use of natural resources are adopted to minimise GHG emissions, starting from the design development for the planned investments (the Project overview is provided in Chapter 5):

- Selecting optimal location of facilities and structures for production, transportation, treatment, liquefaction of natural gas and stabilisation of gas condensate, and offloading of LNG and SGC to minimise energy consumption and losses;
- Selecting most effective process options and equipment for construction and operation;
- Optimising water supply and wastewater disposal schemes, heat, steam and electricity generation and supply;
- The liquefaction technology is based on a consecutive process of natural gas liquefaction with application of mixed cooling agents for efficient liquefaction of natural gas;
- Energy generation at the Plant is arranged using efficient aero-derivative gas turbines instead of large industrial installations;
- Using waste heat recovery units to recover waste heat from liquefaction turbines and utilise it in the process heat cycle or space heating;

[221] Concept of the system of GHG emissions monitoring, reporting and verification in the Russian Federation (adopted by the RF Government Instruction No.716-r of 22.04.2015)

- Using advanced smart controls for fuel combustion and thermal treatment of waste;
- Boil-off gas (methane) from the processes and LNG storage is collected and returned for utilization of cold in heat exchangers in the liquefaction process, or utilized locally as fuel gas.

For the purposes of reporting the amounts of GHG emissions, a Project inventory of emission sources is kept, and the total volume of its GHG emissions is determined in accordance with the applicable national laws.

The annual GHG emissions of the Project (refer to sub-section 9.8.5.8) are higher than the reporting threshold of 50,000 t CO_2-equivalent set by RF Government Directive No.716-r dated April 22, 2015. This value also exceeds the threshold of 25 thousand ton of CO_2-e/year set by the IFC Performance Standards for annual reporting of direct and indirect emissions of GHG from the Project.

Exceedance of the threshold of 100 CO_2-e/year also triggers the requirement to publish annual reports on Scope 1 and Scope 2 GHG emissions during the Project operation stage.

In this connection, the Project will provide for the compilation of annual reports on the actual amount of greenhouse gas emissions, which will be available to relevant government agencies and lenders, and will be published in open sources where they can be accessed by all stakeholders.

9.9.5.5 GHG Assessment Approach

This assessment report has been prepared using the approach to estimation of GHG emissions in accordance with the applicable guidance and reference documents recognised at the national and international level:

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories:
  - Volume 1: General Guidance and Reporting;
  - Volume 2: Energy;
  - Volume 3: Industrial Processes and Product Use;

- Compendium of Greenhouse Gas Emissions Methodologies for The Oil and Gas Industry, American Petroleum Institute, 2009(API Compendium)[222];
- Best Available Techniques Reference Document for the Refining of Mineral Oil and Gas, 2015[223];
- Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the IPCC[224];
- 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories[225];
- Guideline methodology and instructions for quantitative assessment of GHG emissions from entities conducting business and other operations in the Russian Federation, approved by the RF MNR Order of 30.06.2015 No.300) ("the RF Guideline Methodology"

Preferences are given to international methodologies that are compatible with the Russian regulations. Assumptions made for the calculations refer to the general methodologies and scientific reports that sum up the contemporary experience of dealing with the climate change issues.

9.9.5.6 Selection of the Assessment Boundaries

To make the GHG emissions reporting structured, the Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard[226] introduces the concept of "scope" of direct and indirect emission sources according to the organizational and operational boundaries of the assessment.

Scope 1 includes direct emissions of GHG from all sources owned or controlled by the company. Scope 2 accounts for indirect GHG emissions from the generation of purchased electricity consumed by the company (production processes, heating, cooling). Scope 3 is an optional reporting category to cover all other indirect emissions related to the company (Project) activities that occur from sources not owned or controlled by the company. Therefore, emissions from the associated facilities/activities and supply chains can be considered as Scope 3.

[222] American Petroleum Institute. Compendium of Greenhouse Gas Emissions Methodologies for The Oil and Gas Industry. – 2009
[223] Best Available Techniques (BAT) Reference Document for the Refining of Mineral Oil and Gas - Luxembourg: Publications Office of the European Union, 2015.
[224] Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA
[225] 2019 Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories
[226] The Greenhouse Gas Protocol. A Corporate Accounting and Reporting Standard (revised edition). http://ghgprotocol.org/corporate-standard

The main GHG emissions from the Project will be related to the process of production, treatment and liquefaction of natural gas and gas condensate, including main process units, gas turbine units, boiler plant, compressors, flare system, etc., as well as emissions related to the energy systems of the production facilities, buildings and structures, LNG and SGC storage and offloading facilities. These emissions should be considered as part of the Scope 1 assessment.

Given that energy supply for the Project will be provided from the generation facilities specifically designed for the Project, the GHG emissions will be estimated as direct emissions, based on the quantity of fuel used for generation (included in the Scope 1 assessment). Therefore, separate estimation of Scope 2 emissions is not provided.

Scope 3 assessment is not required for the Project by the international guidelines, however, the Company may still produce it to assess its lifecycle "carbon footprint" and consider potential compensation mechanisms and reduction of GHG emissions at the associated facilities and in the Project supply chain, including, inter alia, transportation of products and their applications. The depth of such assessment will depend on the selected boundaries of the system, and on reasonability (from the Company's perspective) of investing in reduction of GHG emissions at suppliers, contractors and customers, as this may have a certain impact on the Project investment attractiveness. This ESHIA Report provides for assessment of GHG emissions for the Utrenniy Airport.

The GHG emissions have been assessed for content of the substances that are generated/released by the Project processes of production, transportation and storage of the feed gas and LNG, namely carbon dioxide, methane, and nitrogen (I) oxide. The GHG precursors (SO_2, CO, NO_x, etc.) have been scoped out, due to the lack of reliable methodology for their estimations in CO_2 equivalent.

9.9.5.7 Identification of Method of Quantitative GHG Emissions Assessment

The 2006 IPCC Guidelines provide for three tiers of quantitative assessment of the emissions, depending on the available data on the operations, fuel, feedstock and processes:

- **Tier I** relies on application of generic average emission factors recommended by IPCC 2006, with no regard to the country-specific attributes of the processes;
- **Tier II** suggests that region-specific or country-specific emission factors are applied to account for local specifics of the processes, properties of the fuel, feedstock and/or materials;
- **Tier III** provides for the use of emission factors that account for specifics of the production processes of specific company. Such factors should be calculated on the basis of detailed information on composition of fuel, feedstock and materials, and on the technological process that produces the emissions.

The methodology approach to quantitative assessment of GHG emissions is selected with due regard to availability of data on the planned operations and the stage of design development, namely estmated values and parameters of various fuels used at different stages of the Project implementation. The method is picked to minimise uncertainty of the assessment result (the accuracy principle) and the risk of underestimating the emissions (the prudence principle).

The quantitative assessment results for each source have been compared against the selected level of significance. In accordance with the Methodology Instructions for quantitative assessment of GHG emissions #300 and recommendations of the GHG Protocol[227], the threshold level for significance is 5% of the total emissions volume, but not more than 50,000 t CO_2-equivalent per year. However, if this approach is adopted, most sources fall below the significance threshold, therefore, reliable calculated values that contribute more than 1% to the total GHG emissions volume have been considered, as far as possible.

The assessment has been conducted for each facility using the selected method, and depending on the available data (Tier II or Tier III). A high level assessment of the Project GHG emissions including description of the assumptions used is provided below.

9.9.5.8 GHG emissions assessment

In 2020, LLC "Arctic LNG 2" assessed GHG emissions from the Plant in the normal operation. Results of this assessment are provided in the updated GHG Emissions Report approved on 28.09.2020[228]. The Report examines GHG emissions from all topside structures and GBS (three gravity-based structures are

[227] GHG Protocol: A Corporate Accounting and Reporting Standard http://www.ghgprotocol.org/corporate-standard
[228] Greenhouse Gas Emissions Report – Company document reference code 3000-D-EC-000-HS-REP-2006-00 – TechnipFMC, 2020. 41 p.

considered, and from the onshore facilities including stationary sources (fuel combustion), vents of process lines and equipment, and fugitive emissions.

The main sources of GHG emissions at the Plant (listed in the descending order of contribution to total emissions) are as follows:

- Aero-derivative gas turbine (GT) with high heat efficiency equal to 41% (normal operation with 6 GT units (+1 in standby), installed capacity 76,990 kW each);
- Process / equipment vents;
- Auxiliary boiler plant (part of the onshore facilities, 2(+1) boiler units);
- Flare systems.

Calculations are prepared considering the operation load for 8 winter months and 4 summer months and 20% of time in loading regime and 80% of time in storage regime. The results are shown in Table 9.9.4.

Table 9.9.4: Results of the Plant GHG emissions assessment

Source		Annual GHG emissions, tpa			
		CO_2	CH_4	N_2O	$tCO_{2\text{-}e}$/year
Stationary sources	Gas turbines	5,808, 444	1882	-	5,855,50
	Boilers	18,007	0.3	32	27,551
	Flares	7,358	0	0	7,358
Process / equipment vents		116,056	359	0	125,031
Secondary and fugitive emissions		0	238	0	5,954
Total					**6,021,394**

Estimation methods used in the GHG Emissions Report are compliant with the IPCC Guidelines for National Greenhouse Gas Inventories (2006, v.2 Energy). The calculations referred to the IPCC Fourth Assessment Report for global warming potential factors of various greenhouse gases[229], which is compliant with the current practice of GHG emissions calculation. However, it should be noted that updated values of global warming potential are provided in the IPCC Fifth Assessment Report, and in 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, and most probably, the new values will be used in calculations by the time of the Project commissioning.

The Plant GHG emissions calculation has not been verified by the Consultant, however, review of the approach and input data indicates that all major sources of GHG are considered.

The comparative analysis in the GHG Emissions Report considering the LNG life cycle data published by the International Gas Union[230] demonstrates the calculated emissions intensity for the Arctic LNG 2 Project of 0.31 t CO2-e per ton of LNG, i.e. 66% of the lower GHG emission target (0.42 t CO2-e per ton of LNG). This comparison demonstrates that the resource and energy efficiency principle has been successfully implemented in the Project design. It is recommended to update the assessment with actual GHG emissions data from the Plant at a later stage, and compare it with best practice again.

Input data for the GHG emissions assessment in the design documentation for the Field and Port facilities at the construction and operation phase, and for the Plant construction phase have been reviewed and are included in Table 9.9.5, along with other parameters used in the calculations (also refer to Appendix 13 details).

[229] IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.
[230] Life Cycle Assessment of LNG. International Gas Union (IGU), June 2015.

Table 9.9.5: Input data for calculation of the Project GHG emissions

Parameter	Unit	Value
Construction phase[231]		
Diesel fuel consumption Field Plant Port	t	 57,991.5 17,564 4,407.5[232]
Operation phase[233]		
Diesel fuel consumption: Port	m^3/a	1100
Fuel gas consumption: Field	million m^3/a	190.67
Fuel gas parameters Field[234]		
Methane content	% mass	97.51
CO_2 content	% mass	0.1
Lower heating value	MJ/kg	44.68
Density	kg/Nm^3	0.6872
Diesel fuel parameters		
Diesel fuel density (winter)[235]	kg/m^3	840
Lower heating value[236]	MJ/kg	42.62
Global warming potential[237]		
Carbon dioxide	-	1
Methane	kg CO_2/ kg CH_4	28
Nitrogen (I) oxide	kg CO_2/ kg N_2O	265
Emission factor for natural gas combustion (IPCC, 2006)		
Carbon dioxide	t/TJ	56.1
Methane	t/TJ	0.001
Nitrogen (I) oxide	t/TJ	0.0001
Emission factor for diesel fuel combustion (IPCC, 2006)		
Carbon dioxide	t/TJ	74.1
Methane	t/TJ	0.003
Nitrogen (I) oxide	t/TJ	0.0006

Estimated quantities of GHG emissions at the Project construction and operation phases are listed in Table 9.9.6.

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231 A more detailed breakdown of fuel consumption during the Project facilities' construction and operation is provided in Appendix 13

232 Consumption at the diesel power plants before putting into operation is not included, due to the lack of information about the DPP running hours.

233 Information on the GHG emissions from the operational Plant is shown in Table 9.9.4 above

234 Salmanovskoye (Utrenneye) oil, gas, and condensate field facilities setup. Gas supply for the power supply facilities to support construction, hydraulic filling and drilling operations. Section 1. Explanatory note. Document code 120.ЮР.2017-2010-02-П31.ТЧ. NIPIgaspererabotka JSC, 2018. 63 p.

235 Interstate standard GOST 305-2013 "Diesel fuel. Specifications"

236 Construction of well pads at Salmanovskoye (Utrenneye) oil, gas, and condensate field, drilling and testing period. Design documentation. Section 8. List of Environmental Protection Measures. Part 2. Text part. Volume 8.2 - Document code 2018-560-НТЦ-ООС2. – NOVATEK Scientific and Technical Centre LLC, 2019. 226 p.

237 2019 Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories

Since different Project facilities will be constructed at different times, and GHG reporting must be prepared using the actual fuel consumption data, a summary assessment of GHG emissions has been prepared for the construction phase of the Field, Plant and Port. For the Plant, fuel consumption projection is available for several years, therefore, a separate assessment of GHG emissions using this data is provided in Table 9.9.7.

Also, it should be noted that, during the period from year 2019 till the gas-fired GTPP units are put into operation, power supply for the Field facilities will be provided from PGTPP-2500G units with the total capacity of 40 MW (16 units arranged in 4 modules, with 4 units in each module). A phased commissioning and decommissioning of PGTPP-2500G units is assumed, considering the planned timing of putting GTPP units into operation: 4 GTPP units in 2022 (3 operational + 1 standby) and 2 GTPP units in 2025 (total 5 units operational + 1 standby). Therefore, fuel gas consumption by the Field facilities is expected to peak in 2022: 243.44 Mm^3/a (refer to Table 9.9.5 and Appendix 13 for comparison). During this period, GHG emissions level from the Field facilities may be up to 420,000 t CO_2-e per year.

Table 9.9.6: GHG emissions at different phases of the Project

Part of the Project	Unit	CO_2	CH_4 (as $CO_{2\text{-}e}$)	N_2O (as $CO_{2\text{-}e}$)	$CO_{2\text{-}e}$
Construction					
Field	t	183,489	208	394	*184,091*
Plant	t	55,308	62	118	*55,489*
Port	t	13,946	16	29	*13,991*
Total for the phase	t	**253,572**			
Operation					
Field	t/year	328,429	164	155	*328,748*
Plant	t/year	*6,021,394*			
Port	t/year	2,924	3	6	*2,933*
Total annual	t/year	**6,353,075**			

Table 9.9.7: Annual GHG emissions from the Plant construction (diesel fuel consumption), t

Year	Diesel fuel consumption, t	CO_2 emissions	CH_4 (as $CO_{2\text{-}e}$) emissions	N_2O (as $CO_{2\text{-}e}$) emissions	GHG emissions as $CO_{2\text{-}e}$
2020	1,148	3,632	4	8	*3,644*
2021	4,818	15,244	17	33	*15,294*
2022	4,296	13,593	15	29	*13,637*
2023	2,922	9,245	10	20	*9,276*
2024	1,948	6,164	7	13	*6,184*
2025	1,774	5,613	6	12	*5,631*
2026	574	1,816	2	4	*1,822*

9.9.5.9 Alternative GHG emissions assessment

The Guidance Note on Climate Change Risk Assessment developed in September 2020 to further explain Equator Principles 4 requirements describes the necessity to include the alternatives analysis evaluating lower greenhouse gas (GHG) intensive alternatives in Climate Change Risk Assessment for the projects with emissions more than 100,000 t of $CO_{2\text{-eq}}$ per year, taking into consideration the design decisions, fuel type and specific emissions per production unit.

As described in Sub-section 9.8.5.4 and in Chapter 6 of the current ESHIA report, the design documentation contains consideration of alternatives, including selection of main technology based on the principles of energy efficiency and rational use of natural resources and allowing for minimization of GHG emissions (see Section 6.1 and Appendix 20 for details).

The largest input into the Project GHG emissions is provided by the Plant and the Field, the calculations are prepared for these Project components.

The following engineering options are introduced into the Project design in respect to the energy efficiency[238]:

- Energy generation at the Plant is arranged using efficient aero-derivative gas turbines instead of large industrial installations based on the higher thermal efficiency (41% comparing to 36-40%);
- Optimising energy generation and supply schemes including use of heat exchangers utilizing cold and heat in the technological process and optimizing water heating in boilers for own needs and for glycol solution;
- Using waste heat recovery units to recover waste heat from liquefaction turbines and utilise it in the process heat cycle or space heating;
- Using advanced smart controls for fuel combustion for minimization of N_2O emissions;
- The liquefaction technology is based on a consecutive process of natural gas liquefaction with application of mixed cooling agents for efficient liquefaction of natural gas;
- Boil-off gas (methane) from the technological processes of LNG production and storage is collected and returned for utilization of cold in heat exchangers in the liquefaction process, or utilized locally as fuel gas.

These options help to decrease the specific GHG emissions from 0.42 t $CO_{2\text{-eq}}$ / t LNG (lower average value by data on LNG life cycle assessment from International Gas Union[239]) to 0.31 t $CO_{2\text{-eq}}$ / t LNG.

For the Field, the comparison is provided using another type of fuel (diesel) taking into consideration the fuel characteristics and GHG emissions coefficient as well a power generation efficiency. The results of comparison is presented in Table 9.9.7a below.

Table 9.9.7a: The Plant and the Field alternative GHG emissions

The Project Component / Alternative	Specific GHG emissions, t $CO_{2\text{-eq}}$/t LNG	Total GHG emissions, thous.t $CO_{2\text{-eq}}$ /year
Plant		
Selected options (in the Project)	**0.31**	**6,021.39**
Average analogue (lower value)	0.42	8,158.01
Field		
Fuel gas (in the Project)	**328,75**	
Diesel fuel	463,54	

The GHG emissions comparison presented in the Table 9.9.7a demonstrates the results of implementation of energy efficiency principles in the Project design. It is recommended to provide more detailed assessment of the actual Project GHG emissions at the operation stage.

[238] Greenhouse Gas Emissions Report –3000-D-EC-000-HS-REP-2006-00 – TechnipFMC, 2020. 41 p.

[239] LNG Life Cycle Assessment. International Gas Union (IGU), June 2015.

9.9.5.10 Assessment of GHG emissions from the Utrenniy Airport

Considering the identified associated facilities and activities of the Project (refer to Section 5.7), the largest contribution to Scope 3 GHG emissions is expected from the Utrenniy Airport. Description of the Airport facilities is provided in Section 5.9.

