ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

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YAMAL LNG

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GLOSSARY OF ABBREVIATIONS

ADMS	Atmospheric Dispersion Modelling System
AGDS	Automated Gas Distribution System
AGRU	Acid Gas Removal Unit
AIDS	Acquired Immunodeficiency Syndrome
AoI	Area of Influence
APC	Agricultural production co-operative
AQTAG	Air Quality Trends Analysis Group
ART	Standard antiretroviral therapy
ARPC	All-Russia Population Census
BAP	Biodiversity Action Plan
BAT	Best Available Technologies
BCG	Bacillus Calmette–Guérin (vaccine)
BES	Below Established Standard
BHS	Baltic Height System
BMWP	Biological Monitoring Working Party
BOD	Biological Oxygen Demand
BOG	Boil Off Gas
BS	Baltic Sea
C3MR	Propane pre-cooled mixed refrigerant process
CAFF	Conservation of Arctic Flora and Fauna
CAPEX	Capital Expenditure
CAVM	Circumpolar Arctic Vegetation Map
CDOM	Colored Dissolved Organic Material
CGMS	Center for Hydrometeorology and Environmental Monitoring
CGTP	Complex Gas Treatment Plant
CGTU	Comprehensive Gas Treatment Unit
CH_4	Methane
CIA	Cumulative Impact Assessment
CIR	Color infrared
CIS	Commonwealth Independent States
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CLO	Community Liaison Officer

CMP	Construction Management Plan
CNODC	China National Oil and Gas Exploration and Development Corporation
CNPC	China National Petroleum Corporation
CO	Carbon monoxide
CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
COWRIE	Collaborative Offshore Wind Energy Research into the Environment
CR	Critically Endangered
CRI	Colour Infrared
CSR	Corporate Social Responsibility
CWMP	Construction Waste Management Plan
DD	Data Deficient
DIV	Dutch Intervention Values
DLN	Dry Low NOx
DMU	Discrete Management Unit
DPT	Diphtheria, Pertussis and Tetanus
EBRD	European Bank for Reconstruction and Development
ECA	Export Credit Agency
EEC	European Economic Community
EHS	Environmental, Health and Safety
EMS	Environmental Management System
ESMP	Environmental and Social Management Plan
EN	Endangered
ENVID	Environmental Identification
EPC	Engineering Procurement and Construction
ESAP	Environmental and Social Action Plan
ES	Ecosystem Services
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EXW	Extinct in the Wild
FEED	Front End Engineering and Design
FGBNU	Federal State-Funded Scientific Institution
FGUP	Federal State Unitary Enterprise

FPIC	Free, Prior and Informed Consent
FSUE	Federal State Unitary Enterprise
FWCC	Federal Waste Classification Catalogue
GBS	Gravity Base Structure
GCF	Gas Condensate Field
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GIIP	Good International Industry Practice
GIS	Geographic Information System
GLC	Ground Level Concentration
GN	Guidance Note
GOST	State Standard
GPH	Good Practice Handbook
GPN	Good Practice Note
GT	Gas Turbine
GTS	Gas Trunkline System
HAZID	Hazard Identification
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HGV	Heavy Goods Vehicle
HIV	Human Immunodeficiency Virus
HIPPS	Hi-Integrity Pipeline Protection System
HR	Human Resources
HSE	Health, Safety and Environment
HSE-MS	Health, Safety and Environment Management System
HTF	Heat Transfer Fluid
HVAC	Heating, Ventilation and Air Conditioning
IBA	Important Bird Area
ICAO	International Civil Aviation Organisation
ICP	Informed Consent and Participation
IFC	International Finance Corporation
ILNP	Indigenous Low-Numbered North Peoples
ILO	International Labour Organisation

IP	Indigenous People
IPCC	Intergovernmental Panel on Climate Change
IPN	Indigenous People of the North
IUCN	International Union for Conservation of Nature
JBIC	Japan Bank for International Cooperation
JSC	Joint Stock Company
KBA	Key Biodiversity Area
KPI	Key Performance Indicator
LC	Least Concern
LLC	Limited Liability Company
LMDL	Laboratory Method Detection Limit
LNG	Liquefied Natural Gas
LP	Low Pressure
LTO	Landing and Take-off Cycle
MAA	Mining Allotment Area
MAC	Maximum Allowed Concentration
MAPP	Mobile Automated Power Plant
MASL	Metres Above Sea Level
MMU	Mobile Medical Units
MOF	Materials Offloading Facility
MOP	Municipal Reindeer Breeding Enterprise
MP	Management Plans
MPC	Maximum Permissible Concentration
MPR	Ministry of Natural Resources
MPD	Maximum Permissible Discharge
MU	Municipal Institution
MUK	Municipal Institution of Culture
MRU	Methanol Regeneration Unit
NAMMCO	North Atlantic Marine Mammal Commission
NGO	Non-Governmental Organisation
NMFS	US National Marine Fisheries Services
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen

NTS	Non-Technical Summary
NORM	Naturally Occurring Radioactive Material
NT	Near Threatened
NTS	Non-Technical Summary
OBM	Oil Based Mud
OECD	Organisation for Economic Cooperation and Development
OHS	Occupational Health and Safety
OHSAS	Occupational Health & Safety Advisory Services
OJSC	Open Joint Stock Company
OPRC	International Convention on Oil Pollution Preparedness, Response and Co-operation
OSRP	Oil Spill Response Plan
OVOS	“Оценка Воздействия на Окружающую Среду” (an Environmental Impact Assessment in the Russian regulatory practice/statutory permitting)
OWS	Oily Water Separator
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PCL	Permissible Contamination Level
PLA	Project License area
PM	Particulate Matter
PNOOLR	Document specifying permissible norms of waste generation and limits for waste disposal
PPE	Personal Protection Equipment
PPP	Purchasing Power Parity
PS	Performance Standards
PSD	Project Standards document
QRA	Quantitative risk assessment
RCIA	Rapid Cumulative Impact Assessment
RDB	Red Data Book
RF	Russian Federation
RL	Red List
RTA	Road Traffic Accident
SAD	Seasonal Affective Disorder
SEE	State Ecological Expertise

SEP	Stakeholder Engagement Plan
SFL	Seasonally Frozen Layer
SIDWL	Solid Industrial and Domestic Waste Landfill
SIMOPS	Simultaneous Operations
SN	Sanitary Norms
SO_2	Sulphur dioxide
SOH	Northern Reindeer-Breeding Enterprise
SPSK	Agricultural consumer cooperative
SPZ	Sanitary Protection Zone
SRO	Self-regulated Organization
SSP	Species Survival Commission
STGCF	South Tambey Gas Condensate Field
STI	Sexually Transmitted Infection
STL	Seasonally Thawed Layers
TB	Tuberculosis
TEEB	The Economics of Ecosystems and Biodiversity
TPC	Temporary Permissible Concentration
TPH	Total Petroleum Hydrocarbons
TSHD	Trailing Suction Hopper Dredger
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
UGSS	Unified Gas Supply System
UN	United Nations
UNCLOS	United Nations Convention on the Law of Sea
UNEP	United Nations Environmental Program
UPRZA	Unified program for air pollution evaluation
VEC	Valued Environmental Component
VOC	Volatile Organic Compounds
VU	Vulnerable
WB	World Bank
WBM	Water based Mud
WHO	World Health Organisation
WMM	Water-Methanol Mixture

WMP	Waste Management Plan
WPZ	Water Protection Zone
WTF	Wastewater Treatment Facility
WWF	World Wildlife Fund
YNAO	Yamal-Nenets Autonomous Okrug

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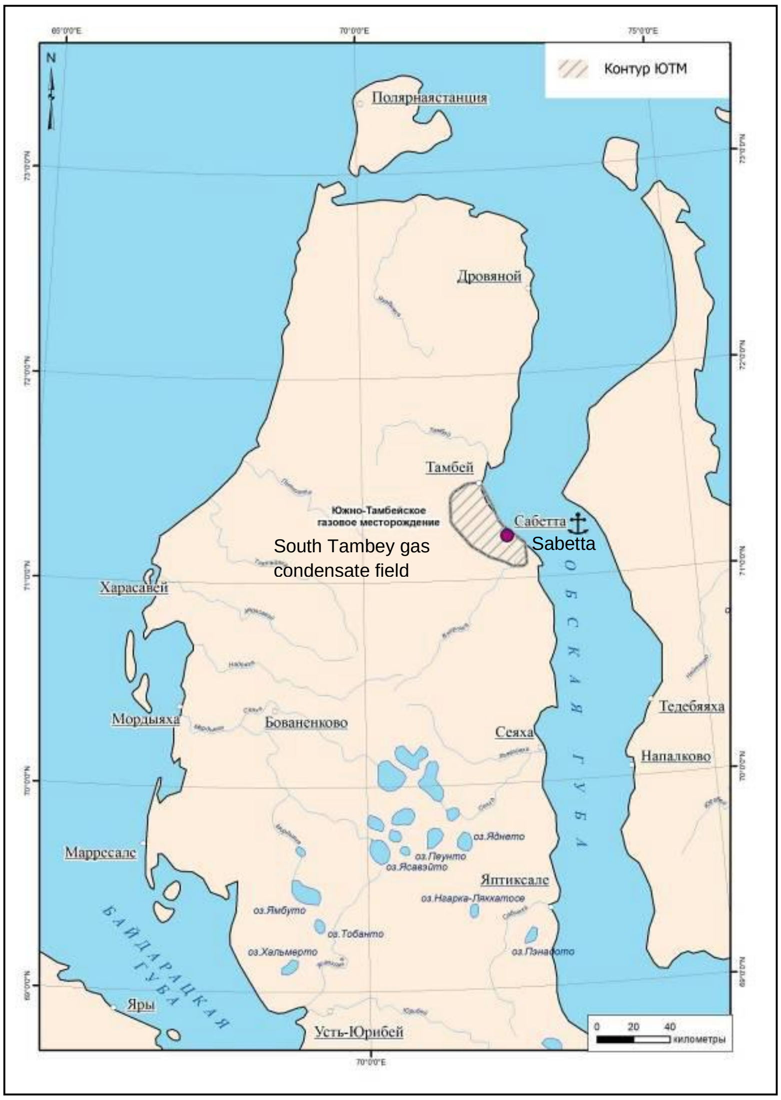
1 INTRODUCTION

1.1 INTRODUCTION TO YAMAL LNG PROJECT

JSC Yamal LNG (the “Company” or “Yamal LNG”) is developing the Yamal LNG Project (the “Project”), which is an integrated upstream natural gas and gas condensate production and liquefaction plant development project located on the Yamal Peninsula in northern Russia. The Project will exploit the South Tambey Gas Condensate Field, which is situated in the north-eastern section of the Yamal Peninsula, some 540 km north-east of the regional centre of Salekhard city (see Figure 1.1).

Figure 1.1 Location of Project



The production facilities and infrastructure required for the Project will comprise:

- Onshore gas production wells and associated pipelines and transport infrastructure to support well development and operation.
- Integrated gas treatment and liquefaction facilities, including an onshore LNG plant consisting of three trains with a production capacity 16.5 million tons per annum and facilities for production of one million tons per annum of gas condensate.
- Marine facilities in the port of Sabetta to ship LNG and condensate and also to provide facilities for materials import and export.
- Workers' accommodation camps and other auxiliary infrastructure facilities for the construction and operation periods.
- An airport.
- Supporting infrastructure in the form of local roads, bridges (for stream and river crossings), aerial electrical transmission lines, workshops, fuel storage and refuelling area, water treatment facilities, waste management facilities and other workers' facilities.

The Company owns the hydrocarbon production rights with respect to the Field[1] and will operate as a project company for the purposes of implementing the Project, i.e. designing, developing, constructing, operating, managing and decommissioning the Project.

The Company comprises the following shareholder parties:

- JSC Novatek – Russia's major independent producer of natural gas that undertakes exploration, production, processing and marketing of gas and liquid hydrocarbons[2].
- Total Exploration & Production – a branch of Total involved prospecting, exploratory drilling, and production of liquid and natural gas[3].
- China National Oil and Gas Exploration and Development Corporation (CNODC) - a wholly owned subsidiary of China National Petroleum Corporation ("CNPC")[4]

The Company is seeking to procure project financing for the Project and funding is expected to be raised from Export Credit Agencies ("ECAs"), commercial banks ("Banks"), capital markets (including bond underwriters and bond investors), and other prospective lending institutions (collectively, the "Lenders" or "Yamal LNG Lenders"). In line with this financing strategy, the Project is being developed in compliance with the following environmental and social requirements (see Chapter 2 for further details):

- Russian law, codes and standards.
- All applicable international laws and conventions to which the Russian Federation is a signatory and which have been ratified into law in the Russian Federation.
- Applicable international Lender requirements, including:
  - The Equator Principles (2013)

[1] The Company holds a 30 year concession.
[2] http://www.novatek.ru
[3] http://www.total.com/
[4] http://cnodc.cnpc.com.cn

- The Organisation for Economic Cooperation and Development (OECD) Common Approaches (2012)
- The World Bank/IFC Environmental, Health and Safety Guidelines (April 2007) including the General EHS guidelines and applicable Industry Sector Guidelines.
- The IFC Performance Standards (January 2012).

The Project performance will therefore be assessed against the standards provided within the above national and international environmental and social requirements.

1.2 OBJECTIVES AND DEVELOPMENT OF THE ESIA

This ESIA has been prepared to identify and assess potential environmental and social impacts of the Project on the biophysical and human environments and to set out measures to avoid, minimise, mitigate and manage adverse impacts to acceptable levels as defined by Russian regulatory requirements and international good practice as defined by the applicable international Lender requirements. To do this, the ESIA has incorporated and documented the following processes:

- description of the Project (including definitions of the Funded Project[5], Associated Facilities[6] and the Project's Area of Influence – see Chapter 4);
- characterisation of a detailed environmental and social baseline;
- identification and assessment of potential environmental and social impacts and issues, both adverse and beneficial, associated with the Project;
- documentation of measures adopted to avoid, or where avoidance is not possible, minimise or mitigate and manage adverse environmental and social impacts;
- identification of feasible opportunities for improved environmental and social performance by the Project;
- development of robust management systems that will manage environmental and social performance in an integrated manner across all Project activities and throughout the life of the Project; and
- demonstration of how environmental and social performance will be improved through a dynamic process of performance monitoring and evaluation.

In support of this process, the ESIA documents previous engagement by the Project with stakeholders that may be affected by the Project, and summarises how they have been informed and consulted on matters that could potentially affect them. The ESIA also provides a framework for how the Project aims to maintain a process of meaningful engagement with stakeholders over the life of the Project.

This ESIA builds upon an extensive body of studies and reports that have been prepared for Project design and to meet Russian Federation regulatory requirements. These include a number of 'OVOS' (environmental assessment) documents, covering different Project facilities, that have

[5] I.e. the scope of the Project for which funding from Lenders is sought.
[6] As defined under the IFC performance Standards – see Chapter 4 for further details

been prepared as a part of the Russian permitting process and submitted to the Ministry of Natural Resources and Ecology for approval.

The OVOS provide information on existing baseline data, impact assessments, mitigation measures, program of environmental monitoring for changes in all component of the ecosystem, cost estimates for implementation of environmental measures and compensation payments.. As such the OVOS materials provide valuable input to the development of the ESIA. OVOS materials have been submitted to and approved by the Russian authorities for “Expertisa” review (this is a formal expert review under the Russian planning approval process) for the following proposed project facilities/activities (see also Chapter 4 for a description of the facilities):

- The complex for the production, processing, liquefaction, and export of liquefied natural gas and gas condensate (i.e. the LNG Plant and associated infrastructure facilities).
- The worker camp facilities necessary for the development of the South Tambey Gas Condensate Field (including worker accommodation).
- The early works seaport facilities near the Sabetta camp, including construction of shipping approach channel in the Obskaya estuary (i.e. for materials offloading during the construction period).
- The main seaport facilities
- The drilling of gas production wells.
- The airport ‘Sabetta’.

Scoping and consultation are integral elements of the ESIA development process. Scoping is the process of determining the content and extent of the matters that should be covered in the ESIA and associated documentation. A scoping assessment has been completed for the Project and has been used as the basis for the development of this ESIA. A full description of the scoping assessment is provided in the Yamal LNG Scoping Report, a copy of which is included as Appendix 1 to this ESIA.

Engagement with stakeholders is of key importance in ensuring both that stakeholders are provided the opportunity to input to the impact identification, mitigation and monitoring process and that the performance of the Project results in the greatest possible benefits to the community. Initiating the engagement process in the early phases of the Project and ESIA process is necessary to ensure timely public access to all relevant information. To facilitate this process the Company has developed a Stakeholder Engagement Plan (SEP), which has been implemented as part of the ESIA process. A further description of the stakeholder engagement processes for the Project is provided in Chapter 5.

This ESIA has been developed as a comprehensive integrated assessment of the Yamal LNG, and reflects compliance with applicable Russian regulatory requirements, international good practice and applicable international Lender requirements.

1.3 STRUCTURE OF THIS ESIA

This document is structured in manner that addressed the objectives of the ESIA described above as follows:

Chapter 1 **Introduction** (present chapter)

Chapter 2 **Legislative and Policy Framework.** This chapter provides an overview of the main regional, national and international policy and legal framework within which the Yamal LNG Project is being developed. The overall policy and legal framework in Russia and in Yamal-Nenets Autonomous Okrug is considered, together with an overview of applicable international Lender requirements.