At the Airport construction, GHG emissions will be generated from the following main sources:

- Energy generation at the gas-fired boilers, during Q1-Q3 2022;
- Operation of construction machinery with diesel-fired engines;
- Energy generation at diesel-fired power units of various capacity.

During the operation, the following sources at the Airport are expected to make the most significant contribution into the total emissions of GHG:

- Energy generation at the gas-fired boilers, starting from Q4 2022;
- Aircraft landing and take-off;
- Energy generation at diesel-fired power units of various capacity (at the TSF No.13);
- Fuel gas pipeline (planned evacuation of gas from the pipeline before preventive maintenance – annually).

Input data for the calculation have been prepared using the Airport design documentation and are listed in Table 9.9.8 below, and in Appendix 13 (in more details). Calculation of GHG emissions from aircraft is provided below in this section.

Table 9.9.8: Input data for calculation of the Airport GHG emissions

Parameter	Unit	Value
Fuel consumption at the construction phase		
Boiler plant, natural gas	thous. m^3	4,784[240]
Construction machinery, diesel fuel	t	427[241]
DPP 1000 kW, 320 kW, 280 kW (2 units), 80 kW, diesel fuel	t	399[242]
Fuel consumption at operation		
Boiler plant, natural gas	thous. m^3/a	5,700[243]
DPP (CUMMINS engines), diesel fuel	t/year	100
Natural gas parameters		
Lower heating value	MJ/m^3	36.18
Density	kg/Nm^3	0.78
Diesel fuel parameters		
Diesel fuel density (winter)	kg/m^3	840
Lower heating value	MJ/kg	42.62

Aircraft landing and taking off at the Utrenniy Airport are an additional source of emissions of greenhouse gases. For a unified approach to the assessment of air and climate impacts, the International Civil Aviation

[240] Estimated value, based on the data in: Utrenniy Airport. Design documentation. Section 1. Explanatory note – Document code 375-юр/2018-ПЗ - Krasnoyarsk: Design Institute Krasaeroproekt LLC, 2019.
[241] Utrenniy Airport. Design documentation. Section 8. List of Environmental Protection Measures. Part 3. Offsite utilities. - Document code 375-юр/2018-ООС3.2 - Krasnoyarsk: Design Institute Krasaeroproekt LLC, 2019
[242] Estimated value, based on the data in: Utrenniy Airport. Design documentation. Section 8. List of Environmental Protection Measures. Part 2. Construction period. - Document code 375-юр/2018-ООС2.1 - Krasnoyarsk: Design Institute Krasaeroproekt LLC, 2019
[243] Utrenniy Airport. Design documentation. Section 8. List of Environmental Protection Measures – Document code 375-юр/2018-ООС1.1 - Krasnoyarsk: Design Institute Krasaeroproekt LLC, 2019

Organisation (ICAO) introduced a notion of standard takeoff-landing cycle (TLC) which covers all operations with the aircraft from starting the engines to the height gain of 915 m, and from approach at the height of 915 m to stopping the engines after the airplane landing, Average duration of TLC is 32.9 minutes (1974 seconds).

GHG emissions calculation is prepared in accordance with the Calculation Methodology for Pollution Emissions from Civil Aircraft Engines (TsEBGA CJSC, 2007, updated version of 01.02.2020). Information on the expected types of aircraft and numbers of TLCs, and on nitrogen oxides emissions as NO_x is adopted from the design documentation[244]. CO_2 emissions from aircraft engines are calculated considering the mass of consumed fuel. Fuel consumption rates and engine capacities of specific aircraft are adopted from public domain – manufacturers' websites. Annual consumption of fuel is calculated on the basis of fuel consumption rate, number of engines and annual number of flights of specific types of aircraft. The GHG emissions data are shown in Table 9.9.9.

Table 9.9.9: GHG emissions from aircraft at the Utrenniy Airport

Type of aircraft	Type of engine	Engine capacity, h.p.	Number of engines	Annual number of flights	Fuel consumption rate			GHG emissions, tpa	
					kg/s	kg/h.p. *hr	t/year	CO_2	N_2O
AN-12	AI-20	4000	4	60	0.288	0.259	136.34	425.37	0.005
AN-24	AI-24	2550	2	3600	0.174	0.245	2466.5	7695.5	0.323
AN-26	AI-24	2820	2	720	0.192	0.245	545.53	1702	0.065
ATR-42	P&WC PW121	1900	2	360	0.165	0.313	234.51	731.67	0.023
ATR-72	P&WC PW124B	2475	2	360	0.165	0.240	234.51	731.67	0.028
Dash-6-400	P&WC PT6A	578	2	180	0.104	0.647	73.82	230.32	0.015
Dash-8	P&WC PW120	2400	2	90	0.165	0.248	58.63	182.92	0.007
L-410	M601A	740	2	20	0.058	0.281	4.56	14.24	0.000
Gulfstream G550	Rolls Royce BR710 C411	1800	2	12	0.290	0.581	13.75	42.91	0.005
Mi-8	TV2-117	1500	2	1080	0.115	0.275	488.57	1,524.3	0.148
Mi-26	D-136	10000	2	360	0.583	0.210	829.08	2586.7	0.178
							Total	**15,867**	**0.80**

GHG emissions from aircraft at the Airport are 16,079 t CO2-e/year. It should be noted that this volume of emissions is maximum, considering the high estimated load on the Airport in the design documentation. Actual emissions of greenhouse gases from this activity may be lower.

Estimated quantities of GHG emissions for the Airport construction and operation (considering the fuel consumption rates and emissions from aircraft) are listed in Table 9.9.10. GHG emissions at the construction phase are calculated as total quantity for the phase; the operation phase emissions are described as annual quantity of GHG emitted during full-scale operation.

Table 9.9.10: GHG emissions from the Airport at different phases of implementation

Source	Unit	CO_2	CH_4 (as CO_{2-e})	N_2O (as CO_{2-e})	CO_{2-e}
Construction					

[244] Utrenniy Airport. Design documentation. Section 8. List of Environmental Protection Measures – Document code 375-юр/2018-OOC1.1 - Krasnoyarsk: Design Institute Krasaeroproekt LLC, 2019

Source	Unit	CO_2	CH_4 (as CO_{2-e})	N_2O (as CO_{2-e})	CO_{2-e}
Boiler plant	t	9,710	4.85	4.59	*9,720*
Construction machinery	t	1,351	1.53	2.90	*1,355*
DPP	t	1262	1.43	2.71	*1267*
Total for the period	**t CO_{2-e}**	**12,342**			
Operation					
Boiler plant	t/year	11,569	5.77	5.46	*11,581*
DPP	t/year	316	0.36	0.68	*317*
Aircraft	t/year	Refer to the calculation in Table 9.9.9 above			*16,079*
Gas pipeline	t/year	-	26.46	-	*26*
Total annual	t/year	**28,003**			

The annual GHG emissions of the Airport are below the reporting threshold of 50,000 t CO_2-equivalent set by RF Government Directive No.716-r dated April 22, 2015. However, GHG emissions quantity at the Airport exceeds the threshold of 25 thousand ton of CO_2-e/year set by the IFC Performance Standards for annual reporting of direct and indirect emissions of GHG from the Project. In this respect, annual reports on the actual amount of greenhouse gas emissions will be required during the Airport operation.

9.9.5.11 Analysis of the assessment results

According to the assessment results, expected level of GHG emissions from the Project is 253,680 t CO_2-e during the whole period of construction; during the period of operation (starting from 2026), the Project emissions of GHG are not likely to exceed 6.35 million t CO_2-e per year.

After the facilities commissioning, the actual emissions will be re-assessed using the measured values or records. A more detailed inventory of operation phase emissions must be prepared for the Port and Field facilities.

It is expected that actual GHG emissions from the Project will be lower than the estimated values, as the calculation is based on conservative approach, using the projections in the design documentation and operation of facilities at full capacity. Furthermore, actual consumption of fuel gas for generation may be lower, due to better gas quality and optimization of combustion mode.

Since the Project represents a new development, the principle of ensuring maximum possible energy and resource efficiency is incorporated in the process of design development for the structures and facilities in compliance with the Russian law, particularly Federal Law No.261-FZ of 23.11.2009 "On energy saving and improvement of energy efficiency, and on amendments to certain legal acts of the Russian Federation" and the RF Government Resolution No.87 of 16.02.2008 "On the structure of design documentation and its contents".

The spatial design, processes and equipment configurations have been selected with reference to the best available techniques, and with a view to optimising the production and auxiliary processes and logistic schemes. Therefore, implementation of the designed schemes will minimise direct and fugitive emissions of greenhouse gases, due to the use of the most efficient generation processes and reasonable use of heat and electric energy, as well as reduction of potential leaks of natural gas and gas condensate in the process lines and at transportation and processing.

Implementation of the designed resource and energy efficient solutions for the Project will be ensured through the designer supervision and oversight of the practices at the stage of construction and commissioning, through monitoring of process performance over the transition period till full-scale operation, monitoring of implementation of the Environmental and Social Management Plans in terms of air emissions.

The key factors for effective management of GHG emissions during the operation phase are: timely maintenance of equipment; emissions monitoring and control; updating the inventory of emission sources and GHG emissions register; annual evaluation of absolute and specific GHG emissions of the Project. Sensible energy-saving solutions in accordance with international best practice should also be implemented whenever possible.

Since the annual GHG emissions of the Project are higher than the reporting threshold of 50,000 ton CO2-equivalent set by RF Government Directive No.716-r dated April 22, 2015, and the threshold of 25 thousand ton of CO2-e/year set by the IFC Performance Standards, direct and indirect emissions of GHG from the Project must be reported on annual basis. Exceedance of the threshold of 100 CO_2-e/year also triggers the requirement to publish annual reports on Scope 1 and Scope 2 GHG emissions during the Project operation stage.

In this connection, the Project will provide for the preparation of annual reports on the actual amount of greenhouse gas emissions, which will be available to relevant government agencies and lenders. To ensure compliance with the IFI standards, annual reports on greenhouse gas emissions during the Project operation must be made available to all stakeholders.

10. SOCIAL AND HEALTH IMPACT ASSESSMENT

10.1 Introduction

The Section describes the results of assessment of socio-economic and human health impacts of the Project. The assessment discusses impacts of Project construction and operation. Also, the Section considers measures to mitigate potential adverse impacts and enhance expected benefits. Therefore, each identified impact is assessed both before and after mitigation (i.e. residual impact).

Socio-economic and human health impacts of the Project are assessed with account for its social area of influence (refer to Chapter 8). The social area of influence is defined to include the areas and communities which may be affected by beneficial and adverse impacts of the planned activities.

The assessment was conducted in accordance with the ESHIA methodology described in Chapter 3 in the context of the social area of influence of the Project and considering the socio-economic baseline within the Project area of influence (refer to the description in Chapter 8).

This Section is structured to consistently describe the process of assessment of potential impact at various stages of the Project in relation to the following social aspects:

- Community health and safety;
- Economy and employment;
- Labour relations;
- Immigration flow;
- Behaviour of security personnel;
- Land use (including traditional activities); *and*
- Cultural heritage.

Sections on assessment of each of the above aspects are structured as follows:

- Overview and description of anticipated potential impact or impacts;
- Assessment of impact prior to mitigation and enhancement measures (impact significance before mitigation);
- Description of measures to mitigate adverse impact / enhance benefits;
- Assessment of impact after mitigation and enhancement measures (significance of residual impact); *and*
- Summary table with characteristics of expected impacts and mitigation measures.

10.2 Impact on Community Health and Safety

The Section provides assessment of impact of the Project on community health and safety, including:

- Impact of construction site activities on safety of local communities;
- Community health impacts caused by noise, vibration and air emission;
- Impact of stress; *and*
- Impact of traffic.

Potential impacts are considered in detail in dedicated sections below.

There are also other aspects related to potential impact of the Project on community health and safety, namely:

- Impact on customary economic activities of indigenous people conducting nomadic life in the Salmanovskiy (Utrenniy) LA. A description of this impact is provided in Section 10.7 below;
- Impact of the immigration flow which is discussed in Section 10.5 (including impacts of the possible spread of contagious diseases, including COVID-19, associated with the arrival of migrant workers; *and*
- Impact of risks of accidents is considered in Section 9.10.

Baseline conditions within the social area of influence of the Project, including community health characteristics, are described in Chapter 8.

10.2.1 Construction phase

10.2.1.1 Impact description

Impact of construction site activities on safety of local communities

The existing construction sites pose certain risks in the absence of adequate control of public access to the sites. Construction sites of the Project and associated facilities are situated at a significant distance from populated localities, therefore, the planned activities do not pose immediate threat for permanent residents. However, the area of the designed Project and associated facilities is used for customary economic activities of indigenous people, which is why ISPN representatives and their reindeer may be exposed to risks posed by construction sites and onsite operations, including operation of construction vehicles, machinery and equipment. Hazardous materials and substances which may be kept and used at the construction sites, e.g. solvents, paints, oils and lubricants, etc., may also entail risks for nomadic communities and their reindeer herds.Emergencies involving fuel tankers or other flammable and explosive substances with a risk of fire / chemical exposure could pose a certain risk to the indigenous communities migrating within the Salmanovskoye (Utrenneye) LA.

A more detailed description of the emergencies that could be caused by the Project is provided in Section 9.9 Emergency Impact and Natural Hazardous Processes. In particular, this section describes the potential impacts of explosions, fires, breakdown of lifting equipment, collisions of vehicles and vessels.

There is also a risk of collision of grazing reindeer with above-ground structures, which may result in accidents and injuries at the time of construction of line infrastructure (gas pipelines, power transmission lines). Such risks may be particularly high in the poor visibility conditions, or in case of low awareness of ISPN about the location of construction activities.

The magnitude of impact of construction activities on safety of local communities is assessed as high. Given the high sensitivity of recipients (indigenous people) the impact significance is also assessed as **high**.

Community health impact caused by noise, vibration and emission

Construction noise, vibrations and emissions will be associated with operation of construction vehicles, machinery and equipment. For instance, they may be caused by piling, drilling operations, running generator units, etc. Noise impacts are also possible in case of aircraft (helicopter) transport operations, especially at night time.

Due to the remote location of the designed Project and associated facilities relative to permanent settlements, indigenous people may be present in the area of the planned activities only for short period in the course of migration with the herds. Therefore, no significant community health impact of noise, vibrations and emissions is expected at the construction phase. The impact magnitude is assessed as low. Given the high recipient sensitivity to the impact its significance is assessed as **moderate**.

Impact of traffic

Considering a sparsity of roads in the area of the Project, it is expected that the most likely mode of cargo delivery will be sea transport. The construction workforce will be, as a rule, carried by air (helicopters). Sea transport during the navigation season may be also used for the purpose. Currently, workers are carried to the Salmanovskiy (Utrenniy) LA by helicopters via the airports in Sabetta or Tazovskiy twp. By preliminary data, after passing the peak values of the construction personnel influx, an airport will be commissioned in the territory Salmanovskiy (Utrenniy) LA which, apart from the Arctic LNG 2 Project, will serve other development projects on the Gydan Peninsula. After the airport is put in operation, it will be the major point of the workforce delivery to the Project. Accordingly, public roads may be used in relation to the Project for transportation of personnel from Novy Urengoy to Tazovskiy – for working in the central office or for a further transfer by air to the OGCF. In such case, recipients of the impact will be residents of Tazovskiy Municipal District and YNAO in general who use the Novy Urengoy – Tazovskiy motor road. At the time of the ESHIA studies, information neither on traffic intensity nor on the rate of accidents on this motor road section was available. However, the Consultant' experience of travelling by the motor road evidences that this section is not "overloaded".

Traffic impacts in the area of the planned activities may be expected due to regular transportation of the construction workforce and materials/equipment by infield roads between the main construction sites. As indigenous people use the concerned area for reindeer herding, there is a risk of road accidents involving vehicles and nomadic indigenous people and reindeer herds. The magnitude of potential traffic impact is assessed as moderate. Given the high sensitivity of recipients (indigenous people) the impact significance is assessed as **high**.

According to information cited in Chapter 8, the studies have not identified any fishery companies active in water areas within or in the vicinity of the Project. Fishing areas with the known positions in the Ob Bay are located far upstream of the Project water area and the sea port. Indigenous communities also practice fishing in rivers and lakes of Tazovskiy Municipal District. Therefore, impact of the Project water transport on fishing activities is assumed to be zero. Impact of the Project on fishing activities of nomadic population within the Salmanovskiy (Utrenniy) LA is discussed in Section 10.7.

Impact of stress

This potential impact will not affect residents of the nearest settlements within the social area of influence of the Project due to their remote location. However, it may affect indigenous nomadic communities migrating in the construction area of the Project and associated facilities. The key sources of nuisance are:

- Construction activities in greenfield areas traditionally used for customary economic activities;
- Arrival of the construction workforce and potential conflicts;
- Traffic, including helicopters;
- Noise, vibration and light impacts;
- Limitation of customary economic activities in the Salmanovskiy (Utrenniy) LA, particularly of reindeer herding and fishing; *and*
- Potential impact on tangible heritage objects[245] (including sacred sites and burial grounds) and on intangible heritage, etc.

Considering the construction scale, the magnitude of potential impact of a set of listed nuisance sources is assessed as high. Given the high sensitivity of recipients the impact significance is assessed as **high**.

10.2.1.2 Mitigation measures

Main measures to minimise the above impacts are listed below.

Impact of construction site activities on safety of local communities

- Development of a Construction Management Plan (CMP) – Community Health and Safety (a title and a type of a document may be altered in future);
- Installation of protective barriers and fences with warning signs at the construction sites, particularly in the areas where linear facilities are routed across reindeer herd migration routes;
- Roads and other linear infrastructure will be equipped with adequate crossing points where herders and their reindeer can safely migrate across such facilities (details are provided in Section 10.7);
- Hazardous materials will only be transported by operators licensed to transport these specific materials; transportation will be conducted in appropriate containers properly labelled in vehicles equipped with warning signs and signatures;
- Vehicles transporting hazardous materials will be equipped with fire extinguishers and other fire safety equipment appropriate to the nature of the cargo being transported;
- The Company is developing Oil Spill Prevention and Response Plans (OSPRP) in accordance with the requirements of the Russian law. Design documentation for the Utrenniy Terminal of liquefied natural gas and stable gas condensate includes an OSPRP for the onshore and offshore emergencies (see Section 9.3.3);
- The Company will ensure necessary interaction with regional and local authorities overseeing compliance with the provisions of the regulations on emergency response procedures;
- Measures identified in Section 9.9.5 for potential impacts during emergencies during the construction phase;
- Main construction sites will be guarded by security personnel and/or regular patrol inspections will be arranged in the area;
- In case of hazardous works, warning signs will be set up with the indication of the planned place and time of such works. The signs will be installed at a safe distance from the facilities under construction to prevent access of nomadic herders;

[245] Detailed description of the cultural heritage sites is provided in Section 8.10

- In addition to the warning signs, indigenous communities migrating in the social area of influence of the Project will be advised of the time and place of construction activities well in advance by the Project CLO (if deemed necessary); *and*
- Functioning of the Grievance Mechanism will also facilitate timely identification of any issues related to safety of local communities.

Community health impact caused by construction noise, vibration and emission

Measures to minimise these potential impacts are covered in Chapter 9.

Impact of traffic

- CMP – Traffic (a title and a type of a document may be altered in future);
- Design of infield roads will take in account available information on migration routes of indigenous people and reindeer herds;
- To minimise off-road traffic, motor vehicle traffic will be only allowed by dedicated road routes;
- Roads and other linear infrastructure will be equipped with adequate crossing points where herders and their reindeer can safely migrate across such facilities (details are provided in Section 10.7 – Impact on Land Use);
- Special signs will be set up on the roads at crossing points for the reindeer herd transit;
- Speed control bumps will be installed to control speed of vehicles near the crossing points intended for the reindeer herd transit;
- Priority will be given to the movement of herders and their reindeer at the approaches to the equipped crossing points on linear facilities;
- Mandatory pre-trip examinations of drivers will be conducted (including tests for potential signs of alcohol of drug intoxication);
- Representatives of indigenous communities migrating in the area of the Project and associated facilities will be advised of the time and place of construction activities well in advance by the Project CLO (if deemed necessary);
- Compliance with the applicable air traffic regulations, including on the minimum flying altitude;
- The Company and contractors will regularly monitor compliance with safe driving practices;
- The Company and contractors will see to the compliance with driving speed limits on the infield roads;
- The Company and contractors will adopt policy of zero tolerance in relation to the use of alcohol in the area of the Project, with immediate termination of the employment contract in case of violation; *and*
- Functioning of the Grievance Mechanism will also facilitate timely identification of any issues related to safety of local communities.

Impact of stress

Mitigation of this impact will include a combination of measures which have been identified for minimisation of other impacts, including:

- Development of the Construction Management Plan (CMP) – Community Health and Safety (a title and a type of a document may be altered in future);
- Measures identified in relation to potential impact of construction site activities on community safety (including setting up protective barriers and fences; providing adequate crossing points for safe transition of herders and their reindeer across line facilities, etc.);
- Measures to address the issues related to the workforce influx (including development and implementation of a Personnel Code of Conduct (a title and a type of a document may be altered in future)) – refer to Section 10.5;
- Transport impact mitigation measures (refer to the above);
- Measures to address potential impact on land use (including impact on reindeer herding and fishing activities – refer to Section 10.7);
- Measures defined in Chapter 9 in relation to various environmental impacts of the Project;
- Measures to mitigate potential impact on cultural heritage – refer to Section 10.8;
- Regular engagement with nomadic communities (indigenous people and their representatives) in the area of the Project and associated facilities; *and*
- Functioning of the Grievance Mechanism.

A detailed description of the mitigations is provided in the dedicated subsections of the Report. The Grievance Mechanism is outlined in the Stakeholder Engagement Plan.

10.2.1.3 Residual impact

After implementing the above mitigation measures, the significance of residual impacts of the Project is assessed as follows:

- Impact of construction site activities on safety of local communities will be **low**;
- Community health impact of noise, vibration and air emission – **low**;
- Traffic impact – **low**; *and*
- Potential stress impact – **moderate**.

10.2.2 Operation phase

10.2.2.1 Impact description

Impact of operational site activities on safety of local communities

This impact is basically similar to that of construction and will be associated with risks of operational facilities rather than of construction works. These facilities will constitute a hazard unless access to them is adequately controlled. Hazards may originate from operational sites (particularly the Complex) and linear infrastructure facilities. Given the remote position of the planned activities in relation to populated localities the only recipients exposed to potential impact of operational facilities are nomadic communities and their reindeer herds migrating in the immediate vicinity of the Project and associated facilities.

In particular, there is a risk of collision of animals with above-ground structures, which may result in accidents and injuries of reindeer or herders. Such risks may be particularly high in the poor visibility conditions, or in case of low awareness of ISPN about industry locations.

During the operation phase the potential for impacts due to emergencies remains. These impacts are described in more detail in Section 9.9. In particular, this section provides an assessment of impacts caused by emergency situations at the Project facilities (CGTP, pipelines), close to which there may be routes of indigenous people. Section 9.9 indicates that the social risk to the CGTP personnel (total annual frequency of events with deaths of at least 10 people) for one shift is estimated as 9.31×10^{-9} year^{-1}. For the other facilities, events with the deaths of ten or more people are practically impossible, therefore, in accordance with the established terminology, it can be concluded that no social risk is present there. No residential units will be exposed to affecting factors of accidents at the declared facilities, even in case of the worst-case emergency scenarios. The lethal risk to third parties in case of accidents at the Salmanovskoye (Utrenneye) OGCF Facilities Setup is zero.

The magnitude of potential impact is assessed as moderate. Given that by the operational stage the recipient (indigenous communities) may increase their level of adaptivity to presence of Project facilities, their sensitivity is assessed as medium. the significance of potential impact of operational facilities on community safety is assessed as **moderate**.

Community health impact caused by noise, vibration and emission

Potential impact of the Project and associated facilities may be caused by onsite operations and their inherent noise, vibrations and air emissions. These potential impacts will be especially well perceived within the boundaries of SPZ areas. Considering a maximum size of the SPZ, which is 1,000 m for industrial sites of hazard class 1, and the remote location relative to the nearest settlements, the Project will not exhibit any impact on health of permanent residents. Nomadic indigenous communities in the vicinity of the Project and associated facilities may appear exposed to potential impact. However, due to the nomadic lifestyle, indigenous communities and their reindeer herds are likely to stay in the vicinity of the operational facilities only for a short period of time. Therefore, potential impact will be local and short-term and its magnitude is assessed as low. Considering vulnerability of the recipients, the significance of potential impact is expected to be **moderate**.

Impact of traffic

Operational facilities will cause a similar range of traffic impacts as the construction activities; however, such impacts will have a less magnitude due to lower traffic intensity. Details on this impact were discussed in this section above. The significance of potential traffic impact is assessed as **moderate**.

Impact of stress

Potential stress impact of the Project in the operation phase will be similar to that at construction. Additionally, it is expected that during Project operation an airport (an associated facility) will be in use, which will pose additional stress factor caused by generated noise, light and vibration impacts. The significance of potential impact on nomadic indigenous communities in the area of the Project and associated facilities is assessed as **high**.

10.2.2.2 Mitigation measures

Main measures to minimise the above impacts are listed below.

Impact of operational site activities on safety of local communities

- Setting up protective barriers and fences at the main operational sites;
- Constructing adequate crossing points for a safe transition of herders and their reindeer across linear infrastructure facilities (details are given in Section 10.7);
- Making aware indigenous communities migrating in the area of the Project and associated facilities, as well as their representatives, of the exact locations of the available crossing points, including supplying them with maps (locations of the crossing points should be agreed with indigenous communities in advance – refer to Section 10.7);
- Locating security guards at the main operational sites and regular patrolling in the area;
- Measures identified in Section 9.9.5 for potential impacts during emergencies during the construction phase;
- The Company will ensure necessary interaction with regional and local authorities overseeing compliance with the provisions of the regulations on emergency response procedures; *and*
- Facilitating timely identification of any issues related to safety of local communities using the Grievance Mechanism.

Community health impact caused by noise, vibration and emission

Measures to minimise these potential impacts are covered in Chapter 9.

Impact of traffic

This potential impact will be minimised by implementing mitigations similar to those identified for the construction phase (refer to the above).

Impact of stress

This potential impact will also be minimised by mitigations similar to those identified for the construction phase (refer to the above).

10.2.2.3 Residual impact

After implementing the above mitigation measures, the significance of residual impact of the Project is assessed as follows:

- Impact of operational site activities on safety of local communities will be **low**;
- Community health impact of noise, vibrations and air emissions – **low** or **moderate**;
- Traffic impact – **low**; *and*
- Stress impact – **moderate**.

10.2.3 *Impacts summary*

Table 10.1: Summary of community health and safety impacts

No.	Impact	Recipient	Phase	Impact significance	Impact mitigation measures	Residual impact
10.1	Impact of construction/ operational site activities on safety of local communities	Indigenous communities in the area of the Project and associated facilities	C O	High	• Setting up of protective barriers and fences with warning signs at the construction sites, particularly in the areas where linear facilities are routed across herds migration routes; • Developing the CMP – Community Health and Safety (a title and a type of a document may be altered in future); • Constructing adequate crossing points on roads and other linear infrastructure for the safe transition of herders and their reindeer across such facilities (refer to Section 10.7); • Locating security guards at the main construction sites and/or regular patrolling of the area; • In case of hazardous works, setting up signs indicating the planned place and time of such works. The signs will be installed at a safe distance from the facilities under construction to prevent access of nomadic herders; • Installing protective barriers and fences at the main operational sites; • Making aware indigenous communities migrating in the area of the Project and associated facilities, as well as their representatives, of the time and place of construction activities well in advance; • Functioning of the Grievance Mechanism.	Low
10.2	Community health impacts caused by construction/operation noise, vibration and emissions	Indigenous communities in the area of the Project and associated facilities	C O	Moderate	Measures to address various aspects of environmental impact of the Project are identified in Chapter 9.	Low / Moderate
10.3	Impact of traffic	Indigenous communities in the social area of influence of the Project	C O	High / Moderate	• Developing the CMP – Traffic (a title and a type of a document may be altered in future); • Designing infield roads with due consideration of available information on migration routes of indigenous people and reindeer herds; • Minimising off-road traffic; motor vehicle traffic will be only allowed by dedicated road routes; • Constructing adequate crossing points on roads and other linear infrastructure for the safe transition of herders and their reindeer across such facilities (refer to Section 10.7); • Setting up special road signs at the crossing points for reindeer herds;	Low

No.	Impact	Recipient	Phase	Impact significance	Impact mitigation measures	Residual impact
					• Installing speed control bumps (e.g. "sleeping policeman") near the crossing points intended for reindeer herds; • Giving priority to movement of herders and their reindeer at the approaches to the crossing points on linear facilities; • Conducting mandatory pre-trip examinations of drivers (including alcohol of drug tests); • Making aware indigenous communities migrating in the area of the Project and associated facilities, as well as their representatives, of the time and place of construction activities well in advance; • Regular monitoring of compliance with safe driving practices by the Company and contractors; • Ensuring compliance with driving speed limits on infield roads in the authority of the Company and contractors; • Availability with the Company and contractors of policy of zero tolerance in relation to the use of alcohol during work hours; immediate termination of the employment contract in case of violation. • Functioning of the Grievance Mechanism.	
10.4	Impact of stress	Indigenous communities in the area of the Project and associated facilities	C O	High	Impact mitigation will include a combination of measures which have been identified for minimisation of other impacts, including: • Measures identified in relation to potential impact of construction site activities on community safety (including setting up protective barriers and fences, arrangement of adequate crossing points for the safe transition of herders and their reindeer across line facilities, etc.); • Measures to address the issues related to the inflow of labour migrants (including Personnel Code of Conduct development and implementation (a title and a type of a document may be altered in future)); • Transport impact mitigation measures (refer to the above); • Measures to address potential impact on land use (including impact on reindeer herding and fishing activities); • Measures defined in Chapter 9 in relation to various environmental impacts of the Project; • Measures to mitigate potential impact on cultural heritage; • Regular engagement with nomadic communities (indigenous people and their representatives) in the area of the Project and associated facilities; • Functioning of the Grievance Mechanism. Detailed description of these measures is provided in dedicated sections of the Report.	Moderate

10.3 Impact on the Economic Situation and Employment

The Section provides assessment of economic impact of Project construction and operation, including:

- Enhanced employment opportunities;
- Involvement of local works and services contractors for the Project;
- Tax contributions;
- Socio-economic programmes;
- Impact on operations of the Antipayutinskiy State Farm;
- Impact on operations of GydaAgro; *and*
- Impact on operations of companies engaged in fishery activities in the Ob Bay;

Potential impacts are considered in detail in dedicated sections below.

Potential economic impacts of the planned activities will also affect customary economic activities of nomadic indigenous people in the social area of influence of the Project. A description of this impact is provided in Section 10.7 below.

A description of the baseline economic situation in the social area of influence of the Project is given in Chapter 8 (Sections 8.6 – Economic Situation and 8.7 – Labour Market).

10.3.1 Construction phase

10.3.1.1 Impact description

Employment opportunities

Significant number of workforce will be involved for the Project construction phase. Also, construction of onshore infrastructure, Port and Field facilities will demand workforce. At the construction phase, according to the Medical Support Concept calculations, the number of Project personnel may reach peak values of 15,000. It is expected that construction works will be performed by contractors. Construction personnel work will be arranged on a shift basis.

Therefore, it is planned that the Project will create new jobs. However, employment opportunities for local communities in the social area of influence of the Project will be limited due to a combination of reasons to include special requirements to technical skills of construction personnel, the remote location of construction sites relative to the nearest settlements, and a skills profile of local residents engaged in customary activities (reindeer herding and fishing).

Despite this, the Company currently implements certain measures to attract local personnel including:

- Engagement with local employment centers and administrations of Tazovskiy district and YNAO is ensured in regard to local employment;
- The Company provides internship opportunities for the students residing in Tazovskiy district and YNAO with a potential for employment at the Project in case if the candidate fits the porition requirements;
- Regional legal requirements for provision of quota for persons with disabilities and young specialists are met in full.

Improved employment opportunities in turn will boost purchasing capacity and improve living standards of the employed.

Therefore, implementation of the Project will have **beneficial** impact by improving employment opportunities. However, this impact will be limited due to demand for special technical skills and the remote location of the construction sites relative to the nearest settlements.

Local procurement opportunities

At the construction phase, works and services providers will be engaged for construction of the Project and for supply of materials. These will be contracted both for construction activities and for auxiliary works and services, e.g. cleaning, catering, etc. Engagement of local contractors will indirectly add to growth of the local employment level. Contractors will be selected through a competitive tendering procedure.

However, local procurement opportunities will be limited since economic activities in the settlements within the social area of influence of the Project are mostly customary practices. In terms of the focus of the District and Okrug economy on development of the oil and gas industry, construction contractors may be attracted from other settlements of Tazovskiy Municipal District and other YNAO areas.

Therefore, the Project will have **beneficial** impact on local procurement opportunities.

Tax contributions

Tax contributions paid by the Company to the District and Okrug budgets may be earmarked to developing local infrastructure and addressing social concerns. Therefore, impact is **beneficial**, however, it does not require any incentive actions on the part of the Company, as tax distribution is beyond the scope of its competence.

Implementation of socio-economic programmes

Arctic LNG 2 ensure implementation of regular social investment projects in YNAO and Tazovskiy district as part of the Agreement on Social and Economic Partnership. The areas areas of the Company's social investments are as follows: support for representatives of the ISPN; sponsorship of schools, kindergartens and social facilities (hospitals, outpatient clinics); targeted support for vulnerable groups of Tazovskiy districtand the YNAO (veterans, children with disabilities, etc.); financing of sports, cultural events and environmental projects in Tazovskiy districtand YNAO, etc.

In order to support the indigenous peoples of the North, the Company provides financially aid to implement the measures to improve the living standards of the tundra communities, such as purchase of mobile huts, various equipment and resources necessary for traditional fishing and reindeer herding activities, organizing helicopter flights to transport tundra residents and food products to remote areas, and supply of fuel, lubricants and firewood to nomadic families and communities.

One of the most significant activities in the field of socio-economic development of YNAO is the construction of an 800-seat boarding school in Gyda village (Tazovskiy district) in 2018. The new school is equipped with modern equipment to support the educational process, cultural and sporting events. The construction of the school was fully financed by Arctic LNG 2.

During 2011 and 2019, total amount of social investment payments made by the Company equalled to more than 1 billion rubles as part of agreements on cooperation in the field of socio-economic development with the government of the YNAO and the administration of the Tazovskiy district.

Implementation of socio-economic programmes by the Company[246] facilitates development of socio-economic infrastructure, improvement of living standards of local communities, etc. This impact of the Project is assessed as **beneficial**.

Impact on operations of the Antipayutinskiy State Farm

Project facilities (especially Field facilities) will be constructed in the areas which are currently leased by the Antipayutinskiy State Farm. The Company will use the area needed for the Project facilities under lease agreements with the Administration of Tazovskiy district and in accordance with agreements on compensation of losses caused by limitation of the lease right reached between the Company and Antipayutinskiy State Farmagricultural enterprise in line with Art. 51 of the Land Code of the Russian Federation. Therefore, the Project will have **beneficial impact** on the Antipayutinskiy State Farm that will derive financial benefits from provision of the land for use.

However, one migration route of the State Farm's (used by one of the farm's brigade) reindeer runs nearby the Project facilities and will be exposed to impact related to implementation of the facilities within the field. This situation may result in the blockage of the route or limitation of its use, in which case alternative routes may be required. Economic activities of the State Farm may also be exposed to potential impact if Project implementation involves changes in migration routes of other herders in the Salmanovskiy (Utrenniy) LA and their use of pastures / migration routes of the State Farm's reindeer herds.. It is important to note that the Company consults regularly with representatives of Antipayutinskiy State Farm. In particular, the location of reindeer crossings over the Project linear facilities was selected in consultation with representatives of the state farm (see also Section 10.3.1.2). In total, approximately 8,500 hectares of land previously leased by the state farm is currently leased by the Project. According to data provided by the Company, the total area of land plots used by the state farm exceeds 1 million hectares; the plots leased by the Project are not considered as key areas for Antipayutinskiy State Farm activities. As noted in Chapter 8, only one route of the state farm will be directly affected by the Project linear facilities.

[246] Initially, the license for use of Salmanovskoye (Utrenneye) field was issued to NOVATEK-Yurkharovneftegas. The data are given taking into account the payments made by this organization.

Thus, at the moment the Company 1) leases municipal land plots and concludes agreements on compensation of losses with Antipayutinskiy State Farm; 2) holds regular consultations with Antipayutinskiy State Farm on compensation of losses within the conclusion as part of these agreements; 3) implements or plans to implement measures to prevent restriction of use of the remaining area of grazing land by Antipayutinskiy State Farm (installation of crossings over linear facilities) agreed with representatives of the state farm. The above factors allow to state that the Project implements or plans to implement measures to mitigate the impacts potentially related to economic displacement of Antipayutinskiy State Farm, and, provided the indicated mitigations are in place, the Project activities are not expected to limit use of pasture lands with the exception of the small area leased by the Project, for which amicable compensation agreements are signed with the state farm. These measures are also described in more detail in Section 10.3.1.2.