Chapter 3 **ESIA Process.** This chapter provides an overview of the overall ESIA process and addresses: definitions of key terms; identification of potential environmental and social impacts (through scoping and consultation process); description of the criteria used to determine the significance of impacts for various environmental and social topics; and how mitigation measures are considered within the assessment process.

Chapter 4 **Project Description.** This chapter describes the Project elements, including descriptions of: existing facilities; the permanent and temporary Project facilities; and construction, commissioning and operational processes. This Chapter also defines the scope of the Project in terms of: the Project Area of Influence; Associated Facilities[7]; and out-of-scope activities/facilities (i.e. activities/facilities that are not to be addressed by the ESIA as they fall outside of the Project's Area of Influence and the Company's control).

Chapter 5 **Stakeholder Engagement.** This chapter describes the stakeholder engagement process adopted by the Project. It describes the results of consultation undertaken to date, including cross references to where issues raised in the consultation process have been addressed within the ESIA.

Chapter 6 **Project Alternatives.** This chapter describes the Project development options considered, including the No Project Alternative, and provides a justification for the selection of the preferred Project development option.

Chapter 7 **Environmental Baseline.** The existing environmental baseline is described and characterised in this section.

Chapter 8 **Social Baseline.** The existing social baseline is described and characterised in this section.

Chapter 9 **Environmental Impacts, Mitigation and Monitoring.** This chapter presents the assessment of potential environmental impacts, including identification of mitigation measures and monitoring requirements. Impacts during each phase of the Project development are assessed on a topic-by-topic basis.

Chapter 10 **Social Impacts, Mitigation and Monitoring.** This chapter presents the assessment of potential social impacts, including identification of mitigation measures and monitoring requirements. Impacts during each phase of the Project development are assessed on a topic-by-topic basis.

Chapter 11 **Decommissioning**. Potential impacts specifically associated with decommissioning

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[7] In accordance with IFC Performance Standard, Associated Facilities are those activities and facilities that are not part of the financed project and would not be conducted, built or expanded if the Project was not carried out, and without which the Project would not be viable.

are addressed in this chapter.

Chapter 12 **Transboundary Impacts.** This chapter considers potential long range transboundary impacts.

Chapter 13 **Cumulative Impacts.** This chapter addresses potential cumulative impacts in terms of both aggregated impacts from different elements and phases of the Project and also as a result of other third party anthropogenic activities in the region.

Chapter 14 **Environmental and Social Management.** This chapter describes the approaches to environmental and social management that are adopted in order to ensure that environmental and social performance is managed in an integrated manner across all Project activities and throughout the life of the Project.

2 LEGISLATIVE AND POLICY FRAMEWORK

2.1 INTRODUCTION

This Chapter provides an overview of the regional, national and international policy and legal framework within which the Yamal LNG Project is being developed. The overall policy and legal framework in Russia and in Yamal-Nenets Autonomous Okrug is considered, together with specific sectoral laws on environment, land use and health & safety. Specific standards that are applied to this ESIA are described in more detail in the Project Standards Document which is provided in Appendix 2. Detailed information on applicable environmental and social standards is also provided in Chapter 3 and in the respective baseline chapters.

2.2 RUSSIAN NATIONAL AND REGIONAL LEGISLATION

2.2.1 INTRODUCTION

Conservation, environmental protection, health, labour and recreation are extensively regulated at national and regional levels. At the national level, legislation is issued by the Russian Federation in the form of Federal constitutions, laws, resolutions, directives and codes. These are supplemented further on a regional level. The regional laws and regulations relevant to the Yamal LNG Project are administered by the Yamal-Nenets Autonomous Okrug (YNAO). Yamal LNG has a procedure in place to maintain an up-to-date register of applicable regulations as part of its management systems.

OVOS materials have been submitted to and approved by the Russian authorities under the Russian planning approval process for all relevant project facilities/activities (see Chapter 1 for further details). Implementation of environmental and social management controls confirmed through the OVOS approvals will be implemented by Yamal LNG through its Environmental and Social Management Plans (ESMP - see also Chapter 14).

2.2.2 NATIONAL LEGISLATION

The primary Federal regulatory controls relevant to the Project are itemised below. More comprehensive details are provided in the Project Standards Document (see Appendix 2).

- General environmental protection
  - Constitution of the Russian Federation
  - Federal Law on Environmental Protection # 7-FZ
  - Federal Law of 27.12.2002 . #184-FZ «On Technical Regulations»
  - Federal Law of 21.02.1992. # 2395-1 «On Subsoil Resources»
  - Federal Law of 04.05.2011. # 99-FZ «On Certain Activities' Licensing»
  - Federal Law of 23.11.1995. #174-FZ «On Environmental Review»
  - RF Government Resolution of 16.02.2008 # 87 "On the structure of sections of design documentation and requirements to their contents"

- RF Government Resolution of 05.03.2007. #145 «On organizing and conducting the state expert review of design documentation and engineering surveys' findings»
- Order by GosComEcologia of 16.05.2000 . # 372 « On the Regulation on environmental impact assessment of planned economic and other activity in the Russian Federation.»

- Land use planning
  - RF Urban Development Code # 190-FZ
  - The Russian Federation Land Code #136-FZ
  - Federal Law of 21.12.2004. # 172-FZ «On lands' or land plots' reclassification»
  - RF Government Resolution of 07.05.2003 . # 262 «On adoption of Rules for compensation to owners of land plots, land users and tenants of land plots for damage caused by withdrawal or temporary occupation of land plots, limitation of land owners' rights or by worsening land quality as a result of other persons' activities»
  - RF Government Resolution of 23.02.1994 . # 140 "On land reclamation, removal, storage and sustainable use of the fertile top soil".
  - Order by MinPrirody RF and RosComZem 22.12.1995 . # 525/67 «On adoption of the Basic Provisions on land reclamation, soil removal, conservation and efficient use of fertile soil layer».
  - Federal Law on Protected Natural Areas # 33-FZ
- Waste management
  - The Federal Law on Waste of Production and Consumption # 89-FZ
  - Order by MinPrirody RF of 25.02.2010. # 50 «On Procedure for development and adoption of standards for waste generation and limits of their disposal».
  - Federal Classificatory Catalogue of Wastes; Adopted by Order by the RF Ministry of Natural Resources of 02.12.2002. # 786.
- Water resources and aquatic habitats
  - The Russian Federation Water Code (Federal Law of 03.06.2006. #74-FZ)
  - Federal Law of 17.12.1998 . # 155-FZ «On internal marine waters, the territorial sea and the adjacent zone of the Russian Federation»
  - Federal Law of 30.11.1995 . # 187-FZ «On the continental shelf of the Russian Federation»
  - Federal Law of 07.12.2011 . # 416-FZ «On Water Supply and Wastewater Discharge»
  - RF Government Resolution of 30.12.2006 . # 844 «On Procedure for drafting and making a decision on a water body's allocation for use».
  - RF Government Resolution of 12.03.2008 # 165. «On Water Use Agreement Preparation and Conclusion».
  - RF Government Resolution of 23.07.2007 # 469 «On procedure for adoption of permissible standards of substances' and microorganisms' discharge into water bodies for users of the water bodies»

  - Order by the RF Ministry of Natural Resources and Ecology of 17.12.2007 #333 «On adoption of Methods for developing permissible standards of substances' and microorganisms' discharge into water bodies for users of the water bodies».
  - Federal Law of 20.12.2004 #166-FZ «On fishery and water biological resource conservation»
  - RF Government Resolution of 30.04.2013 # 384 «On adoption of Rules for the Federal Fishery Agency's (its branches') Approval of construction and upgrade of capital facilities, introduction of new technological processes and implementation of other activities that impact on water biological resources and their habitats"
- Air quality
  - Federal Law on Air Protection # 96-FZ
  - RF Government Resolution of 02.03.2000 . # 183 «On Maximum Permissible Emissions into the Atmospheric Air and Adverse Physical Impacts».
  - Order by the RF Ministry of Natural Resources and Ecology of 25.07.2011. # 650 «On Adoption of the Administrative Regulation by the Federal Service for Nature Management Supervision for provision of the state service to issue permits for harmful (polluting substances' emissions into the atmospheric air (with exception of radioactive substances)».
  - Order by the RF Ministry of Natural Resources and Ecology of 31.12.2010. # 579 «On determining harmful (polluting) substances' emissions into the atmospheric air that are subject to state accounting and standardization and on the list of harmful (polluting) substances' emissions into the atmospheric air that are subject to state accounting and standardization».
  - Sanitary & Epidemiological Rules and Norms SanPiN 2.2.1/2.1.1.1200-03 «Sanitary Protection Zones and Sanitary Classification of Enterprises, Structures, and Other Facilities».
- Wildlife & habitats
  - Federal Law on Animals # 52-FZ
  - RF Forest Code (Federal Law of 04.12.2006. #200-FZ)
  - RF Government Directive of 13.08.1996 # 997 ("On endorsing Regulations on the prevention of killing animals due to industrial processes, and due to transport link, pipeline, communications line and power transfer line operations")
  - RF Government Resolution of 19.02.1996. # 158 «On Red Data Book of the Russian Federation»
- Social / community
  - RF Labor Code (Federal Law of 30.12.2001 . # 197-FZ)
  - Federal Law on Guaranteed Rights of Low Numbered Indigenous Peoples of the Russian Federation # 82-FZ
  - Federal Law on Areas of Traditional Nature Uses by Indigenous Low-Numbered Peoples of the North, Siberia, and Far East of the Russian Federation # 49-FZ
  - Federal Law of 25.06.2002 . # 73-FZ «On Cultural Heritage (cultural sites) of the Peoples of the Russian Federation»
  - Decree of the Government of the Russian Federation 08.05.2009. # 631-r «On approval of List of traditional living areas and traditional commercial activities of

low-numbered peoples of the Russian Federation and list of their traditional commercial activities »

- Emergency / oil spill response
    - Federal Law on the Protection of the Public and Areas against Emergencies of Natural and Technogeneous Nature # 68-FZ
    - Resolution of the Government of the Russian Federation dated 15.04.2002 #240 (Crude Oil and Petroleum Product Spill Prevention and Response Regulations)
    - Resolution of the Government of the Russian Federation dated 21.08.2000 # 613 “On imperative measures on prevention and elimination of accidental spills of oil and oil products”
    - Resolution of the Government of the Russian Federation dated 14.02.2000 # 128 “On approval of of Regulation on provision of information on the state of environment, its pollution and emergency situation of technogeneous origin that resulted, result and can result in negative impact to the environment”
    - Resolution of the Government of the Russian Federation dated 24.03.1997 # 334 “On collection and exchange of information about protection of the public and areas against emergencies of natural and technogeneous nature in the Russian Federation”
    - Resolution of the Government of the Russian Federation dated 30.12.2003 # 794 “On unified state system of prevention and elimination of emergency situations”
    - Resolution of the Government of the Russian Federation dated 01.03.1993 # 178 “On creation of local notification systems in areas of location of potentially hazardous facilities”
    - Resolution of the Government of the Russian Federation dated 10.11.1996 # 1340 “On order of creation and use of material reserves for elimination of emergencies of natural and technogeneous nature”
    - Resolution of the Government of the Russian Federation dated 21.05.2007 # 304 (edition of 17.05.2011 “On classification of emergency situations of natural and technogeneous origin”
    - Order of Ministry of Natural Resources of the Russian Federation dated 03.03.2003 # 156 “On approval of instructive regulation on determination of lowest level of oil and petrochemical products spills for attribution of accidental spill to emergency situation”
- Industrial safety
    - Federal Law on Industrial Safety of Hazardous Production Sites # 116-FZ
    - Federal Law Building and Structure Safety Technical Standards # 384-FZ
    - Federal Law of 21.12.1994 . # 69-FZ «On Fire Safety»
    - Federal Law of 27.07.2010 . # 225-FZ «On mandatory insurance of civil liability of a hazardous facility’s owner for bringing harm as a result of an emergency at hazardous production facility»
    - Order by Rostechnadzor 29.11.2005 . # 893 (RD -03-14-2005) «On adoption of procedure for execution of industrial safety declaration of hazardous production facilities and list of data to be included in the above»

  - Decree by Gosgortehnadzor of Russia of 05.06.2003. # 56 “On adoption of Safety Rules in the oil and gas industry” (PB 08-624-03).
  - Decree by Gosgortehnadzor of Russia of 05.06.2003 . # 54 «On adoption of Safety Rules for gas processing plants and facilities» (PB 08-622-03).
- Health and safety
  - Federal Law on Public Sanitation and Epidemiology Welfare # 52-FZ
  - Federal Law on Backgrounds of Health Protection of the Citizens of the Russian Federation #323-FZ (in edition of 25.06.12)
  - Federal Law on State Guarantees and Compensations for People Working in Far North and Equivalent Areas # 4520-1
  - Federal Law of 09.01.1996 # 3-FZ «On Radiation Safety»
  - Order by Minzdravsocrazvitiya of 16.02.2009 # 45n «On adoption of norms and conditions for provision of employees working under harmful conditions with milk and other food products of equal value at no cost; Manner of compensation payment equivalent of milk cost and cost of food products of equal value; List of harmful occupational factors, under which exposure it is recommended for prophylactic purposes to consume milk and other food products of equal value»
  - Order by Minzdravsocrazvitiya of 12.04.2011 # 302n «On adoption of a List of harmful and/ or hazardous occupational factors, which occurrence require prophylactic regular medical examinations and Procedure of such examinations' conducting».

2.2.3 REGIONAL YANAO LEGISLATION

The regional laws and regulations relevant to the Yamal LNG Project, administered by the YNAO, are listed below. Further details are contained in the Project Standard Document (see Appendix 2).

- General environmental protection
  - YANAO Law No. 53-ZAO of 27.06.2008 (red. Of 25.11.2011) ‘Concerning Environmental Protection in Yamal-Nenets Autonomous Okrug’
  - YANAO Government Directive N 22-P of 18.01.2012 (red. of 31.05.2012) 'On the Endorsement of Long-Term Special Program: Environmental Protection and Environmental Safety in Yamal-Nenets Autonomous Okrug for 2012 - 2016'
- Land use and economic planning
  - YANAO Law N 36-ZAO of 18.04.2007 (red. of 23.12.2011) "Yamal-Nenets Autonomous Okrug Urban Planning Statute"
  - YANAO Legislative Assembly Resolution N 839 of 14.12.2011 'On Yamal-Nenets Autonomous Okrug Socio-Economic Development Strategy till 2020'
  - YANAO Government Resolution of 14.02.2013 # 56-P "On territorial environmental surveillance system within license areas of subsoil use for oil and gas production in the territory of Yamalo-Nenetsky Autonomous Okrug"

Waste management

  - YANAO Government Resolution of 27.10.2011 # 802-P " On adoption of the regional long-term target program "Development of system for solid domestic

and production waste management in Yamalo-Nenetsky Autonomous Okrug for the years of 2012 - 2014"
- YANAO Administration Decree of 14.09.1994 # 645-r "On used petroleum products".

- Surface water bodies
  - YANAO Government Resolution of 25.10.2012 # 886-P "On execution of regional governmental supervision in relation to use and protection of water bodies"
  - YANAO Administration Decree of 09.10.2008 # 536-A "On Adoption of Procedure for water bodies' use in traditional living areas and traditional commercial activities of low-numbered peoples of the North for provision of primordial living environment safety and traditional way of life of these peoples in the territory of Yamalo-Nenetsky Autonomous Okrug"
- Wildlife & habitats
  - YNAO Government Directive N 792-P of 27.10.2011 'Concerning the Endorsement of the Requirements for the Prevention of Animal Losses as a Result of Industrial Processes, as well as Operations of Transport Links, Pipelines, Communications Lines, and Those of Power Transfer within Yamal-Nenets Autonomous Okrug"
  - YANAO Governor's Decree of 12.01.2004 # 3 "On keeping the Red data book of Yamalo-Nenetsky Autonomous Okrug"
  - YANAO Governor's Decree of 18.12.2012 # 175-PG "On adoption of Forest Plan of Yamalo-Nenetsky Autonomous Okrug "
  - YANAO Governor's Decree of 20.04.2011 # 52-PG "On adoption of summary plan for forest fires' suppression in the territory of Yamalo-Nenetsky Autonomous Okrug"
- Social / community and cultural environmental
  - YNAO Law N 114-ZAO of 28.12.2005 (red. Of 30.09.2011) 'Concerning State support to indigenous low-numbered peoples of the North and organizations engaged in traditional businesses within Yamal-Nenets Autonomous Okrug'
  - YANAO Law N 49-ZAO of 06.10.2006 (red. Of 08.10.2010) 'On the Protection of Traditional Habitats and Lifestyles of Indigenous Low-Numbered North Peoples (ILNP) in Yamal-Nenets Autonomous Okrug'
  - YANAO Law N. 48-ZAO of 06.10.2006 'On Cultural Heritage Sites in Yamal-Nenets Autonomous Okrug' (red. of 28.02.2011)
  - YANAO Law No. 65-ZAO of 09.11.2004 (red. of 02.11.2005) 'Concerning Fishing in Yamal-Nenets Autonomous Okrug'.
  - YANAO Law No. 52-ZAO of 05.05.2010 (red. of 30.09.2011) 'Concerning Regional Importance Traditional Nature Uses Areas in Yamal-Nenets Autonomous Okrug'
  - YANAO Government Directive N 1007-P of 23.12.2011 'On the Endorsement of Long-Term Special Program: Conservation of Traditional Lifestyles, Culture and Language of Indigenous Low-Numbered Peoples in Yamal-Nenets Autonomous Okrug for 2012 to 2015'

- YANAO Law of 24.12.2012 # 148-ZAO "About Program for socioeconomic development of Yamalo-Nenetsky Autonomous Okrug for the years of 2012 - 2016»
- YANAO Government Resolution of 12.12.2011 # 901-P "On adoption of the regional long-term target program "Preservation of cultural sites of Yamalo-Nenetsky Autonomous Okrug for the years of 2012 - 2014 "
- Resolution by YANAO Legislative Assembly of 09.12.2009 # 1996 "On concept of sustainable development of low-numbered peoples of the North of Yamalo-Nenetsky Autonomous Okrug"

- Health and safety / Healthcare
  - YANAO Law No. 12-ZAO of 10.01.2007 (red. of 04.04.2012) 'Concerning Health Care in Yamal-Nenets Autonomous Okrug'.
  - YANAO Government Directive N 422-P of 27.06.2011 (red. of 26.04.2012) 'On the Endorsement of the Yamal-Nenets Autonomous Okrug Demography Improvement Integrated Program for 2011 to 2013'
- Mineral extraction
  - YANAO Government Directive N 242-P of 30.09.2010 (red. of 26.04.2012) 'On the Endorsement of Mineral Resources Use Procedure for the Exploration and Extraction of Common Fossil Fuels within Yamal-Nenets Autonomous Okrug

2.3 INTERNATIONAL TREATIES AND CONVENTIONS

The Russian Federation has ratified a number of international conventions concerned with environmental and social protection, whose requirements need to be taken into account during the development of the Project. In addition, the Yamal LNG Project is committed to compliance with applicable international lender standards (see Section 2.4 below) which also require that projects seeking funding must, inter alia, meet applicable international social and environmental conventions, standards and regulations.

A description of the relevant international treaties and conventions is provided in the Project Standards Document (see Appendix 2) and a summary is provided below.

Impact Assessment

- Convention on Environmental Impact Assessment in a Transboundary Context, 1991 (amended in 2004) (Espoo Convention)[1] .

Airport

- Convention on the Protection of Migratory Species, 1979 (Bonn Convention)

[1] It is noted that at the time of writing the Espoo Convention has not been ratified by the Russian Federation, but is included here as the RF has announced its intention to do so. It is also noted that the Convention will only be relevant if the Project Area Influence as identified in the ESIA extends beyond international boundaries.

- International Civil Aviation Organisation, Airport Planning Manual, Part 2: Land use and Environmental Control, 2002.

Biodiversity

- Convention on Biological Diversity, 1992
- Convention on the Protection of Migratory Species, 1979 (Bonn Convention)
- Convention on Wetlands of International Importance Especially on Wildfowl Habitat, 1971 (the Ramsar Convention)
- Convention on International Trade in Endangered Species of Wild Flora and Fauna, 1973 (CITES).

Air quality and climate change

- United Nations Framework Convention on Climate Change, 1992
- Kyoto Protocol, 1997
- Vienna Convention for the Protection of the Ozone Layer, 1988
- Montreal Protocol on Substances that Deplete the Ozone Layer, 1989.
- Sofia Protocol on the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes, 1988.

Waste

- Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989 (Basel Convention)
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (The London Convention) and the 1996 London Protocol
- 40 C.F.R (Protection of Environment) Part 146 – Underground Injection Control Program: Criteria and Standards. Sub part C - Criteria and Standards Applicable to Class II Wells.

Stakeholder Engagement

- Convention on Access to Information, Public Participation in decision making and Access to Justice in Environmental Matters, 1998 (Aarhus Convention)[2] .

Cultural Heritage

- Convention Concerning the Protection of the World Cultural and Natural Heritage, 1972
- Convention for the Safeguarding of the Intangible Cultural Heritage, 2003.

Community and workforce

- ILO conventions including the core conventions protecting workers’ rights and the UN conventions protecting the rights of the child and of migrant workers:

[2] It is noted that at the time of writing the Aarhus Convention has not been ratified by the Russian Federation, but is included here as the RF has announced its intention to do so.

- ILO Convention 87 on Freedom of Association and Protection of the Right to Organize
- ILO Convention 98 on the Right to Organize and Collective Bargaining
- ILO Convention 29 on Forced Labour
- ILO Convention 105 on the Abolition of Forced Labour
- ILO Convention 138 on Minimum Age (of Employment)
- ILO Convention 182 on the Worst Forms of Child Labour
- ILO Convention 100 on Equal Remuneration
- ILO Convention 111 on Discrimination (Employment and Occupation)
- ILO Convention 169 on Indigenous and Tribal Peoples
- UN Convention on the Rights of the Child, and specifically Article 32.1([3])
- UN Convention on the Protection of the Rights of all Migrant Workers and Members of their Families.

Human Rights

- The International Bill of Human Rights, 1948

Shipping (in the context of vessels used during the construction phase and as Associated Facilities/activities in the operations phase of the Project):

- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (The London Convention)
- International Convention for the Prevention of Pollution from Ships, 1973 as amended by the Protocol of 1978 relating thereto (MARPOL 73/78)
- International Convention on Civil Liability for Oil Pollution Damage, 1969, and the Protocol of 1992 to amend the International Convention on Civil Liability for Oil Pollution Damage, 1969
- International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971, and the Protocol of 1992
- International Convention Relating to Intervention of the High Seas in Cases of Oil Pollution Casualties, 1969
- International Convention for the Control and Management of Ship's Ballast Water and Sediments (ratified by Russia - not yet in force)
- International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001
- United Nations Convention on the Law of Sea, 1994 (UNCLOS)
- Convention on the International Regulations for Preventing Collisions at Sea, 1972
- International Convention on Oil Pollution Preparedness, Response and Co-operation 1990 (OPRC 90)

[3] Article 32.1 of the Convention requires that States' Parties recognise the right of the child to be protected from economic exploitation and from performing any work that is likely to be hazardous or to interfere with the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral or social development.

- SOLAS Convention for the Safety of Life at Sea, 1974.

2.4 LENDER SPECIFIC POLICIES AND STANDARDS

2.4.1 INTRODUCTION

The Yamal LNG Project is being developed in line with the following international lender standards:

- The IFC Performance Standards (2012)
- The World Bank (WB)/IFC EHS Guidelines (2007)
- Japan Bank for International Cooperation (JBIC) - Guidelines for Confirmation of Environmental and Social Considerations (2012).

Each of these is described in further detail below.

2.4.2 IFC PERFORMANCE STANDARDS

The Yamal LNG Project is being developed in compliance with the IFC Performance Standards (as revised in January 2012), which define requirements for managing environmental and social risks. The IFC Performances Standards comprise:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
- Performance Standard 2: Labor and Working Conditions
- Performance Standard 3: Resource Efficiency and Pollution Prevention
- Performance Standard 4: Community Health, Safety, and Security
- Performance Standard 5: Land Acquisition and Involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7: Indigenous Peoples
- Performance Standard 8: Cultural Heritage.

The eight Performance Standards are supported by IFC EHS Guidelines, which are further described below.

2.4.3 WORLD BANK IFC ENVIRONMENTAL, HEALTH & SAFETY GUIDELINES

The WB/IFC EHS Guidelines (2007) are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP), as defined in IFC Performance Standard 3 on Resource Efficiency and Pollution Prevention. The EHS Guidelines contain the performance levels and measures that are normally acceptable to the IFC and are generally considered to be achievable in new facilities at reasonable costs using existing technology.

The IFC EHS Guidelines comprise both general and industry-specific guidelines. The IFC General EHS Guidelines contain information on cross-cutting environmental, health, and safety issues potentially applicable to all industry sectors. It is designed and should be used together with the relevant industry sector specific guidelines. For the Yamal LNG Project the following sector specific guidelines are relevant:

- Onshore Oil and Gas Development (applicable to the onshore wells, pipelines and onshore condensate handling facilities)
- Liquefied Natural Gas (LNG) Development (applicable to the LNG facilities)
- Thermal Power plant (applicable to the main power units)
- Crude Oil and Petroleum Product Terminals (applicable to the condensate export facilities)
- Ports, Harbors and Terminals (to the extent applicable to the LNG and condensate export and materials import port facilities)
- Airports (to the extent applicable to the airstrip facilities)
- Shipping (applicable to the control of Project-related shipping)
- Waste Management Facilities (to the extent applicable to waste management facilities developed by the Yamal LNG Project)
- Water and Sanitation (to the extent applicable to the potable water facilities developed at the Yamal LNG facilities).

2.4.4 JBIC GUIDELINES FOR CONFIRMATION OF ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

The objective of the JBIC Guidelines is to ensure consideration of the environmental and social aspects in all projects subject to lending or other financial operations by JBIC. Within these guidelines environmental and social considerations refer not only to the natural environment, but also to social issues such as involuntary resettlement and respect for the human rights of indigenous peoples.

The JBIC Guidelines have been formulated on the basis of "*discussions about the international framework on environmental and social considerations and human rights, and discussions held at the Organisation for Economic Co-Operation and Development (OECD) regarding common approaches to the environment and public export credits, which requires consistency between public export credit policies and environmental conservation policies, and other issues*".

2.5 PROJECT STANDARDS

Where national regulations and/or international conventions differ from the levels and measures presented in the applicable Lender standards (including GIIP) described in Section 2.4, the Yamal LNG Project in every such case applies the most stringent standard unless the most stringent standard breaches Russian Federation law or else there is a strong justification to deviate from the most stringent standard. In the event of any ambiguity or conflict between any of the Lender standards and the Environmental and Social Law, the standards applicable in order to comply with Environmental and Social Law shall apply, as will be set forth in the Environmental and Social Management Plan. Specific Project standards applied are given in the Project Standards Document.

Compliance assurance with the adopted Project Standards will be managed through Yamal LNG's management system (see Chapter 14 for further details).

3 ESIA PROCESS

3.1 INTRODUCTION

This section provides an overview of the overall ESIA process and addresses:

- Definitions of key terms (Section 3.2).
- Identification of potential environmental and social impacts through scoping and consultation process (Section 3.3).
- Description of the criteria used to determine the significance of impacts for various environmental and social topics (Sections 3.4 and 3.5).
- The approach to cumulative impacts (Section 3.6, with a detailed description provided in Chapter 13).
- Consideration of mitigation measures in the assessment process (Section 3.7).

3.2 DEFINITION OF TERMS

Definitions of key terms used in this section are provided below.

- A Project ***phase*** is a series of related activities, which together form a distinct stage in the life of the Project. Four phases are considered in the ESIA as follows (although for simplicity these may be combined in some sections of the ESIA where appropriate):
  - Construction
  - Commissioning
  - Operation
  - Decommissioning
- Environmental and social ***receptors*** are those elements of the environment and/or human society that may be affected by the Project.
- Environmental and social ***impacts*** are changes on environmental and/or social receptors that occur as a consequence of the Project. Impacts to individual receptors may be either ***adverse*** (having a detrimental/negative effect on a receptor) or ***beneficial*** (having an advantageous/positive effect on a receptor). Different types of environmental and social impacts are defined in terms:
  - ***Duration.*** The precise definition of the 'duration' of impacts is dependent on the nature of the impact and the receptor of the impact, and includes both the period over which the source of impact occurs and also, for reversible impacts, the period over which recovery may occur (see also 'reversibility' below). Generic terms are used in Section 3.4 based on the qualitative descriptions below. More specific definitions are provided where appropriate on a topic-specific in the tables presented in Section 3.5.
    - ***Short-term*** impacts are predicted to last only for a limited period (e.g. during the period of a certain limited duration construction activity) but will cease either on completion of the activity, or rapidly as a result of mitigation/reinstatement measures and/or natural recovery.
    - ***Medium-term*** impacts are predicted to last for a moderate period. Examples include impacts during the period of extended construction activities or else impacts

during limited duration activities but which extend for a moderate period after the completion of that activity.
  - ***Long-term*** impacts are predicted to continue over an extended period, (e.g. noise from operation of a development, impacts from operational discharges or emissions). These include impacts that may be intermittent or repeated rather than continuous if they occur over an extended time period (e.g. repeated seasonal disturbance of species as a result of well operations, impacts resulting from annual maintenance activities).
- ***Extent.*** The precise definition of the 'extent' of impacts is dependent on the nature of the impact and the receptor of the impact. Generic terms are used in Section 3.4 based on the qualitative descriptions below. More specific definitions are provided where appropriate on a topic-specific in the tables presented in Section 3.5.
  - ***Local:*** impacts that affect environmental or social receptors in areas localised to the source of impact and typically within the Project Licence Area.
  - ***Regional:*** impacts that affect regionally environmental or social receptors or are felt at a regional scale as determined by administrative boundaries (within Yamal-Nenets Autonomous Okrug).
  - ***National:*** impacts that affect nationally important environmental and or social resources or are felt at a national scale.
  - ***International:*** impacts that affect internationally important environmental and social receptors/ resources, such as areas protected by International Conventions or else are felt at an international scale.
- ***Irreversible*** impacts are defined as those impacts that cause a permanent change in the affected receptor.
- ***Reversible*** impacts are those impacts that can be reversed back to pre-existing conditions as a result of mitigation/reinstatement measures and/or natural recovery. The periods over which impacts may reverse/recover is a key link to the duration over which an impact is felt (see 'duration' above).
- Where an environmental/social ***impact*** is not certain to occur (e.g. due to the inherent stochastic nature of the potential impacts from routine/planned activities, or else where impacts are associated with unplanned/emergency events), the significance of the impact ***risk*** is a function of the ***likelihood*** that it occurs and the ***severity*** of the impact should it occur.
- ***Residual impacts.*** Impacts are assessed both on the basis of mitigation and best practice that have been incorporated into the Project design prior to the ESIA development and also after the consideration of any additional mitigation or enhancement measures (the ***Residual Impacts***).
- ***Cumulative impacts.*** Those impacts that result from the incremental impact of the Project when added to other existing, planned, and/or reasonably predictable future projects and developments that are not be directly associated with the Project.
- ***Area of Influence.*** The Area of Influence (AoI) includes areas both directly and indirectly affected by the Project within and beyond the Project licence area. Further definition of the AoI is provided in Chapters 4, 7, 8 and 13.

3.3 SCOPING AND CONSULTATION

Scoping is the process of determining the content and extent of the matters that should be covered in the ESIA and associated documentation. The scoping process aims to identify the types of environmental and social impacts to be investigated and reported in the ESIA, and to identify those aspects that are of potentially greatest significance. The primary methods for identification of potential environmental and social impacts are through:

- Review of existing project assessments and information.
- Stakeholders Engagement. Engagement with stakeholders is of key importance in ensuring that stakeholders are provided the opportunity to input to the impact identification, mitigation and monitoring process and that the Project results in the greatest possible benefits to the community. Initiating the engagement process in early in the Project phases is necessary to ensure timely public access to all relevant information. A further description of the stakeholder engagement processes for the Project is provided in Chapter 5.
- 'Source-Pathway-Receptor' Analysis. Identification of potentially significant environmental and social impacts is also undertaken through a structured consideration of the potential sources of impact, the pathways through impacts may affect the environment and humans (e.g. transport of emissions/discharges through the environment) and the nature of receptors (e.g. humans, flora and fauna etc.) that may be impacted. These structured approaches include interaction with design engineers.

A full description of the scoping assessment undertaken for the Yamal LNG Project is provided in the Yamal LNG Scoping Report, a copy of which is provided in Appendix 1 to this ESIA.

3.4 SIGNIFICANCE CRITERIA OVERVIEW

This ESIA adopts an approach to impact categorisation and significance that is commonly used in the preparation of large project ESIAs, making use of quantitative criteria where available and where not available using qualitative criteria and expert judgement.

It is important that impacts are described consistently throughout the ESIA and therefore the terminology used in the remainder of this section is used throughout the ESIA in the assessment of impact significance.

In order to describe whether an impact is positive or negative, the following terminology should be used:

- Adverse – refers to a detrimental/negative effect on a receptor.
- Beneficial – refers to an advantageous/positive effect on a receptor.

A standardised approach to impact assessment allows potential impacts to be categorised consistently across all aspects. This approach is applied to the assessment of impacts in all phases of the Project (i.e. construction, commissioning, operation and decommissioning).

3.4.1 KNOWN/CERTAIN IMPACTS

Where impacts are certain to occur and the extent of such impacts can be reasonably predicted (for example in relation to routine and/or planned events with reasonably predictable consequences), the significance is defined by the assessed severity of that impact.

> **Severity:** Severity is dependent upon the magnitude of the impact for example in terms of the duration (long, medium, short term), the extent (site, local, regional, national) and reversibility (reversible, irreversible) as well as on the sensitivity of the receptor (as a resource and/or to the change or impact).