The magnitude of this impact is assessed as moderate. The recipient sensitivity is also moderate. Therefore, the significance of potential impact on economic activities of the Antipayutinskiy State Farm is assessed as **moderate**.

Impact on economic activities of Agricultural Enterprise GydaAgro LLC

As mentioned in Chapter 8, GydaAgro LLC does not run operations in the Salmanovskiy (Utrenniy) LA. Impact on the fishing areas used by GydaAgro in the lower reaches of the Yarayakha River that discharges to the Gydan Bay may occur from construction and operation of the Salmanovskoye (Utrenneye) OGCF facilities setup in the drainage area of the Yarayakha River and its tributaries, particularly at the crossing points of roads and utility lines with surface watercourses. Project facilities are located on the shoreside of the Ob Bay (a different drainage area), which is why the planned activities will not influence the flow conditions, water quality, and overall status of fresh water ecosystems of the Yarayakha River.

There is a likelihood of indirect impact on GydaAgro operations in case of informal sale of biological resource (mainly fish) by herders to personnel of the Company and its contractors. This concern was raised by the Director of the agricultural enterprise in the interview to the Consultant on April 18 2018 in the framework of the ESHIA studies for the Complex (2018). In this respect, the recipient's sensitivity (GydaAgro LLC) is assessed as moderate. The impact per se is chiefly expected at the construction phase when the greatest number of rotational personnel will be present in the area (**moderate significance**) to be followed by a decrease of its significance to **low** at the operation phase.

Impact on operations of companies engaged in fishing in the Gulf of Ob

Taking into account that all fish species in the Gulf of Ob, including commercial species in the Project area, have significant seasonal migrations, a number of indirect impacts on their populations in the Project area of influence may extend to the rest of their range, including most of the water area of the Gulf of Ob.

According to engineering survey data and FGBU Gosrybtcentr data, the water area for the proposed construction and operation of the Project facilities is a relatively small (up to 0.05%; including the integrated turbidity zone during dredging and dumping) part of the feeding range of valuable commercial fish such as vendace, broad whitefish, peled, Arctic cisco, Rainbow smelt. The wintering and spawning areas of these species are located at significant distance from the Project area in the middle and southern part of the Gulf of Ob, where seasonal concentrations of the listed fish are also observed. The fishing areas of the Gulf of Ob and Gulf of Taz are associated with the areas of so-called "pre-fish kill" concentrations of Coregonus (vendace, broad whitefish, peled, common whitefish), as well as smelt, nelma, burbot, ide and ruffe, which are ice-fished annually from November to March. In the Northern part of Gulf of Ob commercial fishing activities are prohibited in line with regional legislation. For example, at the fishing area in the Gulf of Ob nearest to the Project area located at considerable distance south in Gulf of Ob (main area of vendace wintering near of Yaptik-Sale village (Matkovsky et al., 2014)), municipal enterprise "Novoportovskiy fish factory" annually produces up to 100 tons of this species[247] with the catch potential of 830 tons[248].

In addition, as noted in Section 7.6, the results of scientific fisheries conducted from 2012 through 2019 demonstrated that in the Project area densities of valuable commercial fish (e.g., vendace and whitefish) are low.

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[247] News agency "Znak". Website: https://www.znak.com/2019-08-09/v_2019_godu_novoportovskiy_rybozavod_planiruet_uvelichit_vylov_ryby_na_75_tonn

[248] Matkovskiy A.K., Stepanov S.I., Yankova N.V., Vylezhinskiy A.V. State of fish stock and prospects of commercial fishing in Yamal district of YNAO // Nauchny vestnik YNAO. Issue № 1 (63). Biological resources YNAO and problems of their efficient use. Salekhard, 2009.

In assessing the impact of the Project on fisheries, the Consultant takes into account the opinion of the Federal Agency for Fishery (FAF), which considers it mandatory to implement a set of high-cost long-term compensatory fish stocking measures due to damage to ichtyocoenosis and reproduction conditions in the Gulf of Ob and mainland water bodies of Gydan Peninsula (see Section 9.6). Regardless of the location of specific sources of Project impacts on aquatic ecosystems, fish stocking measures are sanctioned in the Lower Ob at the locations of the fish farms with which the Company has contracts. From an environmental perspective, the significance of the Project impacts on commercial fish species has been assessed by the Consultant in Section 9.6 as high (prior to the application of mitigation and compensatory measures). However, it is important to note that the scope of fish stocking activities agreed upon by the regional branch of FAF was determined with account for the regional scale of impact on commercial fish species that was not previously associated with the Project and reflects the high regional significance of the problem of reproduction of commercially valuable species in the water system of the Gulfs of Ob and Taz, and the Lower Ob Basin. When considering the companies performing fishing activities within the fishing areas of the southern part of the Gulf of Bay (near Yaptik-Sale) as recipients, the Project's impact on the conditions of their activities, which are very local and remote from the Project area of influence, is considered to be of low importance. Due to the continued general stress conditions of the commercial fish fauna in the Gulf of Ob and Lower Ob, fishing in this aquatic system has a large number of limitations in regard to both species' composition and volume, and the Project's compensatory measures, which are significant in volume, will have a positive impact on the recovery of valuable whitefish and sturgeon species, including primarily their traditional fishing areas, which will ultimately contribute to lifting restrictions and the development of fisheries in the region.

Thus, the following factors have been taken into account in assessing impacts on fishing enterprises in the Gulf of Ob:

- The fishing grounds are located in the southern part of the Gulf of Ob at a significant distance from the Project;
- The water area of the proposed project construction and operation is a small part of the feeding habitat of valuable commercial fish (up to 0.05%, including the integrated turbidity zone during dredging and dumping);
- The wintering and spawning grounds of these species are significantly distant from the Project area and are located in the middle and southern parts of the Gulf of Ob;
- The density of valuable commercial fish near the Project area is low and therefore no significant impacts to these species are anticipated.

These factors were informed by the update of sections 7.6 and 9.6 of the ESHIA on biodiversity in November-December 2020.

Due to these factors allow reaching the conclusion that Project activities will not cause significant alterations of fisheries' conditions at fishing areas in the southern part of Gulf of Ob; therefore, no economic displacement will be triggered in relation to the enterprises involved into commercial fishing in the south of Gulf of Ob;, the magnitude of potential negative impact of the Project on the companies involved into fishing in the Gulf of Ob is assessed to be low. The sensitivity of these recipients has been assessed as medium, the integral significance of the Project impact on the operations of the fishing companies in the southern part of the Gulf of Ob is identified by the Consultant as **low**.

10.3.1.2 Measures to enhance beneficial and to mitigate adverse impacts

The following measures are recommended to enhance the above beneficial effects:

- Develop and implement local recruitment procedures; *and*
- Develop and implement local procurement procedures.

A detailed description of the above measures is provided below.

The following measures are recommended to mitigate the adverse impacts:

Impact on operations of the Antipayutinskiy State Farm

- Setup of safe crossing structures for reindeer at strategic points on linear facilities (also refer to Section 10.7) with proper consultations with Antipayutinskiy State Farm; current location of the reindeer crossings already takes into account the opinions of state farm's representatives who suggested two additional locations for crossings;
- Ensuring land reclamation after expiration of land lease agreements;

- Regular liaison with representatives of the Antipayutinskiy State Farm for timely identifying and addressing potential issues in the Farm operations;
- Monitoring of potential impacts on state farm activities as part of indigenous peoples development plan (IPDP);
- In the event of IPDP monitoring activities, including as part of engagement with Antipayutinskiy State Farm, demonstrate features of economic displacement in relation to affected brigade of the state farm, the Company will implement necessary livelihood restoration measures or compensation as part of IPDP or as part of livelihood restoration plan to be developed additionally; *and*
- Functioning of the Grievance Mechanism.

Impact on commercial fishing operations of Agricultural Enterprise GydaAgro LLC

- Measures to reduce potential impact on the aquatic biological resource – refer to Chapter 9;
- Ban on purchase of products (fish) from indigenous people;
- Consultations with GydaAgro representatives to ensure timely identification and resolution of potential problems in their operations (if necessary);
- Functioning of the Grievance Mechanism.

Impact on operations of companies engaged in fishing in the Ob Bay

- Measures to compensate harm to aquatic biological resources, which is associated with inevitable components of Project impacts (release of juvenile commercial fish species (broad whitefish, peled, humpback whitefish) in Lower Ob – refer to Chapter 9;
- If necessary – consultations with representatives of the companies as part of engagement with the executive authority[249] responsible for aquatic biological resource use and protection, in order to ensure timely identification and resolution of potential problems in their operations; *and*
- Functioning of the Grievance Mechanism.

10.3.1.3 Residual impact

Due to beneficial impact of the Project on the economic situation and employment, the respective residual impacts have not been assessed.

After mitigations, the significance of residual adverse impacts of operation is assessed as follows:

- Impact on operations of the Antipayutinskiy State Farm – **low**;
- Impact on GydaAgro operations in relation to the potential limitation of fishery activities on the Yarayakha River and informal purchase of fish from personnel of the Farm – **negligible**; *and*
- Impact on operations of companies engaged in fishing in the Ob Bay – **negligible**.

10.3.2 Operation phase

10.3.2.1 Impact description

Impacts on local employment and local procurement opportunities will be similar to those at the construction phase, though smaller in magnitude. Accurate numbers of personnel to be employed for operation of the Project were unknown at the stage of the ESHIA studies. A majority of personnel will be employed on a rotational basis immediately in the area of the planned activities. The Company will make efforts to attract local workforce and contractors as much as possible. However, considering the local labour market characteristics and remote location of the Project sites, the possibilities of engaging local workforce and companies will be limited. This impact of the Project will be **beneficial**.

Impacts of the Project in terms of tax contributions to the District budget and implementation of socio-economic programmes will be similar to those at the construction phase, i.e. **beneficial**.

Impacts on operations of the Antipayutinskiy State Farm, GydaAgro and companies engaged in fishing activities in the Ob Bay will be similar to those identified for the construction phase.

10.3.2.2 Measures to enhance benefits

Measures to enhance beneficial impacts at the operation phase are similar to those identified for the construction phase (refer to the above).

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[249] Department for natural resource regulation, forestry affairs and development of oil and gas industry of YNAO.

10.3.2.3 Residual impact

Due to beneficial effects of the Project on the economic situation and employment, respective residual impacts have not been assessed. Residual impacts on operations of the Antipayutinskiy State Farm, GydaAgro and companies engaged in fishing in the Ob Bay will be similar to those identified for the construction phase (refer to the above).

10.3.3 Local recruitment and procurement procedures

10.3.3.1 Local Recruitment Procedure or a similar document

It is recommended that the Company develops a detailed Local Recruitment Procedure that would ensure preferential treatment of local job seekers. The procedure should also apply to contractors and subcontractors. The Procedure will include a clear definition of "local personnel" (e.g., persons registered in Tazovskiy Municipal District or in YNAO) and establish target proportions of local and non-local employees of various grades (unskilled, semi-skilled and skilled).

In accordance with best practices in the oil and gas industry, the Procedure may also elaborate on the notion "local" personnel by introducing the term of "local area" personnel, i.e. persons from communities within the social area of influence of the Project (Gyda, Antipayuta, Yuribey and Tadebya-Yakha, or Tazovskiy District in general), and establishing target percentages for recruitment of "local area" personnel.

It is supposed that the Procedure will determine the approach to the selection and recruitment of candidates for vacancies considering quotas of job positions to be filled with persons with disabilities.

It should be noted that the Company is not legally entitled to require that contractors hire local residents (including indigenous people), or refuse job seekers basing on the place of their permanent residence. However, mechanisms that would encourage local recruitment may be applied. Such measures may include:

- Proactive preparation of a data base of the local (and from the "local area", if applicable) workforce using information available with employment authorities;
- Recruiters (both of the Company and of (sub)contractors) may select personnel from the above data base for respective workforce categories, as defined above;
- Liaison with the local employment authority in relation to recruitment of the local workforce; *and*
- Commitment to advising local communities of vacancies as a matter of priority and making sure that this commitment is applicable to contractors.

The Procedure may foresee preferential recruitment of indigenous people for the jobs which do not conflict with their customary lifestyle (positions with flexible work schedule and long travel distances throughout the license area, e.g. monitoring of the use of crossings over/under linear infrastructure by reindeer herders, monitoring of the state of heritage sites, work as guides for further survey activities in the OGCF area, etc.). Other candidates for such positions can only be considered in cases where it is not possible to provide these positions to representatives of the indigenous minorities with a sufficient level of competence.

The Procedure will further specify that preference should be given only to those local job seekers who have adequate professional competence for the job. The Company is expected to prepare and implement the Procedure with due consideration of its experience of personnel recruitment, which will facilitate establishing a more accurate proportion of local and non-local personnel described above.

10.3.3.2 Local Procurement Procedure or a similar document

A Local Procurement Procedure is similar to that of local recruitment. The Company should use its experience of engaging local contractors in preparation of the Local Procurement Procedure to allow for preferential treatment of local (registered in Tazovskiy Municipal District and YNAO) suppliers of goods and services. The Procedure may specify exceptions in relation to certain categories of services. Once implemented, the Procedure will be applicable to all contractors and subcontractors.

It will include a reservation that preference should be given to local companies on a competitive basis provided they meet the requirements established by Arctic LNG 2 LLC.

10.3.4 Impacts summary

Table 10.2: Summary of impacts on the economic situation and employment

No.	Impact	Recipient	Phase	Impact significance	Mitigation measures	Residual Impact
10.5	Employment opportunities	Population of employable age in the social area of influence of the Project, population of Tazovskiy Municipal District and YNAO in general	C O	Beneficial impact	• Develop and implement a Local Recruitment Procedure; • Develop and implement a Local Procurement Procedure.	Not applicable (beneficial)
10.6	Involvement of local works and services contractors for the Project	Companies providing logistics, transport, personnel accommodation, mobile communication services, etc., and their personnel	C O	Beneficial impact	• Develop and implement a Local Recruitment Procedure; • Develop and implement a Local Procurement Procedure.	Not applicable (beneficial)
10.7	Tax contributions	Population of Tazovskiy Municipal District and YNAO in general	C O	Beneficial impact	Not required	Not applicable (beneficial)
10.8	Implementation of socio-economic programmes	Communities in the social area of influence of the Project and population of Tazovskiy Municipal District in general	C O	Beneficial impact	Not required	Not applicable (beneficial)
10.9	Impact on operations of the Antipayutinskiy State Farm in relation to the use of the leased area	Antipayutinskiy State Farm	C O	Beneficial impact	Not required	Not applicable (beneficial)
10.10	Impact on operations of the Antipayutinskiy State Farm	Antipayutinskiy State Farm	C O	Moderate	• Setup of safe crossing facilities for reindeer at the points of intersection of herds migration routes and utility line corridors (also refer to Section 10.7); • Regular liaison with representatives of the Antipayutinskiy State Farm for timely identifying and addressing potential issues in the Farm operations; • Functioning of the Grievance Mechanism.	Low
10.11	Impact on economic activities of Agricultural Enterprise GydaAgro LLC	Agricultural Enterprise GydaAgro	C O	Moderate or low	• Measures to reduce potential impact on the aquatic biological resource – refer to Chapter 9	Negligible

No.	Impact	Recipient	Phase	Impact significance	Mitigation measures	Residual Impact
	due to informal purchase of products from indigenous people by personnel				• Prohibiting purchase of biological resource (fish) from indigenous people; • Functioning of the Grievance Mechanism.	
10.12	Impact on operations of companies engaged in fishing in the Gulf of Ob	Fishing companies operating in the Gulf of Ob	C O	Low	• Measures to reduce potential impact on the aquatic biological resource - refer to Chapter 9; • Consultations with representatives of the companies, within the scope of engagement with the executive authority responsible for use and protection of the aquatic biological resource, to ensure timely identifying and addressing potential problems in their operations (as appropriate); • Functioning of the Grievance Mechanism.	Negligible
10.13	Impact on conditions for further development in the area of Tazovskiy Municipal District of YNAO	Administration and business community of Tazovskiy Municipal District; scientific research organizations engaged in the studies on the natural and social environment in YNAO; design and construction companies operating in Arctic areas	C O	Beneficial impact	• Not required	Not applicable (beneficial)

10.4 Impact on Labour Relations

The Section discusses potential impacts of Project construction and operation on labour relations and work conditions of Project personnel. It further proposes corrective actions to mitigate the impacts and minimise health and safety risks for personnel.

The main aspects of the Project implementation, related to impacts on physical health and psychological welfare of personnel in the sphere of labour relations and working conditions include:

- Harsh climate in the Project area and, therefore, need for acclimatisation and adaptation of the arriving employees. Such conditions may cause impact on health, performance and psychological well-being of Project personnel;
- Accommodation of personnel, including provision of dwellings of adequate quality and management of accommodation health and safety risks;
- Occupational health and safety during construction and operation of hazardous industrial facilities, ensuring compliance with work conditions requirements and standards;
- Risks associated with engagement of contractors and their failure to comply with the applicable requirements in the sphere of labour relations and occupational health and safety, including:
  - Violation of workers' rights (e.g. in terms of overtime work, provision of amenity facilities and time for rest and days off, remuneration of labour, worker associations, and confidentiality of personal data of employees);
  - Lack of understanding between various groups of Project personnel;
  - failure to comply with requirements in respect of provision of adequate work conditions at workplaces of contractor personnel.

Specific impacts at the construction and operation phases are considered below.

10.4.1 Construction phase

10.4.1.1 Impact description

Work conditions: adverse impact on physical health and psychological well-being of personnel due to the harsh climate

Potential negative impacts on physical health and psychological well-being of Project personnel may develop due to the harsh Arctic climate with prevailing temperatures below zero and potential extreme weather conditions, limited duration of natural daylight, especially in autumn and winter, and the remote location of the Project area. Annual mean absolute air humidity[250] in subarctic regions is lower than in deserts, as water is "frozen out" by bitter cold. In areas with the cold climate, air humidity is low not only outdoors, but also in accommodation, office and industrial spaces, i.e. dry air is an ever-present environmental factor.

It is expected that non-local personnel from other than YNAO regions who are not adapted to the local climatic and geographic conditions will be exposed to a higher risk of adverse impact on physical health and psychological well-being.