Table 3.1 below details high-level generic severity criteria for negative impacts. The generic criteria below are by necessity qualitative in nature as they are intended to cover a wide range of different environmental and social aspects. However, where appropriate, these qualitative generic criteria are supplemented by more detailed and quantitative criteria that are presented on a topic-by-topic basis in Section 3.5.

Table 3.1 Generic (Qualitative) Severity Criteria

None/Negligible	No discernible impact – Effects are non-existent or the impact of a particular activity is deemed to be 'negligible' or 'imperceptible' and is essentially indistinguishable from natural background variations.
Low	Slight effects, well within Project Standards[1]. **Duration:** short term **Extent:** localised to immediate area **Reversibility:** reversible **Sensitivity of the receptor**: low sensitivity/value[2].
Moderate	Noticeable effect but still within Project Standards. **Duration[3]:** short-term (moderate receptor sensitivity/value), medium term (low receptor sensitivity/value) **Extent[3]:** local (moderate receptor sensitivity/value) or regional (low receptor sensitivity/value) **Reversibility:** reversible **Sensitivity of the receptor:** see duration and extent above.
High	Considerable effect and/or repeated breach of regulatory/project limits. **Duration[3]:** medium to long term (moderate to low value receptors), short-

[1] The Project Standards are as defined in the Project Standards Document and as summarised in Section 2 of this ESIA.

[2] For example, low sensitivity might refer to and abundant common species where the Project would not result in any local or regional threat to population numbers. The sensitivities of specific receptors are further described in the baseline characterisation section of the ESIA.

[3] The precise definition of the 'duration' and 'extent' of impacts is dependent on the nature of the impact and the sensitivity of the receptor. Generic terms are therefore used in this qualitative table, but more specific definitions are provided where appropriate in the topic-specific tables presented in Section 3.5.

	term (high value receptors, protected habitats/species) **Extent[3]:** local (high receptor sensitivity/value, protected habitats/species) or regional (moderate receptor sensitivity/value) **Reversibility:** reversible (moderate/high value receptors), or irreversible (low value receptors or localised moderate/high value receptors/habitats) **Sensitivity of the receptor**: see duration, extent and reversibility above.
Major	Major effect, continuous breach of Project Standards. **Duration:** Long term **Extent:** regional, national or international effect **Reversibility:** Limited reversibility/irreversible **Sensitivity of the receptor:** highly valued/sensitive receptors.

Where positive impacts are envisaged these are identified as being 'beneficial' and the nature of the benefit will be described, although the scale of benefit will not be assigned a specific significance level. In the case of assessment of compensation or offsets, for example in relation to socio-economic or biodiversity impacts, a detailed and bespoke analysis of the overall effectiveness of the compensation/offset will be undertaken.

3.4.2 UNCERTAIN IMPACTS AND RISKS

Where an impact is not certain to occur (e.g. due to the inherent stochastic nature of the potential impacts from routine/planned activities, or else where impacts are associated with unplanned/emergency events), the significance of the impact ***risk*** is a function of the ***likelihood*** that it occurs and the ***severity*** of the impact should it occur. Table 3.2 below provides a description of the likelihood categories applied in this ESIA. These are set and do not vary according to impact type.

Table 3.2 Likelihood criteria	
Probable	Events that are known to occur within the specific industry and likely to occur on multiple occasions during the 30 year design lifetime of the Project. Probability of occurrence – more than 50%.
Possible	Known to occur periodically within specific industry and reasonably foreseeable to occur once during the design lifetime of the Project. Probability of an occurrence – less than 50%.
Unlikely	Known to occur rarely in specific industry or periodically within wider industry. Realistically feasible but unlikely to occur during the design lifetime of project. Probability of occurrence – less than 10%.
Improbable	Rarely heard of within wider industry and extremely unlikely to occur during the design lifetime of the Project. Probability of occurrence – less that 1%.

The significance of the overall impact risk is then determined using the following risk matrix.

Likelihood of impact	Severity of Impact				
	Negligible	**Low**	**Moderate**	**High**	**Major**
Probable	Negligible	Low	Moderate	High	Major
Possible	Negligible	Negligible	Low	Moderate	High
Unlikely	Negligible	Negligible	Negligible	Low	Moderate
Improbable	Negligible	Negligible	Negligible	Negligible	Low

3.5 SIGNIFICANCE CRITERIA BY TOPIC

Significance criteria defining the Impact Severity are defined on a topic-by-topic basis in the following sub-sections. Where topic-specific criteria are not directly applicable, the generic severity criteria in Table 3.1 will be used. The topic-specific criteria tables in the sections below make reference to:

- **Project Standards.** These are the standards fully defined within the Project Standards Document (Appendix 2). However, the relevant numeric standards are also provided in specific sub-sections below.
- **Receptors.** Specific receptors are identified in the relevant sub-sections of Chapters 7 and 8 (the environmental and social baseline respectively) and Chapters 9 and 10 (environmental and social impacts respectively), including identification of their significance/importance and sensitivity.

Where multiple criteria are identified for individual significance classifications, the significance classification is based on the highest significance ranking for which one or more of the criteria are met.

3.5.1 SEVERITY OF IMPACT - AIR EMISSIONS

The criteria to define the severity of air quality impacts are defined in the table below.

Negligible	Low	Moderate	High	Major
Air quality				
Trivial contribution (<1%/non-measurable) to background concentrations predicted at locations outside of the boundary of the Project assets/facilities[4]	Concentrations (including background concentrations) at nearest sensitive receptor well within (<50%) Project Standards. Concentrations (including background concentrations) at offsite locations (i.e. outside of the Project facility/asset boundaries) without sensitive receptors approaching but within (50 - 100%) Project Standards. Air quality impacts do not result in the SPZ extending beyond the Project facility/asset boundaries.	Concentrations (including background concentrations) at nearest receptor approaching but within (50 – 100%) Project Standards. Concentrations (including background concentrations) at offsite locations without sensitive receptors marginally above (<110%) Project Standards. SPZ for air quality purposes extends beyond Project facility/asset boundaries, but does not encompass any sensitive receptors.	Regular (1% of time for short time average period standards) exceedance (including background concentrations) of Project air quality standards at nearest sensitive receptor. SPZ for air quality purposes encompasses sensitive receptors and levels at the receptors with the SPZ may exceed the MPC on a regular basis.	Dominant contribution to long term, severe exceedances of Project air quality standards at nearest sensitive receptor. SPZ for air quality purposes encompasses sensitive receptors and levels at the receptors within the SPZ are expected to exceed the MPC on a long-term basis.

Numeric Project Standards for the air quality pollutants of primary concern are provided in the Project Standards Document (see Appendix 2), with a summary of key pollutant standards provided in Chapter 9.2.

[4] The boundaries of the Project assets/facilities are defined in the Chapter 4 ('Project Description') of the ESIA.

For greenhouse gases (GHG), specific significance criteria are not set. Instead GHG emissions are estimated and Project performance is then assessed through:

- Placing the emissions in the national (Russian) emission context
- Placing the emissions in the context of Lender reporting thresholds
- Consideration of the use of BAT for GHG reduction from the primary emission sources.

A high-level estimate of GHG emissions is provided in Chapter 9. Further, more detailed estimation of GHG emissions will be developed by the Project prior to operations in accordance with internationally recognised methodologies and good practice.

3.5.2 SEVERITY OF IMPACT - TOPOGRAPHY, SOILS AND MARINE SEDIMENTS

Negligible	Low	Moderate	High	Major
		Soil erosion (see note 1)		
Trivial loss of top soil (too small to be measured). No potential for rills and gullies to be formed.	Some loss of top soil due to erosion expected, but soil erosion expected to occur at the same rate as soil formation. Formation of rills and gullies not anticipated.	Net soil erosion anticipated but some (>75% of) top soil cover retained in affected areas. Formation of rills and gullies likely.	Significant loss of top soil in affected areas, limiting vegetative cover. Retained topsoil between 50% and 75% of original cover.	Loss of >50% top soil over an extended area severely restricting/preventing vegetative cover.
		Permafrost		
No change in permafrost soils as a result of Project activities	Minor thawing of permafrost in immediate vicinity of foundations/piles/equipment during installation/construction with rapid re-freezing. No long term impacts on permafrost as a result of Project activities.	Permanent/long-duration thawing of permafrost over localised area, not leading to thermokarst, frost heave and thermal erosion.	Permanent/long-duration permafrost degradation over moderate area, leading to minor and localised thermokarst, frost heave and thermal erosion.	Permanent/long-term permafrost degradation over an extended area and for prolonged periods, leading to significant thermokarst, frost heave and thermal erosion.

Negligible	Low	Moderate	High	Major
Soil contamination (see note 2)				
No discernible change in soil/ground baseline conditions. Expert site/pollutant-specific assessment not required.	Change of pollutants' concentration <50% from baseline conditions, but below limiting values. Expert site/pollutant-specific assessment not required. No loss in soil productivity.	Change of pollutants' concentration by 50-100%, but below limiting values. Soil quality may require reinstatement but should naturally recover within 3 years. Expert site/pollutant-specific assessment should be considered in order to prevent escalation of impact.	Significant volume of soil is contaminated exceeding limit values by up to 125%. Expert site/pollutant-specific assessment required to quantify and mitigate impact. Productivity losses predicted to last over 3 years following reinstatement in the absence of mitigation.	Significant volume of soil is heavily contaminated significantly exceeding (>125%) limit values. Expert site/pollutant-specific assessment required to quantify and mitigate impact. Soil productivity losses predicted to be permanent in the absence of mitigation.
Physical disturbance of marine sediments				
No discernible disturbance of sediments.	Short term disturbance that is reversible and restricted over a small area e.g. localised and isolated activities. Negligible impacts on biota (as defined under Section 3.5.5)	Medium term localised disturbance or short term wider disturbance likely to result in a short term negative impact on marine biota (as defined under Section 3.5.5).	Large scale disturbance with detectable adverse to marine biota (as defined under Section 3.5.5).	Long term/continuous/ irreversible disturbance/loss of a large area/volume of marine sediment over an extended period with potential to severely impact marine organisms. Character of sediments is permanently changed.

Negligible	Low	Moderate	High	Major
Contamination of marine sediments (see note 2)				
No discernible change in baseline conditions of bottom sediments. Expert site/pollutant-specific assessment not required.	Increase in pollutant concentration <50% from baseline conditions, but below limiting values. Expert site/pollutant-specific assessment not required. Quality of sediments recovers naturally within 6 months. Negligible impacts on biota.	Increase in pollutant concentration by 50-100%, quality of sediments recovers within 6-24 months. Expert site/pollutant-specific assessment should be considered in order to prevent escalation of impact.	Contamination of sediments above limit values. Quality of sediments predicted to recover naturally within 2-5 years. Expert site/pollutant-specific assessment required in order to quantify and mitigate impact. Likely to cause considerable harm to benthic organisms.	Long term and widespread contamination with little chance of natural recovery within 5 years. Expert site/pollutant-specific assessment required in order to quantify and mitigate impact. Likely to cause severe harm to benthic organisms.
1) The soil erosion criteria apply only areas that will be disturbed and then subsequently reinstated during the construction of the Project. The significance of impacts to soil permanently lost to structures required for the operation of the Project is dealt with in terms of impacts to flora and fauna (see section 3.5.5). 2) Generic quantification of impacts is not possible unless assessed using site specific information (i.e. the type of contaminant, its toxicity, the sensitivity of receptors etc.). The given impact criteria are intended to indicate whether expert site/pollutant-specific assessment is required.				

3.5.3 SEVERITY OF IMPACT - LANDSCAPE IMPACTS

Landscape assessment criteria are based on consideration of both the landscape sensitivity and the magnitude of change to the landscape resource.

- Landscape sensitivity is defined on a 3-point scales as follows:
  - **High Sensitivity:** Highest/very attractive landscape quality with highly valued, designated or unique characteristics susceptible to relatively small changes.
  - **Medium Sensitivity:** Good landscape quality with moderately valued characteristics reasonably tolerant of changes.
  - **Low Sensitivity:** Ordinary/poor landscape quality with common characteristics capable of absorbing substantial change.
- Magnitude of Landscape resource change is defined on a 3-point scale as follows:
  - **High Change:** Total, permanent loss or alteration to key elements of the landscape character, which result in fundamental change.
  - **Medium Change:** Permanent partial/noticeable loss of elements of the landscape character; or

    Temporary (<3 years) loss or alteration to key elements of the landscape character, which result in fundamental change
  - **Low Change:** Minor alteration to elements of the landscape character.

The severity of impacts on landscape is then assessed as follows:

Landscape Impact Severity

Magnitude of landscape resource change	Landscape Sensitivity		
	Low Sensitivity	Medium Sensitivity	High Sensitivity
No change	Negligible	Negligible	Negligible
Low change	Negligible	Low	Moderate
Medium change	Low	Moderate	High
High Change	Moderate	High	Major

3.5.4 SEVERITY OF IMPACT - SURFACE WATER RESOURCES (MARINE AND FRESHWATER)

Negligible	Low	Moderate	High	Major
Freshwater quality				
No discernible change in baseline concentration in receiving water bodies. No discernible changes in water levels/availability	Effluent discharges within discharge limits. Water abstraction rates within abstraction limits. No discernible impacts to water quality or ecology.	Effluent discharges occasionally (<= once per year and/or <= 10% of the time of operation) breach discharge limits, but receiving waters have rapid dilution capacity. Water abstraction rates occasionally <= once per year and/or <= 10% of the time of operation) exceed abstraction limits, but water body has rapid recharge Some limited impact to aquatic organisms likely (as defined under Section 3.5.5).	Repeated (<=5 incidents per year and/or <=20% of time of operation) breach of effluent discharge and/or Occasional (<= once per year and/or <= 10% of the time of operation) breach where receiving waters have a poor dilution capacity and/or water quality Project Standards (at the edge of mixing zone) are exceeded, significantly affecting aquatic organisms (as defined under Section 3.5.5). Repeated (<=5 incidents per year and/or <=20% of time of operation) exceedance of abstraction limits and/or Occasional (<= once per year and/or <= 10% of the time of operation) exceedance of abstraction limit from water body with slow recharge rate leading to significant change in	Persistent breach of effluent discharge limits and/or water quality Project Standards (at edge of mixing zone). Persistent breach of abstraction limits and prolonged significant effects on water levels/availability.

Negligible	Low	Moderate	High	Major
			water levels/availability.	

Numeric Project Standards for the pollutants of primary concern are provided in the Project Standards Document (see Appendix 2), with a summary of key pollutant standards provided in Chapter 9.

3.5.5 SEVERITY OF IMPACT - FLORA AND FAUNA

Negligible	Low	Moderate	High	Major
Ecological impact				
Insignificant impact on habitats integrity – no fragmentation or physical impact.	Slight effects over a localised area (up to 10 km^2) affecting low value habitat. No fragmentation, No discernible change in behaviour Full recovery expected to occur shortly (<1 year) after impacts cease.	Noticeable effect on integrity of: • Localised area (up to 10km^2) of moderate sensitivity/importance habitat • Wider area (10-25 km^2) of low value/sensitivity habitats Species abundance/ distribution may be affected but no threat to the integrity of the population. Full recovery expected to within 5 years after impacts cease.	Noticeable impact on integrity of: • Locally valuable habitat, or loss of habitats between 25-50 km^2. • Low value habitat or loss of habitats >50 km^2 Long term decline in local population abundance of low value species distribution taking several generations (of affected species) and >5 years to recover. Short-term decline in population abundance of moderate or high value species distribution taking several generations (of affected species) and <5 years to recover.	Reduction of nationally or internationally protected habitats and species, or loss of habitat over 50 km^2.

3.5.6 SEVERITY OF IMPACT – NOISE

Negligible	Low	Moderate	High	Major
Noise				
Noise levels remain at or close to ambient levels that are imperceptible to receptors.	Noise level increases detectable but remain below Project Standards. Increase at sensitive receptors <5dB above ambient background levels. Little or no adverse effect on sensitive receptors anticipated.	Noise levels at sensitive receptors occasionally exceed Project Standards during exceptional events. Increase in noise levels at sensitive receptors 6 to 10dB above background. Moderate impacts to fauna as defined in Section 3.5.5.	Noise levels at sensitive receptors repeatedly exceed Project Standards. Increase in noise levels at sensitive receptors 11 to 15dB above background. High impacts to fauna as defined in Section 3.5.5.	Long term or continuous exceedances of Project Standards at sensitive receptors. Increase in noise levels at sensitive receptors >15dB above background. Major impact to fauna as defined in Section 3.5.5.
Ground borne Vibration levels imperceptible to receptors	Ground borne vibration levels at receptors <8mm/s (<10Hz) and <12.5mm/s (>Hz).	Ground borne vibration levels at receptors periodically <8mm/s (<10Hz) and <12.5mm/s (>Hz), but do not affect properties. Moderate impacts to fauna as defined in Section 3.5.5.	Ground borne vibration levels at receptors periodically >8mm/s (<10Hz) and >12.5mm/s (>Hz), affecting properties. High impacts to fauna as defined in Section 3.5.5.	Ground borne vibration levels at receptors repeatedly >8mm/s (<10Hz) and >12.5mm/s (>Hz), affecting properties. Major impact to fauna as defined in Section 3.5.5.

Numeric Project Standards for the noise are provided in the Project Standards Document (see Appendix 2), with a summary of key pollutant standards provided in Chapter 9.

3.5.7 SEVERITY OF IMPACT – WASTE

Negligible	Low	Moderate	High	Major
No hazardous waste (Class I to III) and very limited non-hazardous (Class IV to V) generated. Approved disposal facilities available for all wastes that meet Project Standards. No impact on long term capacity of third party waste disposal/treatment facilities.	Limited hazardous waste (Class I to III) and moderate volumes of non-hazardous (Class IV to V) generated. Approved disposal/treatment facilities available for all wastes that meet Project standards. No significant impact on long term capacity of third party waste disposal/treatment facilities.	Moderate volumes (requiring small-scale dedicated storage, transport and/or disposal facilities) of hazardous waste (Class I to III) and significant volumes (requiring large-scale dedicated storage, transport and/or disposal facilities) of non-hazardous (Class IV to V) generated. Approved disposal/treatment facilities available for all wastes that meet Project standards (Project operated facilities) and RF standards (third party facilities). Moderate impact on long term capacity (<10% of available capacity) of third party waste disposal/treatment facilities.	Significant volumes of hazardous waste (Class I to III) and significant volumes of non-hazardous (Class IV to V) generated. Approved disposal/treatment facilities available for most wastes that generally meet Project standards (Project operated facilities) and RF standards (third party facilities), but minor deficiencies to standards identified. Long term disposal/treatment options not available for small volumes of hazardous waste (Class I to III). Significant impact on long term capacity (10% to 30% of available capacity) of third party waste disposal/treatment facilities.	Significant volumes of hazardous waste (Class I to III) and significant volumes of non-hazardous (Class IV to V) generated. Approved disposal/treatment facilities available for some wastes that partially meet Project standards (Project operated facilities) and RF standards (third party facilities), but significant deficiencies to standards identified. Long term disposal/treatment options not available for significant volumes of hazardous waste. Significant impact on long term capacity (>30% of available capacity) of third party waste disposal/treatment facilities.

Numeric Project Standards for waste facilities are provided in the Project Standards Document (see Appendix 2).

3.5.8 SEVERITY OF IMPACT – SOCIAL

Negligible	Low	Moderate	High	Major
Direct Impacts on People				
Marginal, readily reversible changes or imperceptible changes in the current socio-economic, cultural and community environment that may affect a very limited number of persons (up to 10) over a period of short duration (1 to 3 months).	Minor and readily reversible changes in the current socio-economic, cultural and community environment that may affect a limited number of persons (10-100) over a period of short duration (3 to 6 months).	Noticeable and reversible changes in the current socio-economic, cultural and community environment that may affect a number of persons (100-500) over a period of up to 1 year.	Substantial changes in the current socio-economic, cultural and community environment that may affect a sizeable number of persons (up to 1,000) over a period of 1 to 3 years. Reversibility of the changes depends on application of a range of technical, organisational, financial and other measures. Single case of serious injury	Wide-spread and irreversible disturbance/disruption to the current socio-economic, cultural and community environment that affects population of over 1,000 persons for the period of more than 3 years or permanently. Multiple cases of serious injury or single case of fatality
Impacts on socio-economic and cultural resources				
No effect on social/cultural or cultural resources of critical[5] importance, non-replicable heritage (tangible and intangible), or primary livelihood assets of local indigenous communities.	No effect on socio-economic or cultural resources of critical importance, non-replicable heritage (tangible and intangible), or primary livelihood assets of local indigenous communities.	Potential effect on a limited range of valuable socio-economic or cultural resources, replicable heritage, or livelihood assets of local indigenous communities that are not of primary importance to community/individual	Socio-economic and/or cultural resources of critical importance, non-replicable heritage (tangible and intangible), or primary livelihood assets of indigenous communities are affected on the local and regional levels.	Socio-economic and/or cultural resources of critical importance, non-replicable heritage (tangible and intangible), and a broad range of livelihood assets of indigenous communities are affected, including on the local, regional and

[5] The critically of resources is determined based on a combination of existing designations, expert judgment and stakeholder engagement as appropriate.

Negligible	Low	Moderate	High	Major
		subsistence. Core assets and resources of the local communities may be partially affected but this does not lead to overall deterioration of the main livelihood and its viability.	Core assets and resources of the local communities are affected leading to deterioration of the main livelihood.	national/international levels. Core assets and resources of the local communities are affected, leading to irreversible disruption/disintegration of the main livelihood.
Physical Displacement				
No physical displacement entailed	No physical displacement entailed, apart from short-term/readily reversible (regular) movement of population employed by the Project as related to the rotation-based work	Short-term and reversible physical displacement of minimal extent (up to 10 households), without an effect on their traditional lifestyle and associated activities.	Permanent physical relocation (regardless of the number of households affected), resulting in the change of their traditional lifestyle and activities. The reversibility of such changes requires a range of technical, organisational, financial and other support measures.	Permanent physical relocation is entailed, resulting in the irreversible transformation of traditional lifestyle and the cessation of traditional activities.

3.6 CUMULATIVE IMPACTS

Cumulative impacts are those that result from the incremental impact of a project when added to other existing, planned, and/or reasonably predictable future projects and developments. The approach taken to cumulative impacts in this ESIA is described in Chapter 13.

3.7 CONSIDERATION OF MITIGATION

Mitigation measures are applied, where necessary, to reduce the severity and/or the likelihood of the impact and therefore reduce the overall impact/risk significance. In this ESIA the significance of a potential impact/risk is assessed in terms of the residual impact.

For each topic this ESIA describes potential impacts during each phase of the Project (construction, commissioning and operation[6]) and then assesses their significance. It then describes mitigation measures, developed in line with the mitigation hierarchy[7] that will be applied. In developing mitigation controls, the primary focus will on mitigation of those impacts that have been categorized as having a **High or Major** significance. However, mitigation measures will also be considered for impacts of **Low** and **Moderate** significance to ensure that environmental and social impacts/risks are minimized wherever possible. Following the initial assessment of the impact significance (typically inclusive of any mitigation measures in the design but prior to the application of any additional mitigation measures), the significance of the residual impact is then assessed based on the application of any additional mitigation measures deemed necessary to reduce significance to acceptable levels.

Methods of prediction of impact significance within this ESIA are either quantitative or qualitative or, in certain instances, both. Quantitative methods predict measurable changes as a result of the Project (e.g. air quality predicted by numerical modelling), while qualitative assessment techniques rely on expert judgement and the experience in projects of similar nature/scale, within a structured framework to ensure consistency. It should be noted that impacts on the social environment may not always be readily amenable to the quantification or application of numeric standard values due to the immaterial nature of an effect (e.g. psycho-emotional and perceptive impacts) or correlation of a change with the specific local context (i.e. a scale of in-migration compared with the size of the original host population). Accordingly, qualitative parameters are applied when assessing those social impacts that cannot be measured in quantitative terms.

[6] Note that Decommissioning is considered separately. Also in some cases it is appropriate to combine commissioning with either the construction or operation phases.

[7] In line with good ESIA practice mitigation measures will be developed using the 'mitigation hierarchy' which broadly require that consideration should be given to avoidance, minimization, mitigation and offsetting for impacts in that order of preference.

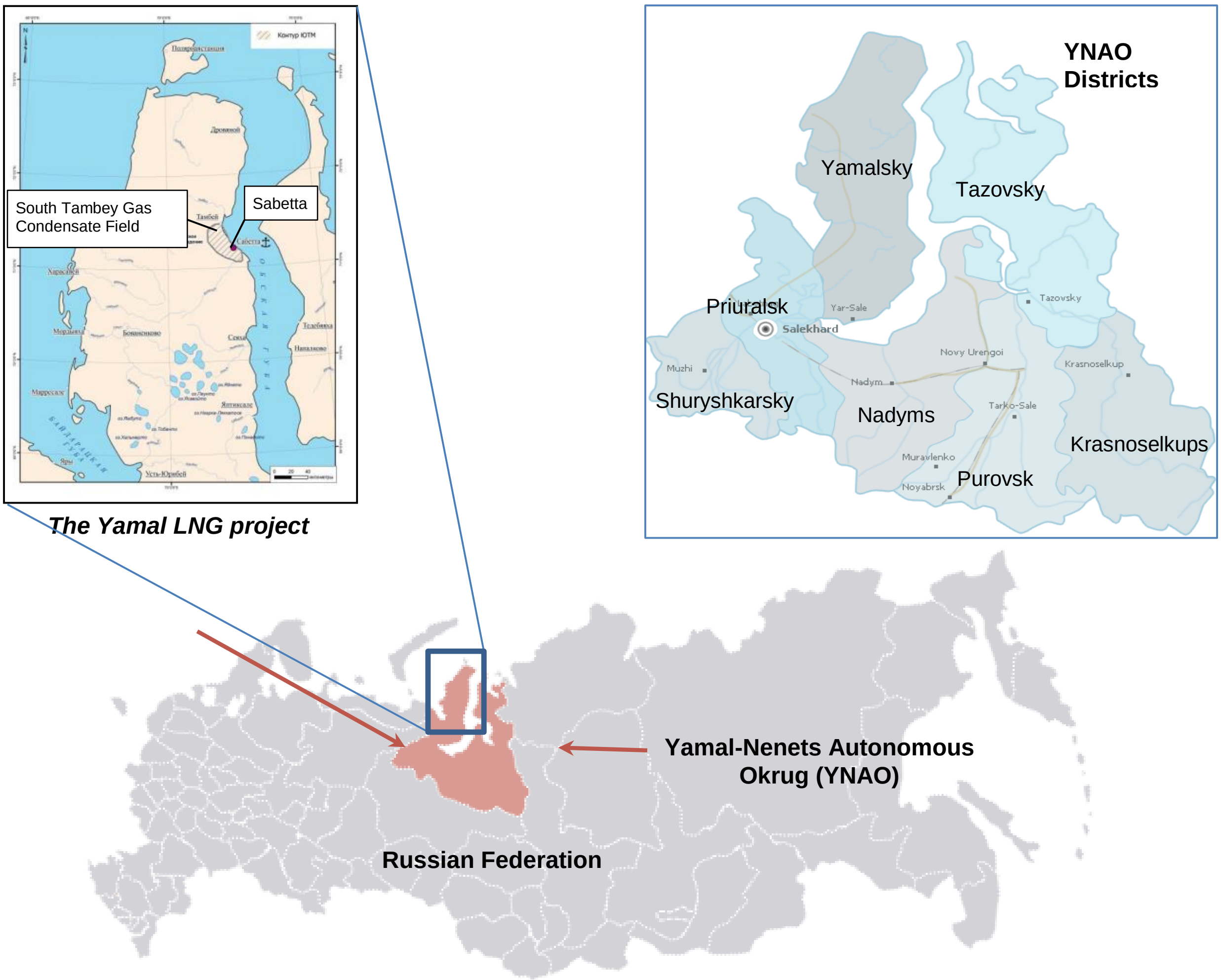
4 PROJECT DESCRIPTION

4.1 GENERAL INFORMATION

The Yamal LNG Project is an integrated complex for production, processing, liquefaction, and export of liquefied natural gas and gas condensate from the South Tambey Gas Condensate Field. The Project will be developed and operated by Yamal LNG.

The South Tambey Gas Condensate Field is an onshore field situated in the north-east of the Yamal Peninsula, some 540 km north-east of the regional center of Salekhard city (see Figure 4.1).

Figure 4.1 Yamal Peninsula and Project Location



The Project's estimated reserves are as follows:

	Total proved	Potential	Possible
Feed gas (mln.м3)	697 949	202 189	162 448
Condensate (thous.tons)	16 151	6 629	6 204

Other operators commenced exploration activities in the field in 1974 and 58 exploration wells have previously been drilled.

The Project location is at latitude 71ºN within the Arctic Circle. Due to its northern location, climatic conditions are extreme, winter daylight is very limited and population densities are very low. The Project's location presents a number of challenges both in terms of working conditions, availability of labour, access to gas markets and environmental and socio-economic sensitivities including protected flora and fauna, the presence of permafrost and indigenous people. A large workforce will be required, particularly during the construction phase, which will be transported to site by air.

In view of its objectives, the Company has opted to develop the South Tambey Gas Condensate Field on the basis of natural gas liquefaction technology, which will further enable the export of liquefied gas via sea to the markets of Europe, North America and the Asia-Pacific region.

In view of the fundamental design decisions (see Chapter 4) and the remote location of the Project relative to both markets and a skilled workforce, the main facilities necessary to realise the Project are as follows:

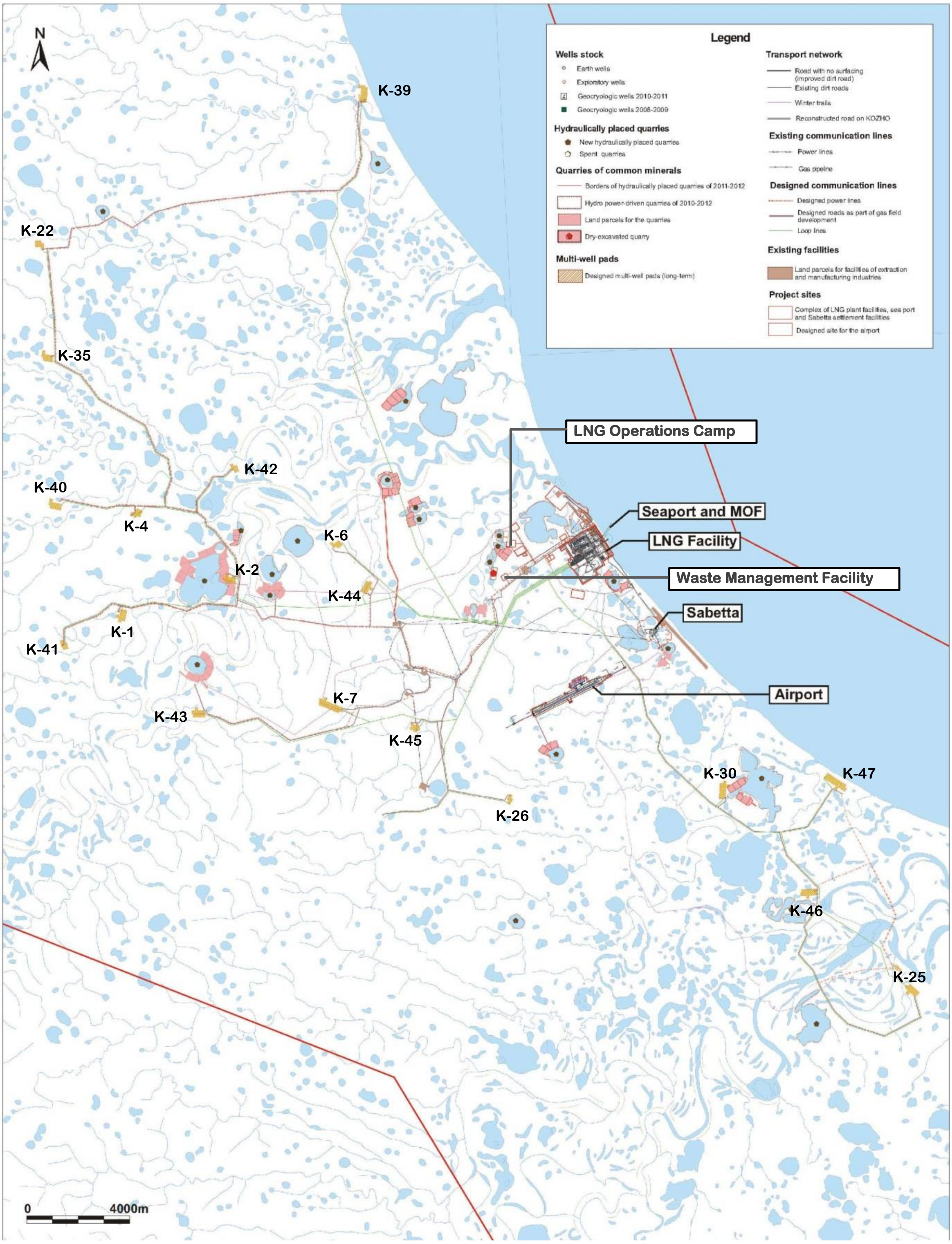
- Gas (and condensate) gathering network, including a network of production wells and gathering pipelines;
- Gas pre-processing treatment facilities and a methanol unit (for treatment prior to liquefaction);
- The LNG plant (for the liquefaction of natural gas) including 3 process trains;
- A 380MW power plant;
- LNG and condensate storage tanks;
- An airport (primarily for transportation of workers);
- Supporting infrastructure in the form of local roads (no roads, including winter ice roads, outside of the Licence will be used), bridges (for stream and river crossings[1]) aerial electrical transmission lines, workshops, waste management facilities and workers' facilities;
- Workers' accommodation (for construction and operation phases) and auxiliary infrastructure facilities;
- A seaport including:

[1] See Chapter 7 for a description of river crossings

   - early seaport facilities consisting of a Materials Offloading Facility (MOF)/berths for the delivery of equipment, heavy plant and construction materials during construction phase; and
   - main seaport facilities, including two jetties, a trestle and two ice breakers, for the shipment of LNG and gas condensate during operations.
- A fleet of diesel-powered double-hulled LNG carriers and condensate tankers for year round operation in the Eastern Barents and Kara Seas as well as in the Gulf of Ob and summer navigation along the Northern Sea Route.