In particular, the following negative health effects may be exhibited:

- Cohabitation with employees from different regions and countries, which may increase a risk of transmission of infectious diseases;
- Hypoxemia[251] (oxygen lack) and so called "polar breathlessness" caused by the Far North climate conditions. This impact may affect the respiratory system (changes induced by adaptation syndrome) with adverse sequential effect on human physiological functions;

[250] Source: Boris Velichkovskiy, member of the Russian Academy of Medical Sciences, Professor of the Russian State Medical University: "Polar Breathlessness", Neft Rossii ("Russian Oil") - information and analytical portal, Sotsialnoye Partnerstvo ("Social Partnership") journal No.3, 2006. http://www.oilru.com/sp/12/534/oilru.com

[3] In the Arctic environment, effects of hypoxemia due to lack of oxygen and carbon dioxide diffusion through lung membrane are further exacerbated by the cold climate. Prolonged hypoxemia results in the increased level of free radicals (and sequential damage of cells), while the number of antioxidants (which would repair the blocking damage caused by free radicals) declines, mainly due to the lack of vitamins C and E which are consumed by the organism at an increased rate, as part of the natural adaptation mechanism. Source: B. T. Velichkovskiy. Causes and mechanisms of the decreasing oxygen utilization coefficient in human lungs in the Far North // Biosfera : Multidisciplinary science and practice journal on study and conservation of the biosphere and utilization of its resource. - 2009. - Vol. 1, No. 2 - pp. 213-217.

[4] Potentially lethal conditions occur when the body temperature drops below 35°C.

- Increased risk of hypothermia[252] and cold injuries in case of working outdoors for a prolonged period at extremely low ambient temperatures and high wind chill factor;
- Seasonal Affective Disorder (SAD)[253], also known as "winter depression", sleep disturbance due to the lack of sunlight in polar night conditions;
- Increased predisposition to fatigability, fatigue, reduced period of concentration even when performing familiar routine tasks of standard duration;
- Predisposition to mental and physical stress, anxiety and feeling of inability to manage a situation, impaired performance and decreased ability to work under time pressure of the Project schedule (irregular work hours and extensive physical stress, particularly when working outdoors or on night shifts);
- Increased predisposition to diseases caused by the cold climate and low resistance of the organism, increased risk of the spread of diseases due to the taut conditions in a rotational camp densely populated with construction workers;
- Risks of late medical evacuation in extreme weather conditions which might impede engagement of ambulance aircraft for emergency medical treatment;
- Psychological disorders of Project personnel provoked by prolonged isolation without their families at remote site of the planned activities;
- Snow blindness; *and*
- Attacks of animals (polar bears, polar foxes, reindeer, and dogs).

Considering the high recipient sensitivity, moderate or high magnitude of health impact, and medium likelihood of the events, the impact significance before mitigations is assessed as **high**.

Occupational health and safety of Project personnel

Harmful occupational factors of the construction phase include:

- Air pollution in the work area with dust, harmful substances, volatile organic compounds and welding aerosols (refer to Section 9.1);
- Physical impacts: noise, vibrations and electromagnetic radiation (refer to Section 9.2);
- Physical and neuropsychic stress.

Injuries at the construction site may be caused by:

- Disregard of health and safety standards and requirements during construction and installation works;
- Falls from height;
- Working in confined space;
- Falls of objects, equipment and unsecured structures due to strong wind; falls of icicles from ice-covered roofs;
- Lifting objects;
- Motion of construction machinery;
- Contact with cold and hot parts of equipment;
- Electric shock;
- Fire outbreaks and explosions (due to hot works, failed air compressors).

Higher risks of injuries at construction sites are associated with falls from height, working in confined space, lifting objects, motion of construction machinery, contact with cold and hot parts of equipment, electric shock, fire outbreaks, and other risk factors.

Therefore, the impact significance varies from **low** to **high**. The risk factors in the sphere of occupational health and safety vary from **low** to **high** and are further aggravated by the severe Arctic climate.

Adverse impacts related to personnel accommodation

The risk of adverse impacts in the sphere of labour relations is enhanced due to the need for providing adequate living conditions for changeover personnel in the harsh Arctic climate. At the construction phase,

[5] This syndrome develops in the emotionally-affected state or in case of mood disorder. The lack of light provokes excessive generation of melatonin (hormone responsible for nocturnal sleep) and reduction of level of serotonin – another hormone, the lack of which causes depression. This syndrome can further enhance due to prolonged dull weather. People living in Arctic regions are especially susceptible to it, due to polar nights. SAD is a serious disorder which sometimes leads to dysthymia or major depressive disorders. Source: Science Reference, Science Daily, http://www.sciencedaily.com/articles/s/seasonal_affective_disorder.htm and 'About Seasonal Affective Disorder' *http://www.sad.org.uk/*

according to the Medical Support Concept calculations, the number of Project personnel may reach peak values of 15,000. Accommodation facilities of such scale, especially in Arctic regions, require special management efforts to ensure adequate health, safety and amenity conditions, etc.

Lack of adequate management measures may result in adverse impacts such as:

- Substandard sanitary and hygienic living conditions in the accommodation facilities for (sub)contractor personnel;
- Potential conflicts between various groups of personnel due to inadequate living conditions and lack of recreational facilities at the construction site;
- Inability to connect with the "greater world" with a subsequent sense of isolation and stress; *and*
- Increased potential for uncontrolled contacts of Project personnel with nomadic communities.

Given the anticipated large number of the construction workforce, harsh Arctic climate, and need to provide dedicated accommodation facilities for Project personnel the impact magnitude is assessed as high. The recipient sensitivity (personnel of the Project) is high. The significance of impacts related to provision of personnel accommodation is assessed as **high**.

Impacts associated with engagement of contractors and supply chain risks

Potential impacts may be caused by violation of requirements on labour relations in contractor companies. Experience of other projects of similar scale indicates that (sub)contractors may hire personnel who are not fully aware of their rights and duties. To this end, the Company should pay special attention to management of contractors. Particular impacts related to engagement of contractors may include:

- Discriminative practices in relation to certain individuals or groups of employees;
- Obstruction of the right of employees to associate;
- Untimely / unfair remuneration;
- Use of forced labour;
- Failure to provide safe and healthy working and living conditions; *and*
- Lack of access to the Grievance Mechanism.

It should be noted that the Company has experience of implementation of similar projects in similar conditions and requires that contractors adhere to certain occupational health & safety and industrial safety standards (refer to the subsection above). Both the likelihood of impact manifestation and its significance may decrease if same practices are applied under the Project.

In addition, risks associated with child and forced labour and occupational health and safety in the Project's supply chain may potentially be identified. It is important to note that based on the preliminary understanding the Project primary supply chain does not include regions and industries that typically pose such risks (e.g. agricultural production in relevant regions as defined by the International Labour Organisation[254]). Nonetheless, the Company will monitor potential risks through the applicable standards allowing supply chain analysis (see Section 10.4.1.2).

In terms of the large number of contractors, the magnitude of this impact is assessed as high. The sensitivity of recipients (personnel of the Project) is high. The significance of impacts related to engagement of contractors is assessed as **high**.

Risks related to personnel demobilisation

On completion of the construction phase (or individual construction stages), a large number of the workforce will be demobilized. This process may implicate completion of the contracts between construction workers and contractors and associated risks including:

- violations in the sphere of labour relations (primarily related to remuneration of any kind, e.g. compensation payments);
- risks associated with organization of workforce transportation to their place of residence (logistical convenience, safety, compensation of transportation costs by an employer);
- risks associated with workers' conduct in the settlements used as transportation hubs (e.g. Tazovskiy settlement).

[254] See https://www.ilo.org/ipec/Regionsandcountries/lang--en/index.htm

Given the large number of the workforce, the magnitude of this impact is assessed as high. The sensitivity of recipients (personnel of the Project, including contractors' personnel) is high. The significance of potential impacts of personnel demobilisation is assessed as **high**.

10.4.1.2 Mitigation measures

The measures recommended below can help mitigate adverse impacts on labour and work conditions. It should be noted that the listed measures are important and relevant for mitigation of all aspects reviewed in the Section.

The Company will ensure a limitation of the changeover and work shift duration, as well as that contractors take in consideration the harsh climatic conditions in organizing their construction activities.

Also, it is advised that a system of measures is developed for the Project to ensure healthy and safe working and living conditions, including:

- Regular breaks during a work shift, including breaks for messing and rest;
- Establishing health centres at the Project construction site;
- Conducting regular medical check-ups of personnel (including contractors) in the onsite health centre (pre-shift and mid-shift check-ups for selected groups of personnel), preliminary and periodic medical check-ups in line with established frequency prior to arrivalto the site, and identification potential chronic diseases which may corrupt natural adaptation processes;
- If necessary, provision of procedures against seasonal affective disorder at the onsite health centre;
- Distributing adequate PPE, as appropriate for the season and type of works. Considering the Arctic climate (special climatic zone, IA), SanPiN 2.2.4.3359-16 requires that rated thermal insulation performance of PPE is within the range of 0.669-0.823 °C·m/W, depending on air permeability of top material;
- Providing adequate rest, sports and recreation facilities for personnel to alleviate physical and psychological stress at the workplace;
- Maintaining optimum indoor air temperature and humidity in the residential and working premises;[255]
- Providing balanced nutrition at specialised catering facilities;
- Entering into agreements for provision of emergency medical evacuation and treatment services with healthcare institutions of YNAO;
- Implementing preventive measures aimed at raising awareness of health issues (including the threat of the spread of COVID-19) and a number of target measures for the adaptation and acclimatization of Project personnel, including contractors;
- Development and implementation of the system of primary supply chain risk analysis. As part of system implementation high-level analysis risk analysis will be conducted associated with child and forced labour, as well as significant health and safety issues. In the event of detection of potential material risks during such high-level analysis, the Company will initiate more in-depth analysis of specific risks and, if necessary, will ensure appropriate mitigation; *and*
- Implementing the Grievance Mechanism to address potential problems and complaints about the workplace arrangement and work conditions.

The Company will develop and implement a grievance mechanism to inform the Project management of potential problems relating to work conditions and labour relations. The Company will ensure that all (sub)contractors engaged at all stages of the Project lifecycle meet the conditions of the mechanism. The mechanism will enable anonymous submissions.

It is recommended that the Company requires (sub)contractors to respect RF labour law and applicable international standards pertaining to labour relations and work conditions, and occupational health and safety (in particular IFC PS2 and PS4). This requirement will guarantee incorporation of respective provisions in construction and supply contracts. The Company will establish a system of inspections and/or audits to monitor Project (sub)contractors' compliance with requirements of the RF Labour Code. If foreign nationals are employed, it is advised that the Company provides them with all necessary information, including about their rights and duties, in a language they understand and in a form acceptable to them.

[255] In living space of camp buildings, it is necessary to maintain the air temperature of 20-22 °C (22-25 °C at daily mean outdoor air temperature above 8 °C) and relative humidity of 30-45 % (30-60 % at daily mean outdoor air temperature above 8 °C) (refer to GOST 30494-2011). In rooms with sit-down workstations and minor physical stress at work (control rooms, etc.) the requirement is 22-24 °C (23-25 °C at daily mean outdoor air temperature above 8 °C) and 40-60 % (also at daily mean outdoor air temperature above 8 °C) (refer to SanPiN 2.2.4.3359-16).

The following management decisions and actions will prevent adverse impacts on physical health and psychological well-being: implementation of Occupational Health & Safety (OH&S) Management systems in contractor companies, certified in accordance with ISO 45001 where possible; compliance of all contractors with health and safety, environmental and social responsibility policy of Arctic LNG 2, equipping workers with PPE, and conducting medical examinations.

It is necessary to check the availability of required work permits and occupational health & safety (OH&S) and industrial safety (IS) certificates and carry out personnel training and knowledge testing (probation, toolbox talks). A full list of the recommended measures is provided in the tabular format in subsection 10.4.3. The recommendations have been developed basing on RF legal requirements and best practice in the sphere of occupational health and safety in the Benelux countries.

It is recommended that the Company provides workforce accommodation in compliance with sanitary standards of the Russian Federation and international best practice (in particular, Guidance Note of the IFC and EBRD "Worker's Accommodation: Processes and Standards"). It is further recommended that the Company see to that accommodation for (sub)contractor personnel is provided in line with the same standards.

An Accommodation Management Plan (a title and a type of the document may alter in future) in terms of sanitary standards) will be developed to manage the facilities provided by the Company for workforce accommodation that would, inter alia, address the following issues:

- Safety of residents and visitors;
- Accessibility of accommodation facilities;
- Welfare conditions;
- Living standards;
- Catering facilities and quality food;
- Communication facilities; *and*
- Living costs.

To minimise potential impact of demobilisation upon completion of the construction phase (or individual stages), the Company should develop a document or a regulation managing the process of workers' demobilization. This document is intended to ensure that contractors fulfil their contractual obligations to personnel, prevention of potential workers' resentment related to non-observance of their labour rights (primarily, in terms of salary payments), minimization of workforce transportation risks (e.g. related to transportation safety), workers' conduct, etc. This document is recommended to be developed by the final stages of construction, when significant workers' outflow is expected.

10.4.1.3 Residual impacts and risks

After mitigations, residual impacts and risks of the concerned aspects will reduce as follows:

- Adverse impacts and health and safety risks for physical health and psychological well-being of personnel to – **negligible** – **moderate** and **insignificant** – **low**, respectively;
- Adverse impacts of workforce accommodation to – **moderate**;
- Adverse impacts associated with engagement of contractors to – **moderate**; *and*
- Adverse impacts associated with demobilisation of personnel to – **low**.

10.4.2 Operation phase

10.4.2.1 Impact description

Adverse impact on physical health and psychological well-being of workforce, health and safety of Project personnel

In terms of the harsh climatic conditions, a scope and nature of adverse impacts on health and well-being of personnel at the operation phase will be similar to the construction phase. Health and safety risks will be generally lower.

Harmful occupational factors at the operation phase include:

- Air pollution with dust, harmful substances, volatile organic and other compounds in the work area (refer to Section 9.1);
- Physical impacts: noise, vibration and electromagnetic radiation (refer to Section 9.2); *and*
- Physical and neuropsychic stress due to the harsh Arctic climate.

Workplace injuries at operation may be caused by the factors such as:

- Onsite vehicle traffic;
- Disregard of health and safety standards and requirements while operating and maintaining process and auxiliary equipment;
- Breach of hazardous work norms and rules; *and*
- Lifting operations, due to ice-covered surfaces, etc.

The impact significance at the operation phase is assessed as **negligible – moderate**; the risk is i**nsignificant – low**.

Adverse impacts related to personnel accommodation

At the operation phase, impact of personnel accommodation in the accommodation facilities of the Project is expected to decrease to moderate due to reduction of workforce numbers in comparison with construction, though its scope will be similar to the construction phase. The recipient sensitivity is assessed as high; the impact significance at the operation phase is assessed as **high**.

Impacts associated with engagement of contractors

Potential adverse impacts of contractor engagement at the operation phase will not exhibit or will be **negligible** and, accordingly, these are not considered in this Section.

10.4.2.2 Mitigation measures

Mitigation measures to address adverse impact on physical health and psychological well-being of workers, alongside with personnel accommodation impact, are similar to those identified above for the construction phase.

Specific technical arrangements and measures are developed at the design phase for reduction of workplace noise and vibration impacts, control of harmful emissions from running engines and stationary sources, protection against electric shock, and minimisation of workplace injuries. The design solutions address the risk of vent loss of oxygen and excessive radiation in order to prevent the workplace hazard factor.

The Project implements a functional occupational health and safety, industrial safety, environmental and social management system[256], which will remain active at the operation phase; additionally, assessment and ranking of risks and hazards, regular internal and external audits, performance reviews of the management system, and special assessment of working conditions will be conducted.

In case of identified deviations from sanitary standards, and when a workplace hazard class is established, benefits and compensations shall be provided to the affected workers as appropriate in accordance with the statutory procedures.

10.4.2.3 Residual impacts and risks

The significance of residual impacts and risks:

- For physical health and psychological well-being of personnel, occupational health and safety – negligible - low; risk - insignificant; and
- For workforce accommodation - **moderate**.

[256] The Company plans to integrate the environmental management and health and safety management systems and certify the integrated management system for compliance with the requirements of ISO 14001:2015 and ISO 45001:2018. More details are provided in Chapter 14.

10.4.3 Impacts summary

Table 10.3: Summary of labour relations impacts and mitigation measures

No.	Impact	Recipient	Phase	Impact significance	Risk	Mitigation measures	Residual impact / risk
10.14	Adverse impact on physical health and psychological well-being of personnel, in terms of occupational health and safety: - injuries; - diseases	Project personnel	C	Low - high	Low - high	Development of a system of measures to ensure compliance with health and safety requirements. Define maximal duration of the changeover period and work shift duration at Project sites. Tool-box talks, training and knowledge tests, certificates and work permits for personnel. Determination of hazard class of the workplace environment factors; in case of identified deviations from the sanitary and hygienic standards – provision of benefits and compensations to personnel as appropriate in accordance with the statutory procedures. Development of the required H&S and IS procedures and instructions. Implementation of Lock-Out/Tag-Out systems with appropriate marking, development of instructions on their use, appointment of a competent officer, provision of training (including for contractor personnel) on prohibiting deactivation of lock-out system and switch on of de-energised equipment.	Negligible – moderate / insignificant – low
			O	Negligible / moderate	Negligible - low		Negligible – low / insignificant
10.15	Adverse impacts related to personnel accommodation	Project personnel	C O	High	High	Development of comprehensive measures to ensure healthy and safe living conditions. Provision of personnel accommodation in accordance with the RF sanitary and hygienic regulations and international best practice. Development of the Accommodation Management Plan or a similar document. Development and implementation of the grievance mechanism for personnel.	Moderate
10.16	Adverse impacts associated with engagement of contractors	Project personnel	C	High	Moderate	Making sure that (sub)contractors comply with the provisions of RF labour law and applicable international requirements, including incorporation of appropriate provisions into contract agreements, conducting inspections, development of a system of reporting on labour relations and working conditions. Development and implementation of the grievance mechanism for personnel, including contractors.	Moderate
10.17	Adverse impacts of demobilisation	Project personnel	C	High	High	Development of a document regulating workers' demobilization process.	Low

10.5 Impact of the Immigration Flow

The Section provides assessment of impacts of the labour migrant inflow to the social area of influence of the Project. Despite different numbers of immigrant workforce at the construction and operation phases, the impacts will be similar, therefore, they are considered jointly. Potential impacts of the Project migrant workforce include:

- Increased load on social, municipal and transport infrastructure;
- Rise in prices for vital goods and services;
- Potential conflicts between immigrants and local communities; *and*
- Potential spread of infectious diseases due to immigration of workforce.