An overview of the main facilities is shown in Figure 4.2 below.

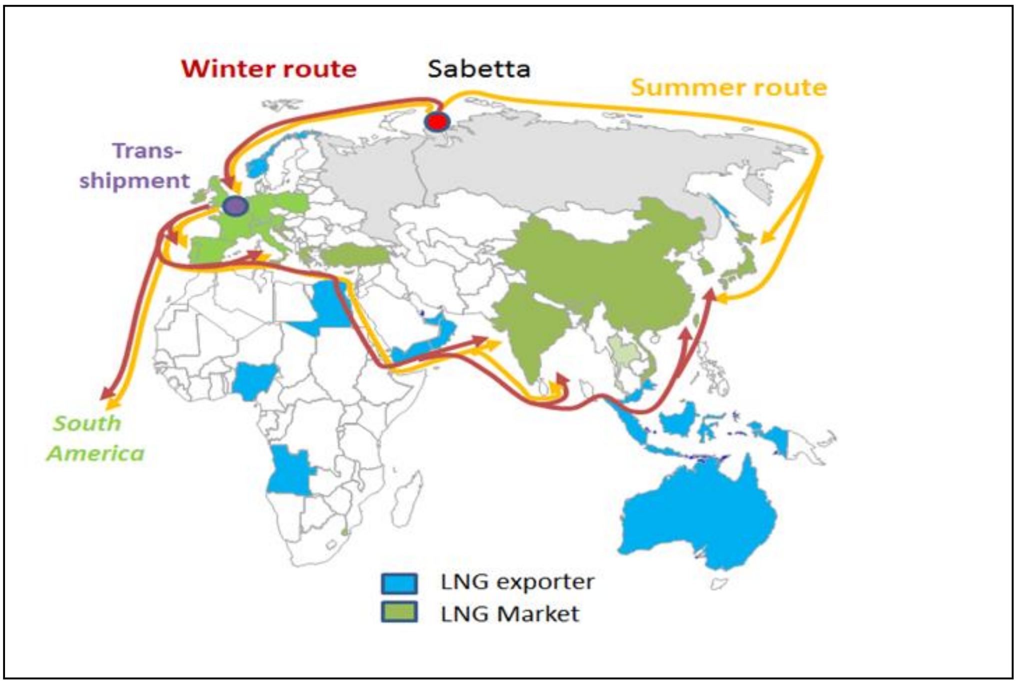
Figure 4.2 Plan of the Project Licence Area and Key Facilities



LNG carrier and condensate tanker operations and offshore activities will be carried out by third parties. The LNG carrier and condensate tanker operations and offshore activities are not subject to project financing nor directly under Yamal LNG's control, but are essential to the Project's viability and are therefore considered within the ESIA as associated facilities[2]. Similarly the seaport will be operated by a third party and is considered an associated facility. Associated facilities are described further in Section 4.9.

Figure 4.3 shows the summer and winter routes for LNG export, which follow the Northern Shipping Route shipping lane between the Atlantic and Pacific oceans.

Figure 4.3 Indicative shipping routes



[2] Associated facilities are defined in line with IFC Performance Standards as facilities "*that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.*"

4.2 PROJECT TIMEFRAMES

Based on current assessment of the available reserves the Project is expected to achieve constant gas production rated at 27.5 billion m^3/year (16.5 million tons / year as liquefied natural gas) for about 25 years. Thus field operations will be completed in the 2040s (the subsoil use license held by Yamal LNG expires at the end of 2045).

However, it should be noted that the exhaustion of the proven field reserves is not likely to result in the end of operations for the LNG plant and other facilities built under the Project. Instead it is likely that the LNG plant, the seaport and the airport will be used for exploitation of other hydrocarbon fields within the region.

In accordance with Yamal LNG's field development plan, LNG production will ramp up over a three year period as production wells and LNG trains are commissioned in 2017, 2018 and 2019. A non-exhaustive list of the major facilities associated with each phase is outlined below.

Initial phase (2016)

The following facilities comprise the first phase:

- 68 wells (multiple wells will be drilled from each well pad).
- Gas inlet facilities consisting of slug catchers, separation and condensate stabilization units, methanol injection, regeneration and production units.
- The first LNG process line (or 'train') with a capacity of 5.5 million tonnes LNG/year (5.5Mtpa). This train consists of a CO_2 removal unit, drier unit, mercury guard-bed and propane pre-cooled mixed refrigerant (C3MR) liquefaction unit.
- The first phase further consists of two LNG tanks, boil-off gas compressor, fractionation unit, ethane and propane refrigerant storage bullets, instrument air system and nitrogen separation unit, as well as water treatment distribution and collection facilities, including a fire water system and a heat transfer fluid (HTF) system.
- The berths for receiving of construction materials (early seaport) and for shipping the LNG and stable condensate (main seaport).
- Four gas turbine units for supply of electrical power.
- Auxiliary and infrastructure facilities.

Second phase (2017)

The second phase will include a further 29 wells, a second LNG train and additional LNG storage tank, a boil off gas (BOG) compressor, an LNG loading jetty, power generating equipment and auxiliary and infrastructure facilities will be commissioned.

Final Phase (2018)

The following facilities comprise the third stage: a further 40 wells (drilled from the phase 1 and 2 well pads); a third LNG process train; an additional LNG storage tank, a BOG compressor and; associated power generating units.

During the operational phase an additional 71 wells will be drilled to maintain the production plateau for the plant. In addition, as field formation pressure falls during production it is planned to build a booster compressor station with the first of several compressor units being commissioned around 2021.

Start of construction

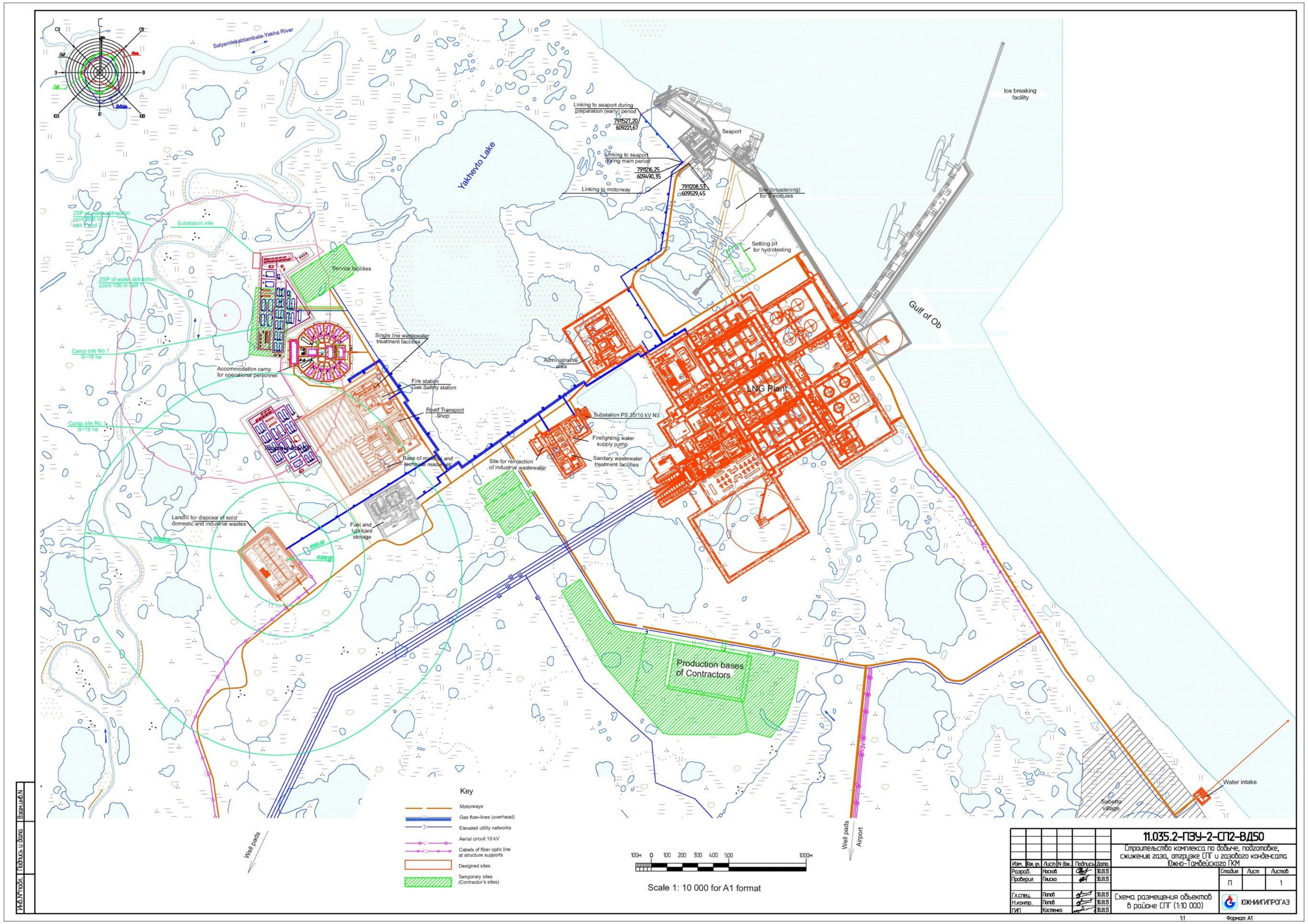
Since 2009, Yamal LNG has been conducting geological and environmental surveys in order to facilitate development of the field, and in 2010 the Company also initiated sand abstraction and stockpiling in accordance with the licenses obtained. During this period a number of YLNG personnel were present within the license area to undertake these works and to maintain the field activity.

In 2012 preparatory construction works commenced to set up engineering utilities and infrastructure facilities, including accommodation and administrative facilities in Sabetta, a fuel depot, the inter-field roads, the MOF and the airport runway.

4.3 MAJOR FACILITIES DESCRIPTION

When implementing the Project, a substantial number of facilities will be required for production, processing and transportation of the gas and condensate prior to liquefaction of the gas and storage and export of both gas and condensate. Other facilities and infrastructure will also be required to support the main production facilities. A brief description of these major facilities/activities is given below and the facilities are also shown on Figure 4.4.

Figure 4.4 Plan of primary facilities in the vicinity of the LNG plant



4.3.1 WELL DRILLING

Over the three phases outlined above a total of 124 wells will be drilled on 19 well pads within the South Tambey Gas Condensate Field. In addition a further 84 wells will be drilled post 2019; the schedule for drilling these additional wells will be developed after 2017 (once the first LNG process train is be under operation). The well pads are identified as follows and their locations are shown on Figure 4.2:

K-1	K-2	K-4	K-6	K-7	K-22	K-25	K-26	K-30	K-35
K-39	K-40	K-41	K-42	K-43	K-44	K-45	K-46	K-47	

Wells will be drilled from a reduced number of pads to minimize the footprint associated with the drilling operations. Oil-based mud (OBM) is used in the intermediate, production casings and liner drilling phases; otherwise water-based mud (WBM) is used. Drill mud will be separated from drill cuttings using centrifuges or thermal desorption systems so that mud can be re-circulated for re-use. The drill cuttings will be disposed to lined pit at the well pads for their further remediation. Drill muds will be replenished with fresh drill muds to compensate mud losses.

When performing the well testing studies, hydrocarbons will be burnt at an appropriately lined flare pit (one per well pad). The minimum volume of hydrocarbons required for the test will be flowed and well test durations will be reduced to a minimum[3]. An efficient test flare burner head equipped with an appropriate combustion enhancement system will be used to minimize incomplete combustion, smoke formation and hydrocarbon fallout. Liquid phase (condensate and water) will be separated. Residual hydrocarbons will be collected from the flare pits and disposed in an appropriately manner via the Project's waste management facilities (described below).

Thermal stabilisers (passive systems for above ground structures and refrigerant systems in wells) will be installed to control risks associated with freeze-thaw effects. Further studies are ongoing to determine precise design needs.

4.3.2 GAS COLLECTION – GATHERING PIPELINES

A network of small diameter gas pipelines will be required to transport gas from each well pad to the LNG plant. Figure 4.2 shows the 19 well pads located within a 20km radius of the main LNG facility and a connecting pipeline network. The total length of the gathering pipeline system is 312km. To protect the permafrost from the warm gas (up to 30ºC) the pipelines will typically be above ground with a diameter of between 250 and 700mm, suspended by stanchions (supports). Reindeer crossings will be installed over the pipeline at strategic locations of reindeer herder migration routes so that it does not hinder reindeer passage. (See Chapter 10 for further details, including number and location of crossings.)

[3] Flaring volumes are also set under local RF permits and flare volumes will also be limited to that required to meet technical flow test requirements.

To prevent hydrate formation, methanol will be injected into the gas collection network pipelines. Methanol will be introduced to the gas collection network via a methanol injection unit located at each well pad. Methanol will be recovered and reused (see Section 4.3.3)

The well pads will also be equipped with a high integrity pipeline protection system (HIPPS) with blocks of relief valves. Any discharge from relief valves will be directed to a vent stack. A separator shall also be installed on the pad to separate liquids from bleed off gas; the liquids will be recovered by road tanker for processing.

Pigging equipment will be installed on pipelines exceeding 15km. Similarly block valves will be installed on flow lines that are >15km long. The intervals for pipeline pigging have not yet been established (the pipeline maintenance procedures will specify the time intervals for the cleaning operations; the need for cleaning the pipelines will be determined on the basis of the pressure difference in the pipeline). The predicted waste volumes generated in the process of pipeline cleaning is 5.42 tonnes per year. Pigging wastes will be disposed of at the Project's waste facility (organic wastes will be incinerated and non-organic waste will be disposed to the landfill).

There will also be a network of intra-field roads to provide access to the well pads, as well as a network of power lines.

4.3.3 LNG PLANT

The Project will use air-cooled APCI C3MR liquefaction technology for each of the three 5.5 Mtpa LNG trains. The following process facilities comprise the LNG plant when complete:

- LNG inlet facilities include: inlet manifolds and slug catchers (Units 003, 103, 203); gas separation units 104, 204 (2x50% trains) to separate gaseous and liquids phases; gas heating unit 008 to heat up the feed separated gas; condensate stabilization units 105, 205 (2x66% trains) to separate produced water from condensate and stabilize the condensate; stabilization gas compression, unit 006 to compress stabilization gas and send it to feed flow; methanol regeneration units 121,221,321,421 to regenerate methanol (4x25% trains); methanol day tanks, unit 021.

Each LNG train include (first digit 1 is relevant for train 1, 2 for train2, 3 for train 3):

- Unit 111 - Acid gas removal unit to remove CO_2 and small amounts of methanol from the raw gas in order to prevent solid CO_2 build up inside the cryogenic equipment.
- Unit 112 - Gas dehydration and mercury removal unit.
- Unit 113 – LPG extraction – to remove heavy hydrocarbons from feed flow to prevent blockage of cold equipment, and to produce feedstock for fractionation unit as C2+ hydrocarbons flow.
- Unit 114 - Liquefaction unit.

Common equipment for all 3 trains includes:

- Units 615/715 – Fractionation – to produce multicomponent refrigerant components (propane and ethane), to produce butanes stream for re-injection into feed gas and to produce stable condensate.
- Unit 031- Refrigerant storage – to store refrigerants – propane and ethane.
- Unit 035 -Various storage units including three tank each of 50,000m^3 capacity for condensate.

- Unit 034- LNG storage and loading includes: Four full containment LNG storage tanks each with a capacity of 160,000m^3 and boil-off gas (BOG) compressors to deliver BOG gas to plant fuel gas system.
- Unit 070 - Compressed air system to feed air to the nitrogen producing units, the utility air system and instrumentation section.
- Unit 071 - Nitrogen system for production of gaseous and liquid nitrogen and to purge the gas flare system.
- Unit 060 - Flare system, used for the emergency release of gas and liquids in abnormal conditions and for gas venting during the maintenance and start-up/shut down periods, and
- Units 146, 246, 346 and 046 - HTF Hot Oil System.