These potential impacts are considered below.

There are also other aspects related to potential impact of the Project migrant workforce such as:

- Impact on the customary lifestyle, traditions and customs of nomadic indigenous communities in the area of the Project. A description of this impact is given in Section 10.8 below.

Baseline information on demography, economy, labour market, as well as social, municipal and transport infrastructure in the social area of influence of the Project is provided in Chapter 8.

10.5.1 Construction and operation phases

10.5.1.1 Impact description

Increased load on social, municipal and transport infrastructure. Price increase

Potential impacts of the Project may affect the following elements:

- *Educational institutions*. The migrant workforce will live in a rotational camp(s) at a significant distance from the nearest settlements. Workers will live in the camps without families (including children). Therefore, educational institutions (schools and kindergartens) in the social area of influence of the Project will not be exposed to an increased load;
- *Medical institutions.* Medical Support Concept plans using a four-level system of medical institutions with 20 medical specialists per shift: 1) feldsher health centre, 2) Health centre, 3) Medical aid centre, and 4) Medical facility (Central District Hospital). Three of the levels are to be implemented by the Project. Also, the Medical Support Concept provides for a number of sanitary and preventive measures, as well as vaccination of personnel. Therefore, no extra load on medical institutions in the social area of influence of the Project is expected. However, specialised medical aid will be provided to workers in case of need by outside medical facilities, e.g. in Novy Urengoy or Salekhard. This may involve an increase in the load on the selected medical facility (facilities);
- *Municipal infrastructure*. All elements of the Project, including rotational camp(s), will have autonomous power and water supply, and sewer systems. Therefore, no extra load on local municipal infrastructure in the social area of influence of the Project is expected; *and*
- *Transport infrastructure*. Due to difficult access to the area of the proposed activities, transport communication will be mainly provided by water and air. Therefore, no extra load on road infrastructure in the social area of influence of the Project is expected.

In view of the above, potential impact of the Project on social, municipal and transport infrastructure may be expressed in the increased load on medical institutions. At the construction phase, this impact will be local and reversible, and its magnitude is assessed as medium. Given the medium recipient sensitivity the impact significance is assessed as **moderate**.

Since Project personnel will live in a rotational camp(s) at a significant distance from the nearest settlements, their potential visits to settlements in the social area of influence of the Project will be only possible while transiting through Tazovskiy twp. Of note is that, after commissioning of the airport in the Salmanovskiy (Utrenniy) LA, the need for this transit point will drop out. Therefore, implementation of the Project will not cause a rise in demand for food or other goods in the populated localities within the social area of influence. The potential impact significance is assessed as **negligible / zero**.

Potential conflicts between immigrants and local communities

Arrival of significant numbers of migrant workers may result in conflicts between immigrants and indigenous communities conducting customary activities in the area of the Project and associated facilities. Such conflicts may intensify due to cultural differences between labour migrants and indigenous people. The use of alcohol or narcotics may provoke a conflict. The risk of conflicts is higher during construction due to the larger number of the workforce; however, conflicts are also possible at the operation phase. Of importance is that the Company has developed Provisions on indigenous peoples, a Regulation-instruction on access control and onsite regimes and the Procedure for staying in the territories of the license areas, strictly regulating the procedure for access to the Project construction sites and establishing a strict ban on the use of alcohol or other prohibited substances by Project personnel and on vehicle / people access to the Project facilities, as well as code of conduct with respect to indigenous peoples. Above that, the Company's in-house documents have introduced a strict ban on hunting and catching aquatic biological resources (including fish) in the license area and in locations of nomadic camps, reindeer migration routes, and grazing lands. Nevertheless, contacts between Project personnel and indigenous communities cannot be completely ruled out. Due to the above factors the potential impact magnitude is defined as high. Given the high recipient sensitivity the impact significance before mitigations is assessed as **high**.

Potential spread of infectious diseases amid the significant migrant inflow

Due to the inflow of the significant number of labour migrants contacts between them and local communities may pose a risk associated with sexually transmitted diseases (STDs) both for local residents and for personnel. The main risks may be characteristic of the construction phase, but they will also be present during operation. Risks of tuberculosis and HIV/AIDS are of particular importance, considering incidence of these diseases among indigenous communities (refer to Chapter 8). It is important to take in account the following factors:

- Workforce will live in a rotational camp(s) located at a significant distance from permanent settlements;
- Only a few individuals / families of indigenous people migrate in the vicinity of the designed sites;
- Company developed the Regulation-instruction on access control and onsite regimes and the Procedure for staying in the territories of the license areas, strictly regulating the procedure for access to the Project construction sites;
- Medical Support Concept was developed for the Project that provides for using the four-level system of medical institutions with 20 medical specialists per shift: 1) outpatient clinic (feldsher health centre), 2) Health centre, 3) Medical aid centre, and 4) Medical facility (Central District Hospital);
- Medical Support Concept suggests, inter alia, the following measures:
    - Sanitary and preventive measures;
    - Sanitary control of life support facilities;
    - Sanitary education;
    - Vaccination of personnel.
- Medical Support Concept also provides for proper equipment of the health centres.

In terms of the above factors, it may be concluded that potential contacts between personnel and indigenous communities will be rare and that the Project is provided with medical personnel and equipment. Nevertheless, considering the possible spread of the coronavirus infection SARS-CoV-2, potential exposure of nomadic communities to this disease and high (at the time of the ESHIA studies) uncertainty regarding possible vaccination or effective treatment of COVID-19, the magnitude of potential impact associated with the spread of infectious diseases is defined as high. Given the high recipient sensitivity the impact significance is assessed as **High.**

10.5.1.2 Mitigation measures

The main measures to minimise the above impacts are listed below.

Increased load on social, municipal and transport infrastructure

- Liaison with medical institutions regarding the load on their facilities and availability of resource to serve the extra load related to Project personnel;
- Development and implementation of the Local Recruitment Policy and Local Procurement Policy which, inter alia, will help reduce the potential load on healthcare infrastructure; *and*
- Functioning of the Grievance Mechanism that will facilitate collection of comments and complaints about the load on medical institutions due to their use by migrant workforce.

Potential conflicts between immigrants and local communities

- Development and implementation of the Personnel Code of Conduct (or similar document) which will include, inter alia, the following aspects:
  - Respect and polite attitude towards indigenous people at any contact with them;
  - Awareness of local behavioural standards;
  - Prohibition of distracting and performing unreasonable photography and filming of indigenous people without their consent;
  - Prevention of damage to local residents, their property, and local environment;
  - Neutral attitude and non-involvement in any situation which may lead to a potential conflict;
  - Prohibition of hunting, fishing and collecting of wild crops[257];
  - Prohibition of any use of dogs;
  - Prohibition of buying meat and fish from indigenous people[258];
  - Prohibition of sale of alcohol to indigenous people;
  - Respect for sacred sites, burial grounds, and other heritage sites of indigenous people;
- Development and implementation of the Accommodation Management Plan or similar document in accordance with the Guidance Note of the IFC and EBRD "Worker's Accommodation: Processes and Standards" which will, inter alia, reflect certain aspects of contacts with indigenous communities;
- Conducting induction training of personnel of the Company and contractors on the issues of interaction with indigenous people;
- Functioning of the Grievance Mechanism to facilitate receipt of information on conflicts between workers and indigenous people and timely response to such incidents.

Potential spread of infectious diseases due to immigration of workforce

- Ruling out or minimising as far as possible contacts between Project personnel and ISPN representatives migrating within the Salmanovskiy (Utrenniy) LA;
- Making personnel aware of necessary measures and procedures aimed at the prevention or minimisation of the spread of COVID-19;
- Placing of a memo for personnel on the rules to be observed at their arrival for entering on the shift, staying at the observatory (if necessary), and, at least, the following rules of conduct during the shift:
  - exclusion of contacts with unauthorized persons not involved in the Project;
  - ban on hiding signs of ARVI and other catarrhal diseases;
  - ban on getting outside the living premises in "home" clothes;
  - mandatory thermal imaging monitoring;
  - ban on excessive crowding in indoor smoking areas;
  - mandatory distancing of at least 1.5 m in recreation and smoking areas;
  - use of personal hygiene products.
- Conducting COVID-19 tests before starting a shift and ensuring that personnel have a two-week quarantine before entering on a shift;
- Functioning of a hotline aimed at informing Company's and contractors' workers on the current situation with COVID-19, action plans related to ensuring sanitary and epidemiological safety at industrial facilities, including observation and removal of workers from industrial facilities;
- Mitigating risks associated with frequent changeovers and, if necessary, increasing the duration of a shift of working personnel without violating the RF Labor Code provisions on rotational work;
- Incorporating measures for prevention of the spread of COVID-19 into the CMP - Community Health and Safety and into the Accommodation Management Plan (names and types of the documents might be changed if necessary);
- Developing and implementing the Personnel Code of Conduct or similar document (refer to the above);
- Developing and implementing the Accommodation Management Plan (or similar document) to reflect, inter alia, certain aspects of contacting with indigenous communities;

[257] Hereinafter term "wild crops" is used to describe wild edible and medicinal plants, as well as edible fungal fruit.
[258] "Peddling" of these goods is illegal, as food products trading outside permanent sales areas is prohibited.

- Making personnel aware of the risk of infectious diseases, including risks of tuberculosis, COVID-19, sexually transmitted diseases (particularly HIV/AIDS)(for example, by spreading information materials);
- Organizing recreational activities for Project personnel in the area of the rotational camp(s) with due consideration of the restrictions associated with the threat of COVID-19 spreading (e.g. a temporary ban on mass sports, preventing mass congestion in enclosed spaces, etc.).

10.5.1.3 Residual impact

Given the above mitigation measures are implemented the significance of residual impacts of the Project is evaluated as follows:

- At the construction phase, the increased load on social, municipal and transport infrastructure is assessed as **low** (as the significant number of labour migrants will arrive to the area); at the operation phase, impact will be **negligible**;
- Impact of potential conflicts between the workforce and local communities is assessed as **low / moderate**;
- Impact of potential spread of infectious diseases is assessed as **moderate**.

10.5.2 Impacts summary

Table 10.4: Summary of immigration flow impact

No.	Impact	Recipient	Phase	Impact significance	Mitigation measures	Residual Impact
10.18	Increased load on social, municipal and transport infrastructure	Population in the social area of influence of the Project, population of Tazovskiy Municipal District and YNAO in general	C O	Moderate	• Liaison with medical institutions regarding the load on their facilities and availability of resource to serve the increased load related to Project personnel; • Development and implementation of Local Recruitment Policy and Local Procurement Policy which, inter alia, will help reduce potential load on local healthcare infrastructure; • Functioning of the Grievance Mechanism.	Low / negligible
10.19	Growth of prices for vital goods and services, e.g. housing, food, etc.	Population in the social area of influence of the Project	C O	Zero / negligible	Not required	Zero / Negligible
10.20	Potential conflicts between immigrants and local communities	Indigenous communities in the area of the Project	C O	High	• Development and implementation of the Personnel Code of Conduct or similar document; • Development and implementation of the Accommodation Management Plan (or similar document) which, inter alia, will reflect certain aspects of contacting with indigenous communities; • Conducting induction training of personnel of the Company and contractors on the issues of interaction with indigenous people; • Functioning of the Grievance Mechanism.	Low / Moderate
10.21	Potential spread of infectious diseases	Indigenous communities in the social area of influence of the Project	C O	High	• Development and implementation of the Personnel Code of Conduct (refer to the above); • Development and implementation of the Accommodation Management Plan (or similar document) which, inter alia, will reflect certain aspects of contacting with indigenous communities; • Implementation of comprehensive measures aimed at reducing the probability of the spread of COVID-19; • Making personnel aware of the risk of infectious diseases, including risks of tuberculosis, COVID-19, sexually transmitted diseases (particularly HIV/AIDS)(for example, by spreading information materials); • Organizing recreational activities for Project personnel in the area of the rotational camp(s).	Moderate

10.6 Impact of Behavior of Security Personnel

The Section discusses assessment of potential impact of behaviour of Project security personnel. Impact will be similar at construction and operation phases (despite certain differences between the phases, e.g. different numbers of the immigrant workforce), therefore, their assessment is combined.

10.6.1 Construction and operation phases

10.6.1.1 Impact description

The Company will employ private security contractors for protection of its permanent and temporary sites throughout the Project lifecycle. Security personnel will be engaged to ensure safety of the employees and industrial facilities, as well as to prevent unauthorised access of third parties to hazardous industrial sites.

Community safety risks are possible in case of abuse of authority by security personnel, especially where such authority is not clearly defined. The risks may be caused by inadequate behaviour of security personnel, e.g. inappropriate use of force or offensive language in relation to indigenous people or workers. For instance, indigenous people may approach Project personnel (including security guards) with requests for fuel, firewood, or on other matters. Risks may be also associated with the use of special means by security guards.

It is important to note that the Company has developed a number of documents regulating activities of Project security personnel, access control and counteraction to prohibited activities in the Project area.

Potential impact will be local, long-term and have low probability. The impact magnitude is assessed as low. Recipients of this potential impact are indigenous communities, as well as personnel of the Company and contractors. The recipient sensitivity was determined basing on the more vulnerable recipient, i.e. indigenous people. Therefore, the recipient sensitivity is assessed as high, and the potential impact significance before mitigations is **moderate**.

10.6.1.2 Impact mitigation

Main measures to be implemented to minimise the above impacts are listed below.

- Ensuring due measures to prevent unauthorised access to the areas of construction and operation sites (fences, entrance check points, etc.);
- In organizing the security service of a site, adhere, in addition to the applicable RF laws, to the provisions of the following documents (to the extent that does not contradict national legislation):
    - Voluntary Principles on Security and Human Rights;
    - IFC Good practice handbook “Use of Security Forces: Assessing and Managing Risks and Impacts: Guidance for the Private Sector in Emerging Markets”;
- As appropriate, updating the documents that regulate activities of the Project security service, or develop a separate Security Management Plan (or similar document) in accordance with the requirements of the international documents listed in the previous paragraph, to ensure at least the following:
    - Identification of potential risks associated with Project facilities security;
    - Description of the structure of the Project security service, as well as of the functions and duties of its personnel;
    - Description of the procedure for the use of force and special means (according to the IFC requirements, the use of force is allowed in self-defense or in the suppression of unlawful actions in proportion to the potential threat);
    - Description of the code of conduct of security personnel, especially when contacting with representatives of indigenous communities of Tazovskiy District to ensure due consideration and respect for the values and economic and cultural features of the ISPN lifestyle;
    - Description of the interaction system between private security companies of the Project and public security services (e.g. the police), which, presumably, will also operate in the territory of the Salmanovskiy (Utrenniy) LA.
- Conducting trainings or other types of educational activities for security personnel with regard to compliance with the Security Policy, Security Management Plan (or a similar document) developed by the Company, taking into account the requirements and recommendations of the Voluntary Principles on Security and Human Rights;
- Practical application of job descriptions established for security personnel;

- Conducting induction training of security service personnel on the issues of interaction with indigenous people;
- Functioning of the Grievance Mechanism that may also facilitate receipt of information and complaints about behaviour of security service personnel, including as regards abuse of human rights by the latter; all submissions on cases of human rights abuse will be investigated by the Company in accordance with the Voluntary Principles on Security and Human Rights.

10.6.1.3 Residual impact

Given the above mitigation measures are implemented residual impact of behaviour of Project security personnel is assessed as **low**.

10.6.2 Impacts summary

Table 10.5: Summary of impact of behaviour of security personnel

No.	Impact	Recipient	Phase	Impact significance	Mitigation measures	Residual Impact
10.22	Abuse of authority and inadequate behaviour of security personnel	Indigenous communities in the area of the Project, personnel of the Project and of contractors	C O	Moderate	• Measures to prevent unauthorized access to the areas of construction and operation sites (fences, entrance check points, etc.); • In organizing the security service of a site, adhere, in addition to the applicable RF laws, to the provisions of the following documents (to the extent that does not contradict national legislation): ○ Voluntary Principles on Security and Human Rights; ○ IFC Good practice handbook "Use of Security Forces: Assessing and Managing Risks and Impacts: Guidance for the Private Sector in Emerging Markets"; • As appropriate, updating the documents that regulate activities of the Project security service or develop a separate Security Management Plan or similar document in accordance with with the requirements of the international documents listed in the previous paragraph; • Conducting trainings or other types of educational activities for security personnel with regard to compliance with the Security Policy, Security Management Plan (or a similar document) developed by the Company, taking into account the requirements and recommendations of the Voluntary Principles on Security and Human Rights; • Application of job descriptions established for security personnel; • Conducting training of security personnel on compliance with the applicable requirements; • Conducting induction training of security service personnel on the issues of interaction with indigenous people; • Functioning of the Grievance Mechanism.	Low

10.7 Impact on Land Use

The Section considers potential impacts of Project construction and operation on land use. A description of the baseline land use conditions in the area of the Project location is given in Chapter 8 (Sections 8.8 "Land Use" and 8.9 "Indigenous Peoples"). The following key impacts on land use have been identified for the Project construction phase:

- Impact on reindeer herding, including the blockage and/or restriction of herd migration routes, physical loss and/or limited access to pastures and fawning sites;
- Impact on customary fishing activities, including physical loss and/or restriction of access to fishery grounds; *and*
- Impact on hunting and wild crop collecting, including physical loss and/or limited access to the respective areas.

Therefore, impacts may be related to resettlement or economic displacement[259] of ISPN from the areas of their customary activities. Individual assessment of impact on each of the above land use types is provided below.

Furthermore, the Project may cause potential impact on indigenous people in the Project's social area of influence in terms of the following aspects:

- Potential impact on tangible and intangible heritage of ISPN discussed in Section 10.8 below;
- Potential impact on community health and safety discussed in Section 10.2; *and*
- Potential impact of the Project on the economic situation and employment of indigenous people assessed in Section 10.3.

10.7.1 Construction phase

10.7.1.1 Impact description

Impact on reindeer herding

Indigenous communities extensively use the territory of the Salmanovskiy (Utrenniy) LA for their customary economic activities, of which reindeer herding is their core occupation. About 65 nomadic ISPN families (i.e. over 300 persons) have been identified within the license area. The total number of reindeer grazed by these families is over 23 thousand. Herders' migration routes within the Salmanovskiy (Utrenniy) LA are shown in Figure 8.10 of Chapter 8. Points of Project facilities intersection with the known migration routes of reindeer herders have been identified by the time of the ESHIA studies. The Field facilities are also located in the immediate vicinity of two known reindeer fawning sites (Figure 10.2).