Figure 4.5 LNG Plant Plot Plan

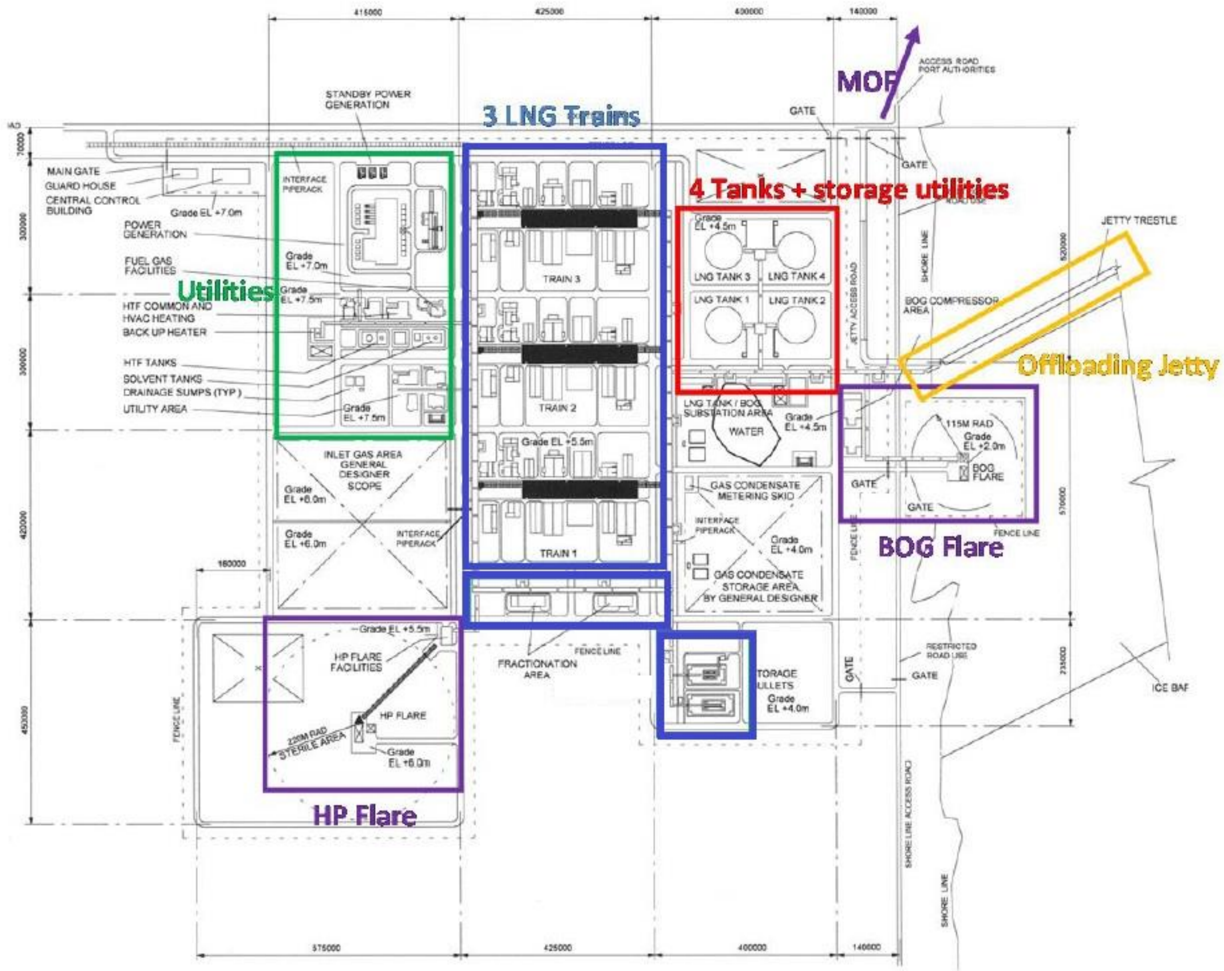
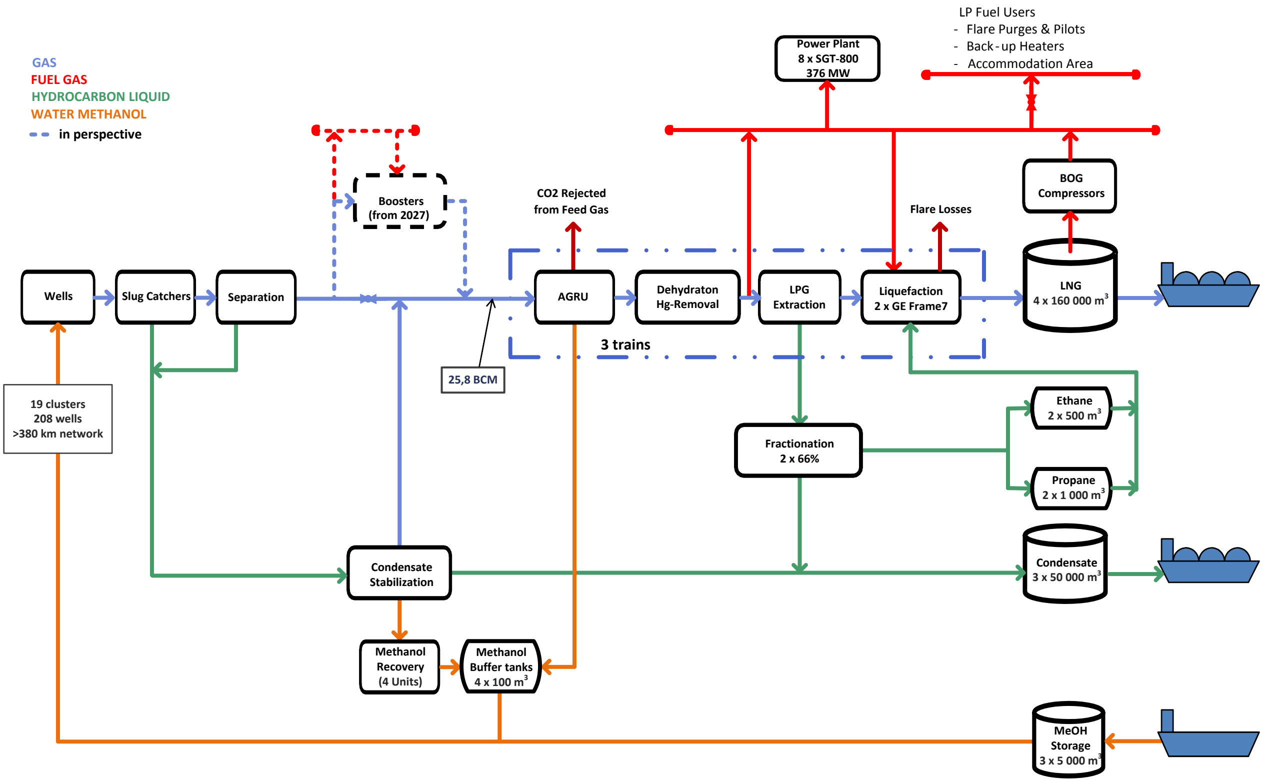


Figure 4.6 High-level LNG Plant Process



The key LNG units from the list above are described in more detail below.

LNG inlet facilities – the inlet facilities are designed to receive and separate mixed hydrocarbon feedstock (gas, liquids hydrocarbons and water methanol mixture (WMM)) from the network of gas gathering flow lines. Liquids will be captured by slug catchers and gas separators and routed to a condensate-WMM separator at the condensate stabilisation unit. Similarly liquids from pig receivers will be routed to the condensate-WMM separator. At the Condensate Stabilization Unit the lighter hydrocarbons are removed from the condensate and compressed by stabilization gas compressors to main gas feed. WMM from separators is routed to methanol regeneration unit. If gas temperature is below low limit for LNG plant, gas will be heated in gas heating unit by HTF coming from LNG plant common area.

Methanol Regeneration Unit – Methanol entering the inlet facilities will be recovered and reused as a hydration inhibitor. The methanol will be injected on an ‘as needs’ basis and consequently the content of methanol will be variable, tending to be higher in the winter. The unit will involve degassing, separation of natural gas liquids, filtering of solid impurities, and methanol regeneration in a distillation column. Water extracted from the process is routed to a waste treatment unit. Separated gas is routed to the LNG plant wet flare system (see below) and natural gas liquids to the condensate stabilisation unit.

Methanol to make up methanol losses will will be imported and stored in the fuel storage area in three 5000 m3 tanks. The methanol day tanks at inlet facilities will include four 100m^3 tanks.

Methanol regeneration unit include four trains for maximum flexibility, two of them will be constructed later when maximum water carryover from the wells will occur.

Acid Gas Removal Unit (AGRU) - A formulated amine shall be used for acid gas removal. Carbon dioxide shall be removed from the feed gas stream to less than 98mg/Nm^3 to prevent freezing and blockage in the downstream cryogenic sections of the plant. There is no requirement for removal of sulphur components due to the low level of sulphur components in the feed gas. The acid gas removed from the feed gas will be vented to atmosphere after mixing with the exhaust from the gas turbines' exhaust stacks.

Acid gas removal unit include methanol recovery column which recovers methanol from the feed gas. The methanol recovered is routed to inlet facilities to reuse as hydrate inhibitor.

The anticipated composition of the AGRU tail gas is as follows (see also Chapter 9 for emission rates):

Gas Composition of AGRU off gas, prior to mixing with gas turbine exhaust gas (g/g)	
H_2O	0,008085
CO_2	0,977128
H_2S	0,000626
CH_4	0,002430
C_2H_6	0,000172
C_3H_8	0,000036
C_4H_{10}	0,000012
i-C_4H_{10}	0,000020
C_5H_{12}	0,000017
C_6H_{14}	0,000002
C_7H_{16}	0,000037
C_8H_{18}	0,000009
C_9H_{20}	0,000001
$C_{10}H_{22}$	0,000007
N_2	0,000011
CH_3OH	0,011221
Benzene	0,000069
Toluene	0,000089
Ethylbenzene	0,000010
m-Xylene	0,000012
CH_3SH	0,000005
H_2	0,000000
Amine	0,000000

Two tanks for storage of fresh solvent (amine) and off-spec solvent or wash water from trains will be provided with a total capacity of 300m^3. This will hold approximately the total solvent inventory of the acid gas removal unit from a single LNG train. A transfer pump will be installed that can fill the AGRU of a single LNG train in 24 hours or less.

Dehydration and mercury removal - The purpose of the Dehydration and Mercury Removal Unit is to reduce the water / methanol and mercury content of the feed gas. Water and Methanol level are reduced in order to prevent freezing and potential blockages in the cryogenic sections of the plant. Mercury level is reduced in the treated gas to prevent mercury corrosion of downstream equipment items made from aluminium.

LPG recovery unit - The purpose of the LPG Extraction unit Unit is to remove heavy and aromatic hydrocarbons and LPG from dry, treated gas arriving from the Dehydration and Mercury Removal Unit (Unit 12) that would otherwise freeze at cold temperatures. The unit also extracts some C2 and C3 from the feed gas which are used as refrigerant make-up in the Liquefaction unit

LNG Processing – The LNG liquefaction process is designed to produce LNG by removing heat from the gas after it has been dried and treated to remove mercury and heavy hydrocarbons. A two-stage coolant system is used in the liquefaction process:

- Pre-cooling using a propane refrigerant system
- Final cooling using a mixed refrigerant (nitrogen, methane, ethane and propane) system.

. Each process train will be fitted with two Frame 7 gas turbines (GT) generators. These GT will utilize Dry Low NOx (DLN) technology and noise mitigation. The main source of fuel gas for the turbines will be Boil Off Gas (BOG) generated from the LNG storage and loading systems (see below).

LNG Storage and Loading Facilities - LNG storage and loading facilities are designed to provide safe storage of the produced LNG and periodic loading of LNG carriers.

LNG storage is provided by four full containment storage tanks each with a capacity of 160,000m^3. During normal operation, the LNG from the process trains is distributed uniformly among all the LNG tanks.

The loading facilities are designed for a maximal loading rate of 14,000m^3 per hour (which enables a 170,000m^3 capacity LNG carrier to be loaded in approximately 12 hours).

A compressor system will be installed to recover BOG from LNG tank storage, loading facilities and carrier vapour returns, and the recovered BOG will be supplied to the fuel gas system.

Condensate Storage and Loading Facilities – Condensate storage is provided by three 50,000m^3 capacity tanks. Each tank will be provided with 110% secondary containment and will be installed with a floating roof to reduce fugitive emissions due to working and breathing losses. The condensate loading facilities will have a loading capacity of 8,000m^3 per hour. Vapour from the loading operations will be recovered onto the condensate tanker.

4.3.4 FLARE SYSTEMS

The LNG facility will have four flare systems comprising a warm/wet flare, cold/dry flare, LP flare and BOG flare as follows:

LNG warm/wet flare – gas reliefs to the warm/wet flare are either constant, periodic or used in emergency situations as follows:

- Periodic flaring will occur during maintenance or repairs

- Emergency or abnormal conditions that will result in flaring include activation of pressure relief valves, or the event of an emergency shutdown.

All of the aforementioned relief sources will be routed to the LNG wet gas flare system.

Low Pressure (LP) Flare –

A separate independent LP flare at inlet facilities area is required for early fuel gas system which will be in operation prior to main flares availability. Gas reliefs to the LP flare are either, periodic or used in emergency situations.

The constant flares are from unstable condensate tanks 105-V001, 205-V-001 and from methanol regeneration unit.

LNG cold/dry flare - The cold/dry flare system consists of flare and drain headers along with associated collection/knockout drums and flares/liquid burners for disposal. The dry flare headers collect cold discharges that do not contain water or water vapour.

BOG flare - A separate independent low pressure flare is required for the LNG Storage and Loading area due to the very low pressure reliefs from this system. The capacity of this system will be sufficient to handle vapour resulting from the operational and minor upset conditions in the storage/vapour handling areas. Vapour loads generated under emergency scenarios such as vacuum breaker control valve failure and equipment failure, or tank rollover scenarios will be relieved to atmosphere via the LNG storage tank relief valves.

All the flare systems will be continuously purged with fuel gas. A nitrogen purge connection will be provided as a back-up in the event that the fuel gas is not available. There will also be a spare flare system and spare LP flare, to be used during maintenance and inspection to ensure no interruption of the flare. Each flare will be provided with its own dedicated electronic ignition system.

The flare stack heights have been designed to meet net radiation limits of 9.46kW/m^2 in worker operational areas at the base of the stack and 4.73kW/m^2 at the sterile (fenced) area and are as follows:

- The wet and dry flares will be mounted on a common support structure and will have the same height of 125m.
- The BOG flare height will be 40m.

Final design of the flare systems is ongoing and the following control measures are to be considered for the final design options:

- Efficient flare tip design to ensure a combustion efficiency of > 98%
- Use of low noise flare tip
- Metering of flare gas.

In addition to the main flare systems, a horizontal burner unit will be installed at the inlet facilities to combust gas during purging of gathering lines and flowlines.

4.3.5 POWER PLANT

The main power supply for the Project during the operational phase will be a 380MW power plant located within the LNG plant territory (see Figure 4.4). The power plant comprises a total of eight Siemens SGT-800 gas turbines with waste heat recovery provided by four UTO-40 units. Emergency power will be provided by back-up diesel generators.

The main source of fuel gas will be BOG from the LNG storage tanks, which will be supplemented by feed gas from the inlet facilities and a normally fixed amount of dry sweet gas from downstream of the Mercury Removal Units in each train.

Power will be distributed to the various Project facility areas via overhead transmission lines. The total length of transmission lines will be 330km.

4.4 EARLY SEAPORT FACILITIES

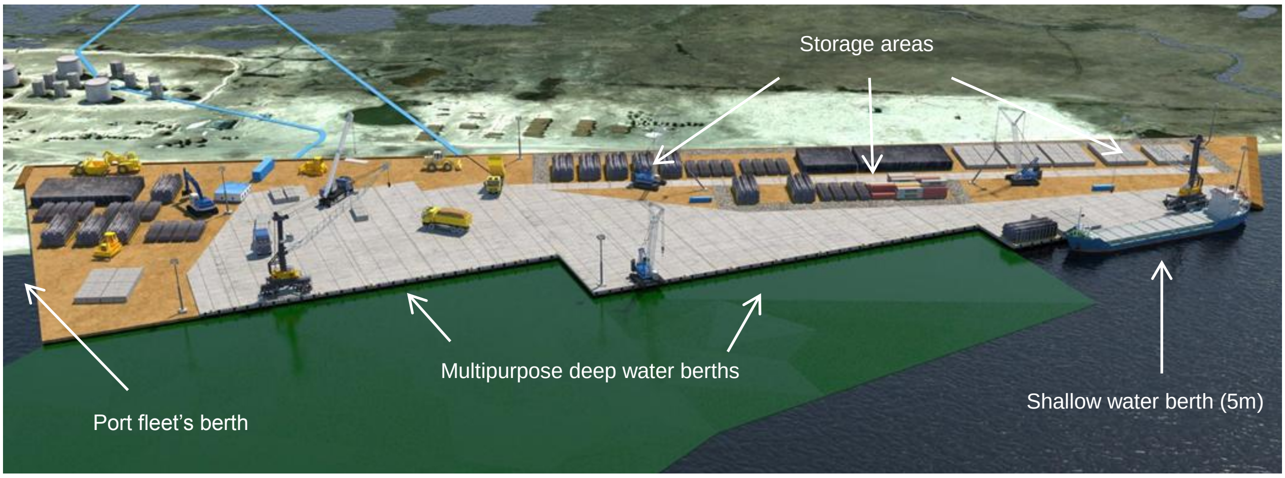
Due to the Project's remote location and absence of suitable year-round over land transport infrastructure, most of the construction materials and equipment will be delivered to site by sea. Yamal LNG will construct facilities to receive heavy equipment and other construction materials via a basic seaport (or Materials Offloading Facility (MOF). The MOF will be located adjacent and to the north of the main LNG site (see Figure 4.2) and include the following facilities and activities:

- Berth waters (turning/manoeuvring area) and approach channel that is 4km in length and 240m in width with a minimum water depth of 11.4 m that will necessitate some dredging.
- Navigation aids.
- Berth for river-sea vessels and specialized barges with oversized modules that will be reconstructed to receive vessels carrying oil products after delivery of all modules (a berth of 156 m length and 4.4 m water depth).
- Two multi-purpose deep water berths for offloading of oversized modules and construction materials. These berths will have water depths of 11m and 12.5m and lengths of 223m and 250m respectively.
- Berth for seaport vessels may be used for shipment of freights (112 m long berth with a 6.75 m water depth).
- Facilities for administrative, industrial and warehouse purposes (including site for washing the floating booms, administrative building, repair garage and storage facilities, utility lines and structures).