Given that implementation of the Project will cause the blockage or limitation of certain known migration routes used by reindeer herders, with the follow-ups such as:

- Increased duration of reindeer transhumance by indigenous people;
- Physical loss or limitation of the pasture use;
- Limitation (and potential physical loss) of reindeer fawning sites; *and*
- Alteration of reindeer migration routes which may in turn result in a potential increase of the load on pastures used by other herders at the eastern boundary of the LA and outside its boundaries.

Reindeer herding activities may be also exposed to impact on pastures caused by pollutant emissions at the construction phase (refer to Chapter 9). Apart from that, impact of the Project on reindeer herding should be regarded in the context of impact of the airport whose territory is adjacent to a reindeer fawning site. The area of restrictions based on aircraft noise factor will affect reindeer fawning site and herders' migration routes (including the route of the workers of Antipayutinskiy State Farm), which can also lead to the listed above impacts.

Due to the high magnitude of the impact and in terms of the high sensitivity of the recipient (indigenous people), the potential impact significance before mitigations is assessed as **high**.

Impact on fishing practices

Several customary fishing areas used by nomadic indigenous people have been identified within the Salmanovskiy (Utrenniy) LA (refer to Section 8.9). Indigenous peoples use the fishing areas depending on

[259] Economic displacement is defined as loss of assets or other means of livelihood, with or without physical displacement of the affected parties (refer to IFC PS5).

the fishing season and when they migrate close to such areas. The GBS LNG & SGC Complex will be located close to two of them (Figure 10.1):

- a section of the Khaltsyney-Yakha River near the estuary and floodplain lake Khaltseyakha-Khasre; *and*
- a section of the Nyaday-Pynche River near the estuary.

The first one is potentially subject to greater impact as it is located 110 m north-west of the Port area, within its sanitary protection zone[260], whereas the second is located 2 km south-east of the Complex. There will be water intake in one of the floodplain lakes of the Khaltsyney-Yakha River, whereas treated wastewater will be discharged in the Nyaday-Pynche River (Chapter 5). In addition, hydraulic structures of the Complex and Port may have indirect impact on the rivers and their biocenoses, which may evoke local transformations of water circulation, lithodynamic and other processes in the river estuaries and areas adjoining the Ob Bay. Spawning grounds and fishing areas in the lower reaches of the Khaltsyney-Yakha River and the Nyaday-Pynche River might be also temporarily disturbed; the significance of the relevant Project impact on freshwater ecosystems is moderate (Section 9.5). In addition, the close location of the Complex and Port facilities, having sanitary zones, may also impede access of those ISPN representatives that use these fishing areas in the estuaries of the two rivers.

Linear facilities of the OGCF facilities setup will also affect a part of the fishing area within the Salmanovskiy (Utrenniy) LA – the Neita-Yakha River, its tributaries and floodplain lakes. In addition, two hydraulic sand quarries will be located within this fishing area (Figure 10.1). Nonetheless, it is not anticipated that this fishing area will experience significant impacts. Access to this section may be limited due to construction of the Field facilities.

[260] Several Field facilities will be sited in the valley of the Khaltsyney-Yakha River, including quarries for production of soil construction materials, and water intake facilities confined to the valley lakes; the Nyaday-Pynche River will be used for disposal of wastewater from the Field facilities which will be treated to MPC standard for fishery before discharge. The designed buildings and structures of the Field, Complex and Port will use a common water intake and pretreatment facility, and a common local wastewater treatment plant.

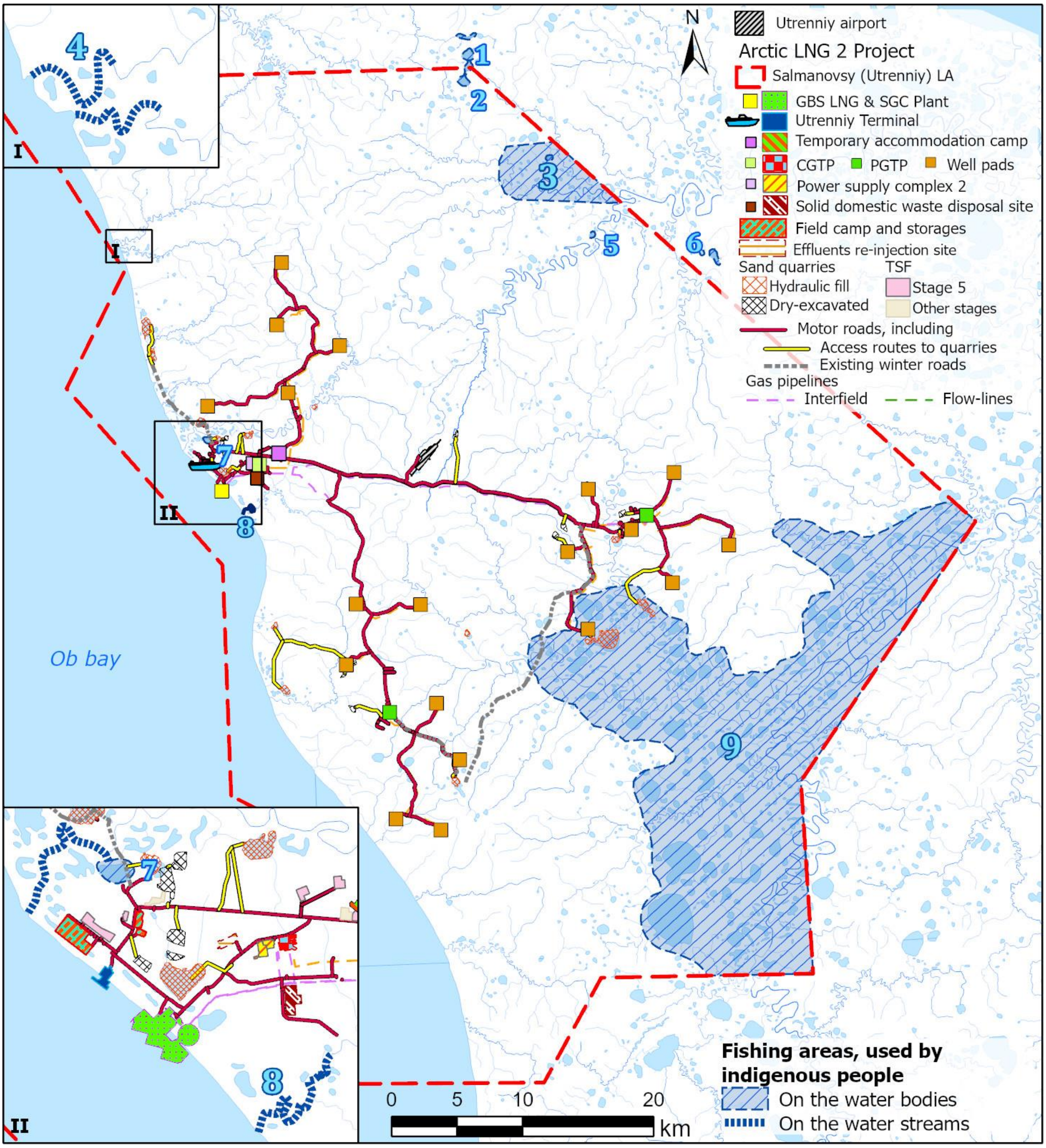

Figure 10.1: Information on customary fishing areas within the Salmanovskiy (Utrenniy) LA

Other fishing areas that are known by the time of the ESHIA studies and are used by indigenous peoples will not be affected by the Project. However, access to these areas might be limited due to construction of the Field facilities. Because of the potential limited access to the part of the fishing grounds, indigenous people may also more often visit other fishing areas within the Salmanovskiy (Utrenniy) LA and beyond it.

In should be noted that a pre-design survey (Purgeocom LLC, 2015) identified a relatively poor availability of water bodies suitable for fishing within the Salmanovskiy (Utrenniy) LA.

Therefore, considering the following:

- Project impacts on fishing areas at the Khaltsyney-Yakha River (and floodplain lake) and the Nyaday-Pynche River;
- Potential limitation of access to the fishing area at the Neita-Yakha River;
- Importance of fishing activities for the livelihoods of nomadic Nenets;

- The territory of the Salmanovskiy (Utrenniy) LA is used by approximately 65 Nenets families;
- Relatively poor availability of fishing areas within the LA (therefore, the available fishing areas have greater value);
- Potential additional load on the available fishing areas in case of potential limitation of use of the named above fishing areas,

the magnitude of impact on the fishing activities of indigenous peoples is assessed as moderate/high. Considering high sensitivity of the receptor (indigenous peoples), the impact significance is assessed as **high**.

Impact on hunting and collection of wild crops

The area of the planned activities may be used by indigenous communities for hunting and wild crop collection. No areas specifically assigned for hunting have been identified since indigenous herders practice hunting along reindeer migration routes. The amount of hunting prey is not great and, like wild crops, it is mostly used for own consumption. Similarly to the impact on reindeer herding activities described above, potential impact on hunting and collecting of wild crops may manifest itself in physical loss or limited access to the concerned areas. The magnitude of potential impact of the Project on customary hunting and gathering is assessed as moderate. The recipient sensitivity is defined to be high. Therefore, the impact significance before mitigations is assessed as **high**.

10.7.1.2 Impact mitigation

Reindeer herding, fishing, hunting and collecting of wild crops

The above main potential impacts of the Project on customary economic activities of indigenous communities have been combined for the identification of impact mitigation measures. The main mitigation measures are:

- Preparation of an Indigenous People Development Plan (IPDP). The Plan will define the Company's approach to engagement with indigenous communities and FPIC, assessment of the main Project impacts on indigenous people, livelihood restoration measures, and activities to support development of ISPN. The IPDP will also take in account gender aspects. The FPIC process is detailed in Chapter 4;
- As noted in Section 9.6, the Company will conduct additional research on pasture capacity, as well as provide measures to monitor the condition of pasture lands used by indigenous people for reindeer grazing. These activities are recommended to be coordinated with the IPDP;
- Installation of safe crossing structures for reindeer at strategic points on linear facilities. Particular aspects of such crossing facilities designing are covered further in this section. Locations of the proposed crossing points, as by the time of the ESHIA studies, are shown in Figure 10.2. The location of these crossing points was defined based on information on migration routes identified by the Ethnographic Survey conducted by Purgeocom LLC in 2015 and based on interaction with the Gyda Administration[261]. These crossing points have been tentatively agreed by Arctic LNG 2 Project with four representatives of indigenous people. The representatives of ISPN suggested locations of additional crossing points and articulated their concerns about characteristics of such crossing points. The installation of crossing structures will further improve access to customary fishing areas of ISPN;
- Further consultations with local reindeer herders and their representatives for agreement on the crossing points, discussion of potential impact on pastures and fawning sites, and access to fishing grounds, as well as for clarification of the requirements of indigenous communities in terms of granting access to and the right of passage through the areas they use by conventional rights;
- To minimise off-road motor vehicle traffic, driving will be only allowed by dedicated road routes. Traffic-bearing surface of the roads will be compacted to minimise dust emission. These measures will help mitigate potential adverse impact on the reindeer forage base; *and*
- Technical and biological remediation of the disturbed areas allocated on a short-term lease during the construction phase will allow the return of previously barren land (including pastures) upon construction completion into the economic circulation for use by representatives of indigenous peoples (also refer to Chapter 9).

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[261] Information on interaction with Gyda Administration during coordination of locations of the crossing points was provided by the Company.

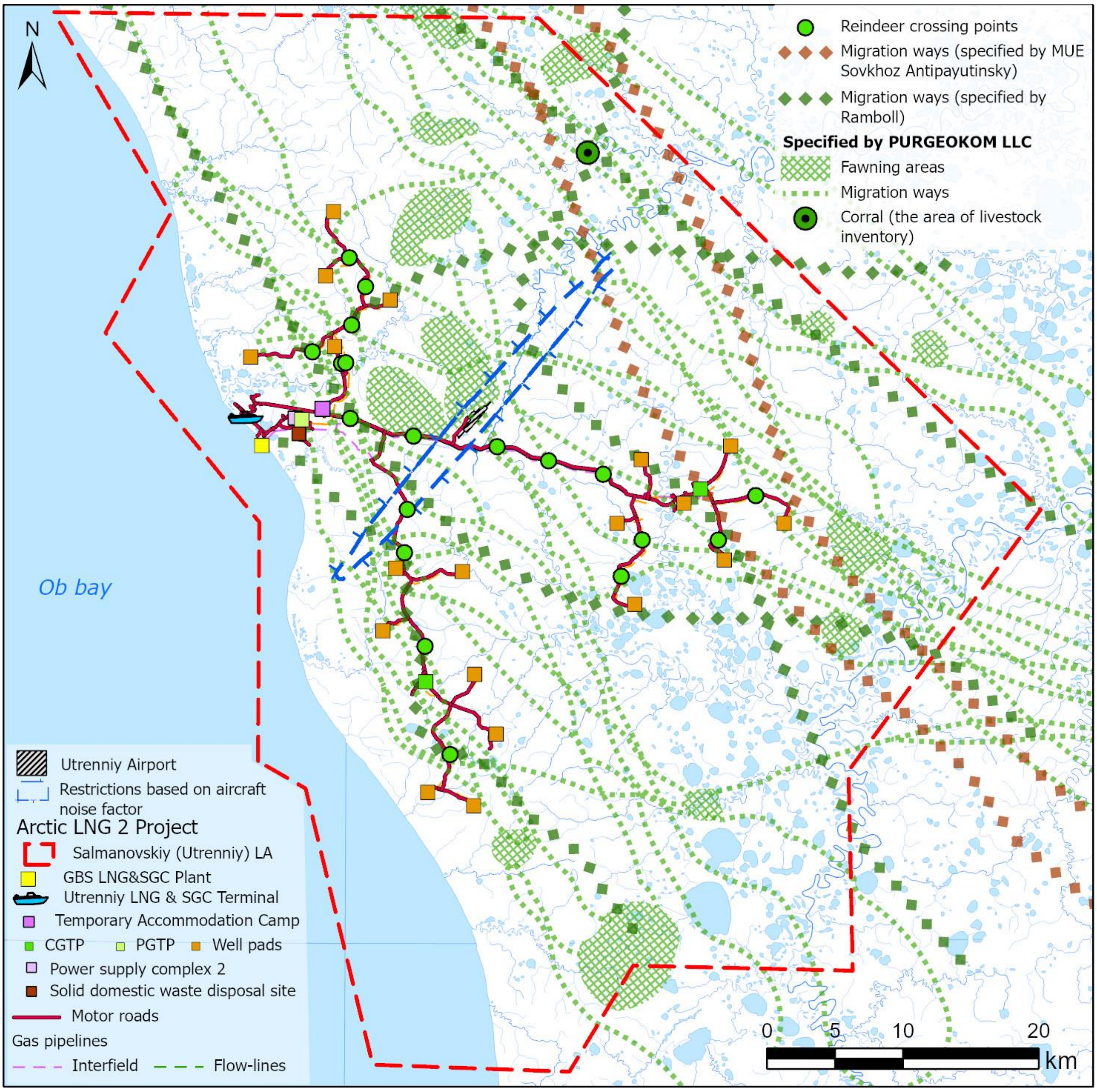

Figure 10.2: Proposed location of crossings over linear infrastructure facilities of the Field.

10.7.1.3 Residual impact

The above mitigation measures will reduce the significance of residual impacts as follows:

- Impact on reindeer herding activities is assessed as **moderate**;
- Impact on customary fishing activities is assessed as **moderate**; *and*
- Impact on hunting and collecting of wild crops as **low**.

10.7.2 Operation phase

10.7.2.1 Impact description

Impacts on land use associated with customary activities (reindeer herding, customary fishing, hunting and wild crop collection) will be similar to those identified above for the construction phase. It is supposed that reindeer grazing will not be practiced within the SPZ of the Complex at the operation phase. Potentially, reindeer grazing activities might be conducted within the SPZ of the other Project facilities, however this is unlikely (as the Nenets usually conduct such activities at a distance from industrial facilities). In case grazing activities within the SPZ boundaries of the Project facilities occur, these will be short-term due to the characteristics of customary activities and the necessity to continue moving along migration routes.

Operation of the industrial facilities of the Project (particularly, the Complex) is also likely to produce noise and light impacts on reindeer herding. Also, impacts of the Project need to be considered in the context of impacts of the airport (see above). The significance of potential impact on the concerned customary activities is assessed as **high**.

10.7.2.2 Mitigation measures

Reindeer herding, fishing, hunting and collecting of wild crops

Measures for mitigating impacts on the customary activities will be similar to those identified above for the construction phase.

10.7.2.3 Residual impact

After mitigations, the significance of residual adverse impacts of operation is as follows:

- Impact on reindeer herding is assessed as **moderate**;
- Impact on fishing is assessed as **moderate**;
- Impact on hunting and wild crop harvesting – as **negligible**.

10.7.3 Crossings over/under linear facilities of the Field

Construction of adequate crossings over/under linear facilities of the Field (motor roads, gas pipelines, power transmission lines) that would ensure safe migration of reindeer and access of ISPN to cultural heritage sites is vital for economic activities of nomadic indigenous communities.

By the time of the ESHIA studies, the Arctic LNG 2 Project identified tentative locations of the crossing points which are subject to further agreement and adjustment in the process of consultations with nomadic indigenous communities within the Salmanovskiy (Utrenniy) LA. As mentioned above, the location of these crossing points was defined based on information on migration routes identified by the Ethnographic Survey conducted by Purgeocom LLC in 2015 and based on interaction with the Gyda Administration. The crossing points were tentatively agreed by the Arctic LNG 2 Project with four representatives of indigenous people at a meeting in April 2018. During the meeting, the representatives of ISPN further suggested locations for additional crossing points.

The following issues should be considered in design development of the crossing points and in the procedure of their use:

- Arrangement of flat slopes on the road sides for unimpeded access of reindeer and herders' sledges, and for convenient driving of the latter across the road surface. The already arranged road crossing points within the territory of the Salmanovskiy (Utrenniy) LA are shown on the figures below;
- Undertaking temporary traffic control measures at the crossing points (signalmen, temporary traffic lights), especially in situations where heavy traffic is expected;
- Purposeful traffic regulation and stopping the traffic flow at a safe distance from the crossings points (to the nearest vehicles at least 5 m) during the entire time of road crossing. It is necessary to prohibit harassing, chasing, rushing or in any other way distracting reindeer herders and reindeer during their crossing the road. Unreasonable photography and filming, sound signals and other loud sounds during road crossing by a reindeer herd should be ruled out to avoid scaring the animals and in deference to reindeer herders and their traditions;
- Covering the road surface with geotextile in the immediate area of crossing to provide sliding effect and prevent damage of herders' sledges;
- The time of road crossing by reindeer herds should be agreed well in advance to assure that a Company representative is present onsite to control and assist in the process of crossing (if needed);
- Installation on the project roads of signs warning of crossing points and indicating the applicable restrictions in accordance with the traffic rules (e.g. speed limits);
- To facilitate crossing over above-ground (or buried) pipeline sections, smooth ramps will be set up. The slopes will be made of suitable material (e.g. excavated soil) to ensure structural stability and proper drainage, as well as the unimpeded passage of reindeer and herders' sledges. The embankment surface will be seeded with suitable varieties of herbs. According to concerns articulated by the ISPN during the meeting in April 2018, surface laying of pipeline sections with embankment with flat slopes (not "П"-shaped crossings) is preferred. According to the information

provided by the Company, the embankment above the top of the pipeline will be at least 0.8 m[262]; *and*

- Crossings over/under linear infrastructure facilities of the Project will be clearly marked. The crossing points will be marked in the layout maps of the license area, so that this information is available to personnel and indigenous communities.

Figure 10.3: Road and crossing point within the Salmanovskiy (Utrenniy) LA – picture 1

Figure 10.4: Road and crossing point within the Salmanovskiy (Utrenniy) LA – picture 2

[262] According to the Letter of Arctic LNG 2 to NIPIGAZ as of 18.04.2018 г. No.0924-01.

Figure 10.5: Road and crossing point within the Salmanovskiy (Utrenniy) LA – picture 3

The Company will conduct further consultations with local indigenous communities with a view to clarify their requirements for construction of crossing points and their locations in order to arrange additional crossing points, etc.

10.7.4 Impacts summary

Table 10.6: Summary of land use impacts and mitigation measures

No.	Impact	Recipient	Stage	Impact significance	Mitigation measures	Residual Impact
10.23	Impact on reindeer herding, including the blockage and/or limitation of herd migration routes, physical loss and/or restriction of access to pastures and fawning sites	Indigenous communities in the area of the Plant and associated facilities	C O	High	• Preparation of the Indigenous People Development Plan; • Installation of safe crossing structures for reindeer at strategic points on the linear facilities; • Further consultations with local reindeer herders and their representatives for agreement on crossing points, discussion of impact on pastures and fawning sites, and for clarification of their requirements in terms of granting access to and right of passage through the areas they use by conventional rights; • To minimise off-road motor vehicle traffic, driving will be only allowed by dedicated road routes; traffic-bearing surface of the roads will be compacted to minimise dust emission. These will help minimise potential adverse impact on the reindeer forage base; • Technical and biological remediation of the disturbed areas allocated on a short-term lease during the construction phase will allow the return of previously barren land (including pastures) upon construction completion into the economic circulation for use by representatives of indigenous peoples (also refer to Chapter 9).	Moderate
10.24	Impact on fishing activities, including physical loss and/or limitation of access to fishing sites of ISPN (without formal designation)	Indigenous Peoples	C O	High	• Preparation of the Indigenous People Development Plan; • Installation of safe crossing structures for reindeer at strategic points on linear facilities to facilitate access to fishing areas; • Further consultations with local reindeer herders/fishermen and their representatives for agreement on crossing points, discussion of issues related to access to fishing grounds and for clarification of their requirements in terms of granting access to and right of passage through the areas they use by conventional rights.	Moderate
10.25	Impact on hunting and gathering, including physical loss and/or limitation of access to the respective areas	Indigenous communities in the area of the Project	C O	High	• Preparation of the Indigenous People Development Plan; • Installation of safe crossing structures for reindeer at strategic points on linear facilities to facilitate access to hunting and gathering areas; • Further consultations with local reindeer herders and their representatives for agreement on crossing	Not significant

No.	Impact	Recipient	Stage	Impact significance	Mitigation measures	Residual Impact
					points and for clarification of their requirements in terms of granting access to and right of passage through the areas they use by conventional rights; • To minimise off-road motor vehicle traffic, driving will be only allowed by dedicated road routes; traffic-bearing surface of the roads will be compacted to minimise dust emission. These measures will help reduce potential adverse impact on hunting and wild crop harvesting activities; • Technical and biological remediation of the disturbed areas allocated on a short-term lease during the construction phase will allow the return of previously barren land (including pastures) upon construction completion into the economic circulation for use by representatives of indigenous peoples (also refer to Section 9).	

10.8 Impact on Cultural Heritage

The Section provides assessment of Project impact on objects of tangible and intangible cultural heritage in the area of the Project. A description of baseline heritage conditions in the social area of influence of the Project is provided in Chapter 8 (Section 8.10). Impacts of construction and operation on cultural heritage will be similar, therefore, they are considered jointly. Separate assessment is provided for tangible and intangible cultural heritage.

10.8.1 Tangible and intangible cultural heritage

10.8.1.1 Impact description

Archaeological sites

Two cultural heritage sites, viz. Khaltsyneysalya-1 and Khaltsyneysalya-2 medieval settlements, have been discovered by archaeological / historical-and-cultural surveys in the area of the Salmanovskoye (Utrenneye) OGCF near the Khaltsyneysalya Cape, on the eastern shore of the Ob Bay. The survey company recommended that construction, design and other activities are carried out with due consideration of the layout of the identified CHSs and that any economic or other operations within the boundaries of the two sites are avoided.

No other CHSs have been identified in the area of the Salmanovskoye (Utrenneye) OGCF. The survey further concluded that there was still a chance to discover historical artefacts or sites in the area of future construction.

One of the identified sites (Khaltsyneysalya-1) is located immediately at the site of the future GBS LNG & SGC Complex, in the area assigned for construction of flaring facilities. The other site is situated at a distance of 700 m from the Port facilities, 700 m from the nearest element of the OGCF facilities setup, and 750 m from the nearest linear facility (communications corridor).

The State Historical and Cultural Expert Review of planned construction of the Complex (Act No. 134-2017 dated 12.12.2017) sets out a system of measures for conservation of the Khaltsyneysalya-1 settlement site. The conservation measures include archaeological rescue field operations (excavations) for the comprehensive examination of the site. After that, it was recommended to remove the identified archaeological heritage site "Khaltsyneysalya-1 settlement site" from the list of identified heritage sites in YNAO.

After the site is removed from the heritage list, construction activities in its area (and destruction of the site) will be possible. As long as Khaltsyneysalya-1 settlement site is listed as an identified CHS in YNAO, any construction activities near or within its fenced area were banned.

The above measures were implemented in 2018. A draft project for archaeological rescue measures in the mode of excavations of the Khaltsineisaly-1 site was developed with the aim to preserve information about the site. After that, the CHS was removed from the Register of identified CHSs.

Therefore, impact of the Project on the identified archaeological sites is low probable (Khaltsyneysalya-2 is situated at a distance 700 m and more from the Project facilities). However, there is a likelihood of discovering new archaeological sites when construction is underway and, therefore, there is a risk of their physical loss or damage. Given the low impact magnitude and high recipient sensitivity the significance of the potential impact of the Project on the archaeological sites is assessed as **moderate**.

Sacred sites and burial grounds

About 20 sacred sites of indigenous people are known within the Salmanovskiy (Utrenniy) LA (Figure 10.6). More sacred sites which have not been identified by the time of the ESHIA studies may be present in the area.

The nearest identified sacred sites are located at the following distances in relation to the Project:

- Varku' ngeva khebidya-ya ('brown bear's head sacred site'), No.8 – 1,300 m;
- Tatngamla ('becalmed' or a 'stop'), No.9 – 900 m;
- Oleg khebidya-ya ('Oleg's sacred site'), No.11 – 130 m;
- Khurekho' seda, No.157 – 550 m; *and*
- Id' Erv' khekhe'' ya, No.199 – 900 m.

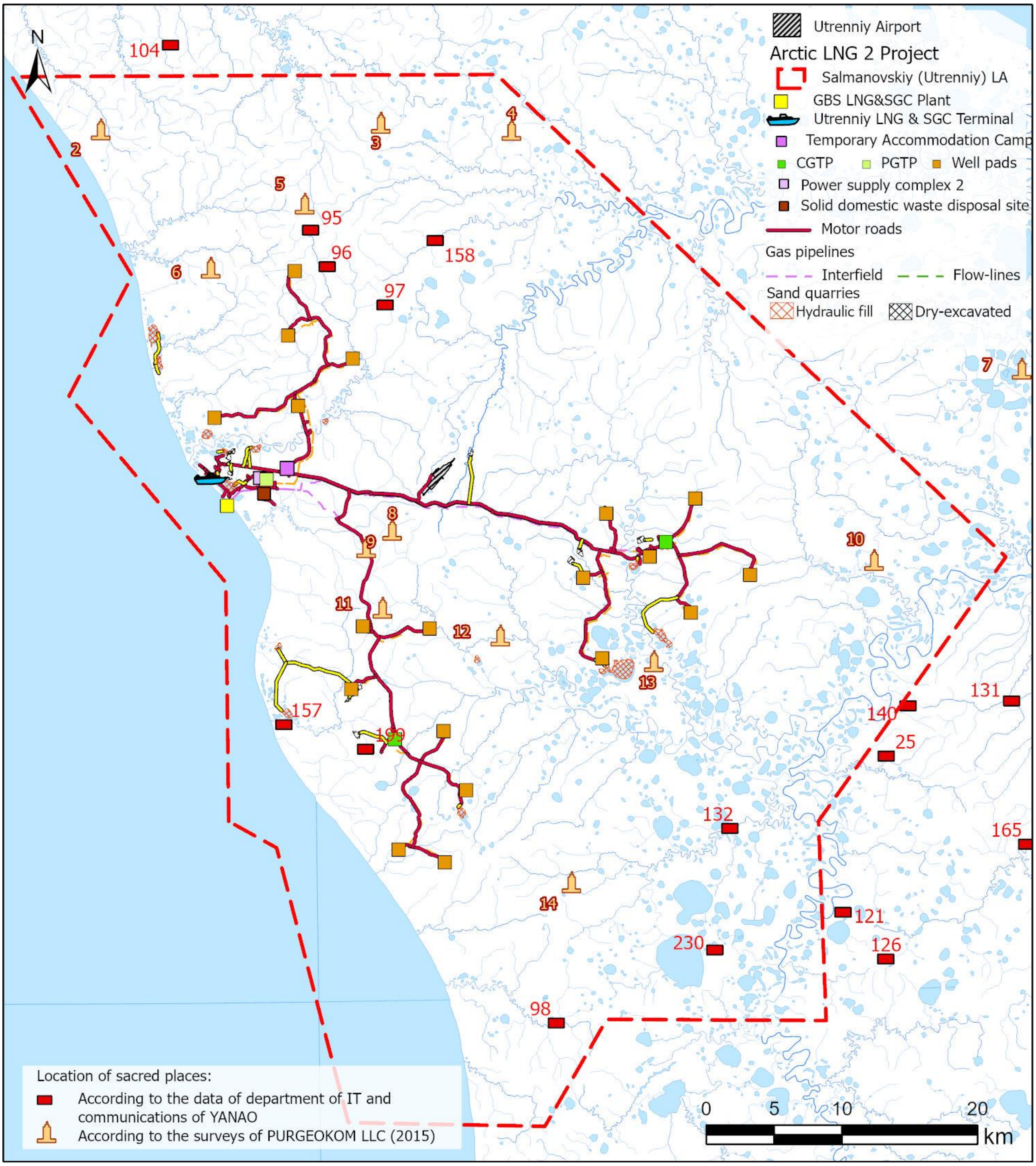

Figure 10.6: Location of sacred sites within the Salmanovskiy (Utrenniy) LA and nearby

As mentioned in Chapter 8, burial sites are very common throughout the area of Salmanovskoye (Utrenneye) OGCF[263], as Nenets often bury their decedents in the immediate vicinity of place of death.

Sacred sites and burial grounds may be damaged or destroyed due to construction activities and the associated presence of the workforce. Potential impacts may further include restriction of access to burial grounds of indigenous people due to construction of linear facilities.

[263] Based on results of the Ethnographic Survey conducted by Purgeocom LLC in 2015 in the area of the Salmanovskoye (Utrenneye) OGCF.

Therefore, the magnitude of potential impact of the Project on sacred sites, burial grounds and access to them is assessed as high. Given the high recipient sensitivity the impact significance before mitigations is assessed as **high**.

10.8.1.2 Mitigation measures

Main measures to minimise the above impacts on tangible heritage sites are:

- Ensuring conservation of the Khaltsyneysalya-2, including:
  - Fencing of the site protection zone;
  - Installation of warning signs and information boards;
  - Prohibiting vehicle traffic, use of soil, and any exploration and earth works within the site protection zone.
- Development and implementation of a Chance Finds Procedure to be followed by personnel of the Company and contractors in case of any chance finds of potential cultural value;
- Strict compliance of personnel of the Company and contractors with the Personnel Code of Conduct (or similar document) which will determine, inter alia, the approach to dealing with cultural heritage items (including sacred sites, etc.);
- Strict compliance with the Accommodation Management Plan (or similar document) by incorporating appropriate clauses into contract agreements;
- Conducting induction training on cultural heritage issues for all construction personnel, including contractors;
- Setting up adequate crossings over/under Field facilities (incl. above-ground gas pipelines, roads, and power transmission lines) to ensure unimpeded access for local indigenous communities to their sacred sites;
- Continuous engagement with representatives of indigenous communities for identification of any violations of the Personnel Code of Conduct of the Company and contractors (in respect of heritage sites, etc.), and on potential need for further crossings over/under linear facilities of the Field;
- Functioning of the Grievance Mechanism.

10.8.1.3 Residual impact

After the above mitigation measures are implemented, the significance of residual impact is assessed as follows:

- Impact on archaeological sites – **negligible**; *and*
- Impact on sacred sites and burial grounds, and access to them – **moderate**.

10.8.2 Intangible cultural heritage

10.8.2.1 Impact description

Potential impact of the Project on intangible cultural heritage of ISPN is possible due to a disturbance of their lifestyle, traditions, and customs. The customary lifestyle may be disturbed by the limitation of customary economic activities of ISPN and by the aspects related to security of sacred sites, burial grounds and their accessibility for indigenous communities. These issues were covered in this section above.

Further impact on intangible heritage may occur due to the presence of the migrant workforce in the area of the Complex and other Project facilities. Nomadic indigenous communities may perceive industrial facilities and labour migrants as a disturbance of their traditional lifestyle, especially in case of inadequate behaviour of workers and their unawareness of local cultural norms and customs.

Limited contacts between indigenous people and migrant workers are expected in relation to implementation of the Project. Workers will be accommodated in a dedicated rotational camp(s) and their contacts with indigenous communities will be limited. The functions of personnel will have no ties to customary activities of ISPN. However, it is likely that the workforce will have contacts with nomadic communities, as indigenous people actively use the area of the planned activities for reindeer herding, fishing, etc.

Considering the limited interaction between personnel and indigenous communities, the magnitude of potential impact of the Project on intangible cultural heritage is assessed as low. Given the high recipient sensitivity the potential impact significance is assessed as **moderate**.

10.8.2.2 Mitigation measures

Main measures to mitigate potential impact of the Project on intangible cultural heritage are:

- Development and implementation of the Personnel Code of Conduct (or similar document) (see Section 10.6 above);
- Development and implementation of the Accommodation Management Plan (or similar document) that, inter alia, will reflect certain aspects of contacting with indigenous communities; and
- Conducting induction training of personnel of the Company and contractors on the issues of interaction with indigenous people and requirements with respect to cultural heritage; and
- Functioning of the Grievance Mechanism to facilitate identification of cases relating to adverse impact on the customary lifestyle, traditions and customs of ISPN.

10.8.2.3 Residual impact

After implementing the above mitigation measures, the significance of residual impact of the Project on intangible cultural heritage is assessed as **low**.

10.8.3 Chance Finds Procedure

The Procedure for dealing with chance finds of cultural value will apply to all excavation sites where earthwork will be carried out. The Procedure is designed to ensure security, integrity and adequate management of any of the heritage items which have not been formally documented as the previously identified, including sacred sites. All contractors and subcontractors will be obliged to follow the Procedure during earthwork (the appropriate provision will be incorporated into contract agreements). The Procedure will include the following provisions:

- Definition of what may be regarded as heritage objects based on the available examples in Tazovskiy Municipal District / YNAO (including photographs);
- Description of the course of actions in case such items are discovered:
    - Suspension of works;
    - Signage and security arrangements;
    - Notification (within the Company and externally – notification of respective competent authorities);
    - Expert examination; and
    - Determination of "red light" (works stop until the find is recovered) or "green light" (works resumed after the survey) for any activities.

The Procedure should clearly indicate telephone numbers and persons to be notified in case of any chance find of potential cultural heritage value.

10.8.4 Impacts summary

Table 10.7: Summary of cultural heritage impacts

No.	Impact	Recipient	Phase	Impact significance	Mitigation measures	Residual impact
10.26	Potential physical loss or damage of the identified archaeological sites	All residents in the area of the Project, academic community, indigenous people	C O	Moderate	• Conservation measures for the Khaltsyneysalya-2 site, including: ○ Fencing of the site protection zone; ○ Installation of warning signs and information boards; ○ Prohibition of vehicle traffic, use of soil, and any exploration and earth works within the site protection zone. • Development and implementation of the Chance Finds Procedure to be followed by personnel of the Company and contractors in case of any chance finds of potential cultural value.	Negligible
10.27	Potential physical damage, loss or restriction of access to sacred sites and burial grounds	Indigenous communities in the area of the Project	C O	High	• Development and implementation of the Chance Finds Procedure to be followed by personnel of the Company and contractors in case of any chance find of potential cultural value • Strict compliance with the Personnel Code of Conduct by personnel of the Company and contractors; • Conducting induction training on cultural heritage issues for all construction personnel, including contractors; • Setting up adequate crossings over/under Field facilities (above-ground gas pipelines, roads, and power transmission lines) to ensure unimpeded access for local indigenous communities to their sacred sites; • Continuous engagement with representatives of indigenous communities; • Functioning of the Grievance Mechanism.	Moderate
10.28	Impact on intangible cultural heritage (disturbance of customary lifestyle, etc.)	Indigenous communities in the social area of influence of the Project	C O	Moderate	• Development and implementation of the Personnel Code of Conduct (or similar document); • Development and implementation of the Accommodation Management Plan (or similar document); • Conducting induction training of personnel on the issues of interaction with indigenous people and requirements in respect of cultural heritage objects; • Functioning of the Grievance Mechanism.	Low