Sheet piles will be used to construct the quay wall. Early port facilities are currently under construction; with completion scheduled for December of 2014

An illustrative image of the proposed MOF is provided in Figure 4.7.

Figure 4.7 Materials Offloading Facility



4.5 MAIN SEAPORT FACILITIES

In addition to the MOF, separate seaport facilities will be required for the export of LNG and condensate during the Project's operations phase. The operations phase seaport will primarily serve Yamal LNG needs, who will be a port operator. However, some of the facilities, including dredging facilities, ice-barriers and navigation equipment, will be assigned as federal property under the supervision of the Federal State Unitary Enterprise Rosmorport (Rosmorport).

Main seaport facilities include the following:

- navigation channel in the northern part of the Gulf of Ob of 49 km length, 295 m width and approximate water depth of 14.2 m;
- berth waters (turning/ manoeuvring area) and approach channel of 5.6 km length and 495 m width with minimum water depth of 14.2 m, that will require dredging;
- two ice-barriers of 3,500 m total length;
- navigation aids;
- two berths with loading platforms for LNG and gas condensate offloading of 375 m length and 14.2 water depth;
- technological pipeline trestle for LNG and condensate offloading of 1300 m length, connecting onshore storage tanks to offloading berths;
- ice formation control system (IFCS) for reduction of ice thickness within berth waters;
- administration and auxiliary facilities.

At the present time, the design solutions for these facilities are being finalized. The seaport will be designed to accommodate ice breaking LNG carriers up to 300m in length with a draft of 11.7 m and the width of 50 m. Each LNG carrier is expected to be capable of transporting up to 170,000m^3 of LNG. In order to allow safe year-round operation, technology will be used to reduce the thickness of broken ice generated during berths waters freezing and passing of ice-breaking vessels. This will maintain ice thickness to natural levels.

Figures 4.6 and 4.7 show the sea port facilities and the route section of South-Eastern ice barrier with offloading berths and process trestle.

LNG will be loaded to the carriers via a LNG trestle, integrated with an ice barrier that will connect to two LNG loading berths. Figures 4.8, 4.9 and 4.10 show the sea port facilities and the route section of South-Eastern ice barrier with offloading berths and process trestle.

Figure 4.8 Integrated LNG Trestle Ice Barrier and berths

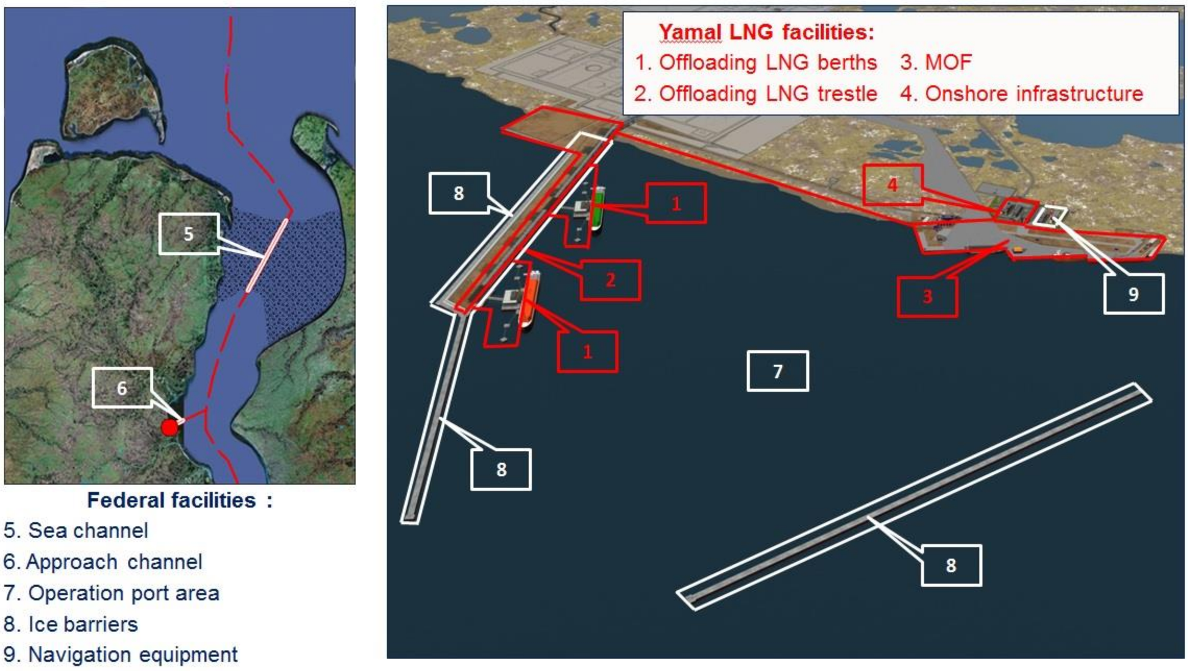
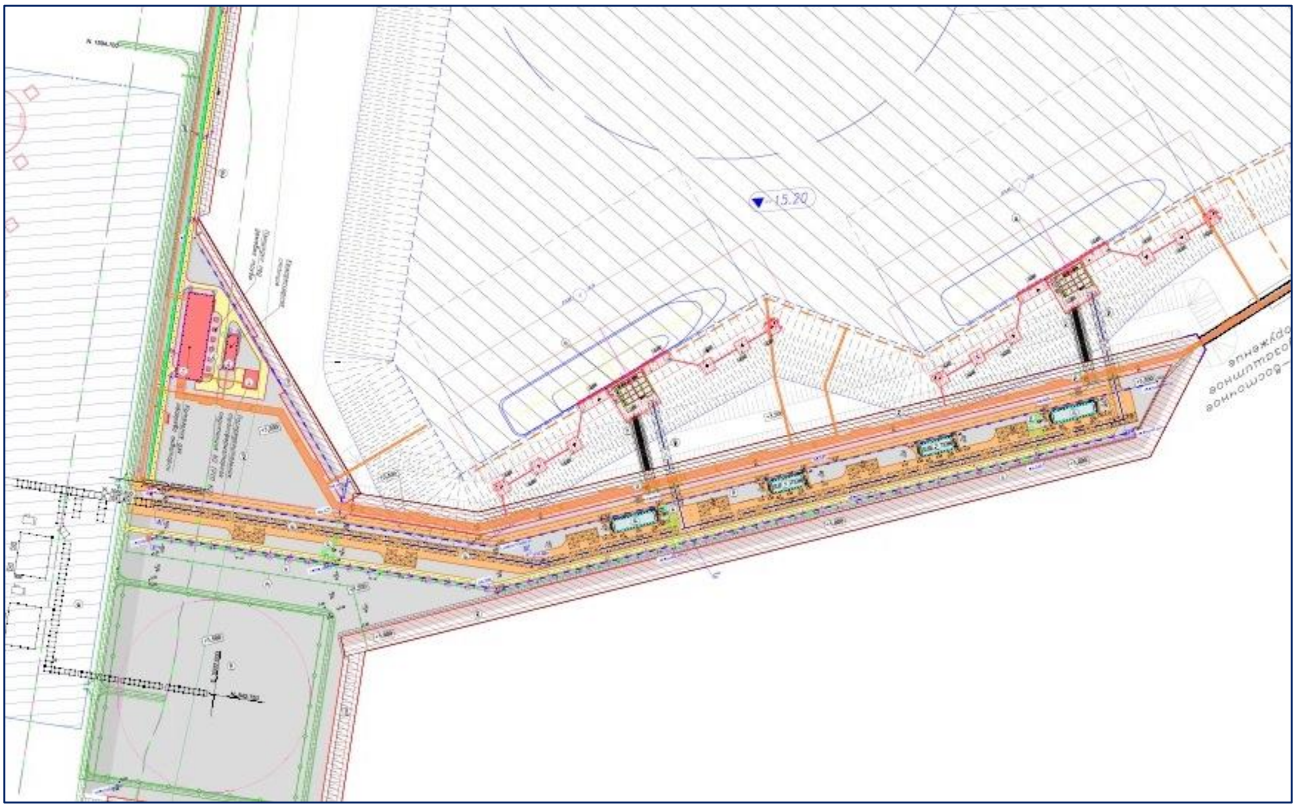


Figure 4.9 Onshore part of South-Eastern ice barrier with offloading berths and process trestle



The number of vessels receiving LNG and condensate cargoes will increase with the phased commissioning of the LNG trains reaching 215 loading operations/voyages following the commissioning of the third train in late 2019.

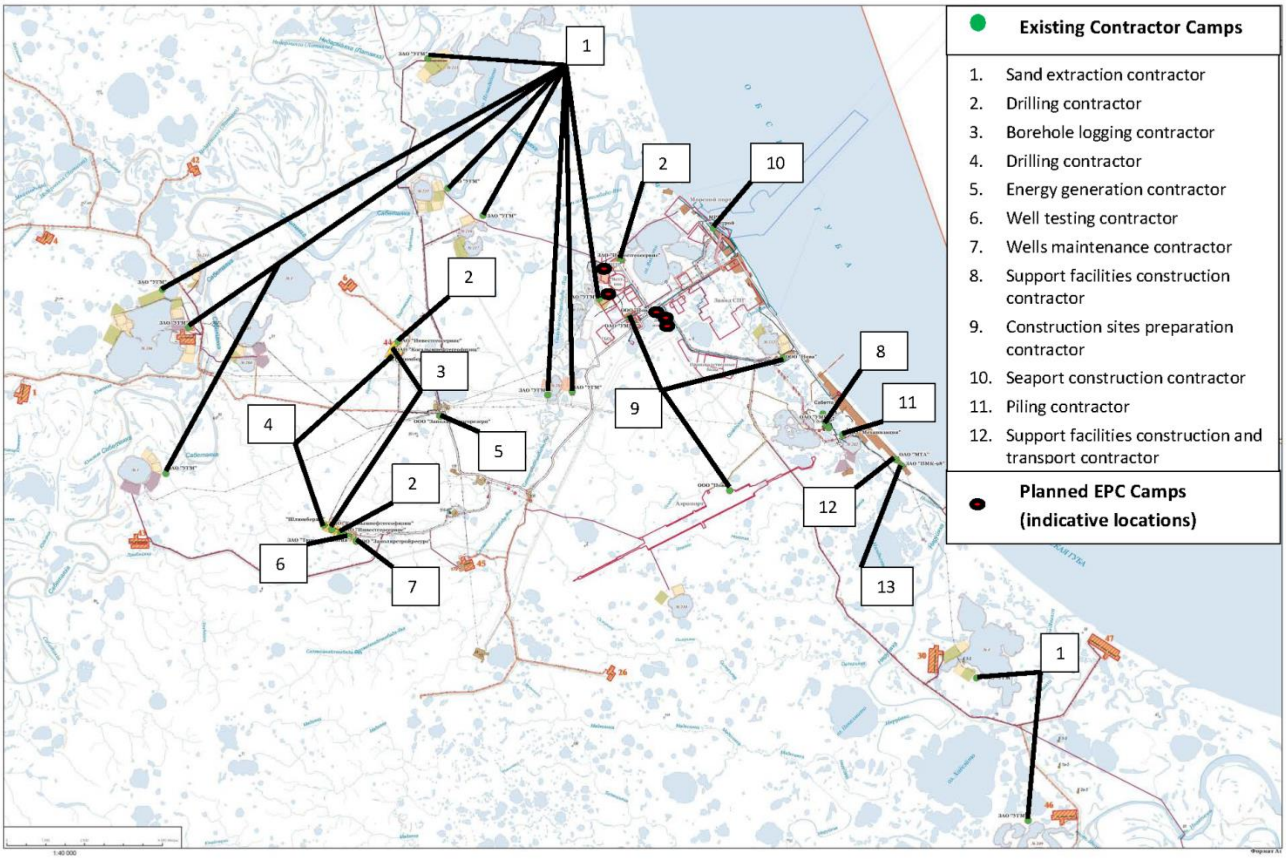
Because the operations phase seaport will be operated by Rosmorport, and is only part funded by Yamal LNG, it is considered to be an Associated Facility (see Chapter 4.9 Area of influence, associated and out-of-scope facilities). Construction of the main port facilities was commenced in Q2, 2014.

Figure 4.10 Construction of onshore part of South-Eastern ice barrier

4.6 WORKER ACCOMMODATION AND AUXILIARY FACILITIES COMPLEX

During the construction period the Project will require a large skilled workforce that is estimated to peak between 2015-2017 at approximately 14,000 personnel working in rotation, i.e. 7,000 construction workers present on site at any one time. The workers' accommodation will be located mainly at Sabetta (circa 5,200 personnel per rotation) approximately 6km south of the main LNG site (see Figure 4.2). In addition, smaller temporary satellite contractor accommodation camps (housing circa 1,800 personnel per rotation) will be located within the license area during the construction period that will be located to minimize travel distances between workers and their relevant work sites. The currently existing contractor camp sites are shown on Figure 4.11, which also shows indicative locations of future planned EPC camp sites.

Figure 4.11 Location of Temporary Construction Contractor Camps



Workers will be housed in dedicated workers' accommodation blocks that will either be newly built or renovated existing buildings. Existing structures that are not required for the Project will be dismantled and the areas will be reinstated.

Due to the remote location of the Project, all utilities and services required to support worker accommodation will have to be purpose built, including: boilers for heating, water supply and wastewater treatment, solid waste management, power supplies (gas powered), firefighting system, fire tenders and personnel, canteen and link roads with the main site and accommodation/welfare facilities. The accommodation areas will evolve in line with the phased construction approach.

Further accommodation will be constructed in close proximity to the LNG plant for operations personnel (see Figure 4.2). The operations phase field camp will be designed to accommodate 1,050 workers during each shift. Operations phase workers will work in rotation i.e. two shifts each of approximately 1,050 workers. The operations phase facilities will include:

- Dormitories
- Community centre
- Canteen
- Health and recreation module
- Warehouse for food and non-food products

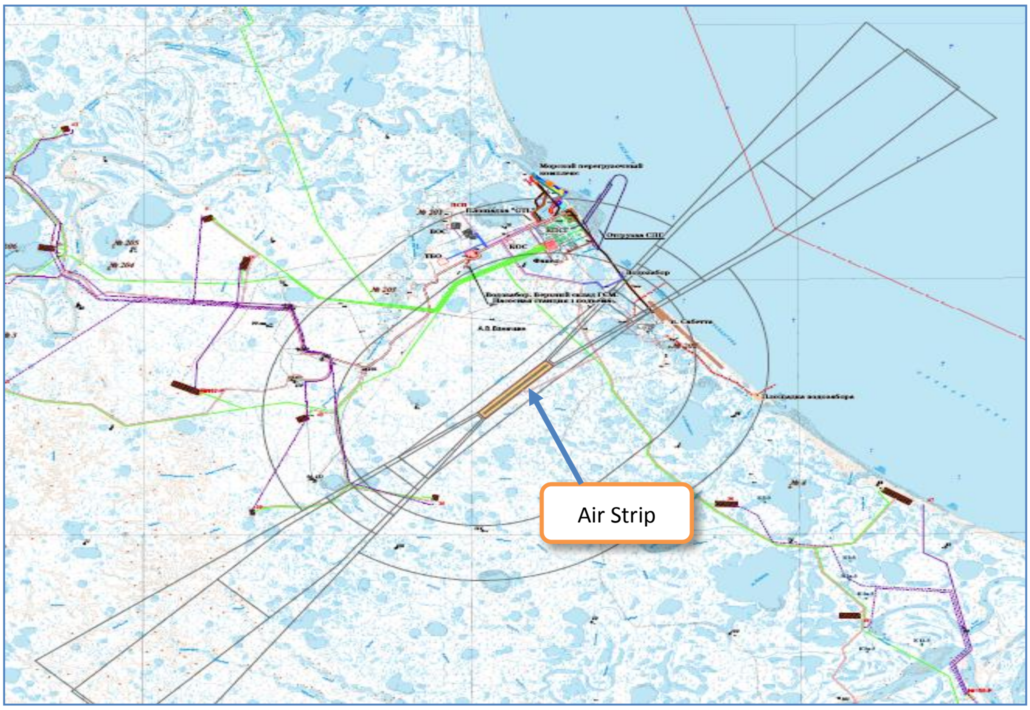
- Enclosed parking area
- Checkpoint
- Auxiliary buildings

Buildings will be constructed with piled foundations with ventilated crawl space below and thus elevated above ground level for permafrost protection, i.e. to prevent the thawing of permafrost. Piled foundations may also have vertical thermal stabilizers to further ensure soils are preserved in a frozen state.

4.7 AIRPORT

The proposed airport site is approximately 4km to the west of an existing unpaved air strip of the decommissioned airport located on the bank of the Gulf of Ob. The airport location is shown in Figure 4.12. Construction will be carried out on imported soil of suitable load bearing capacity that will raise the ground level at the airport by 1.6m relative to the pre-existing elevation.

Figure 4.12 Airport Runway and Obstacle Limitation Surface



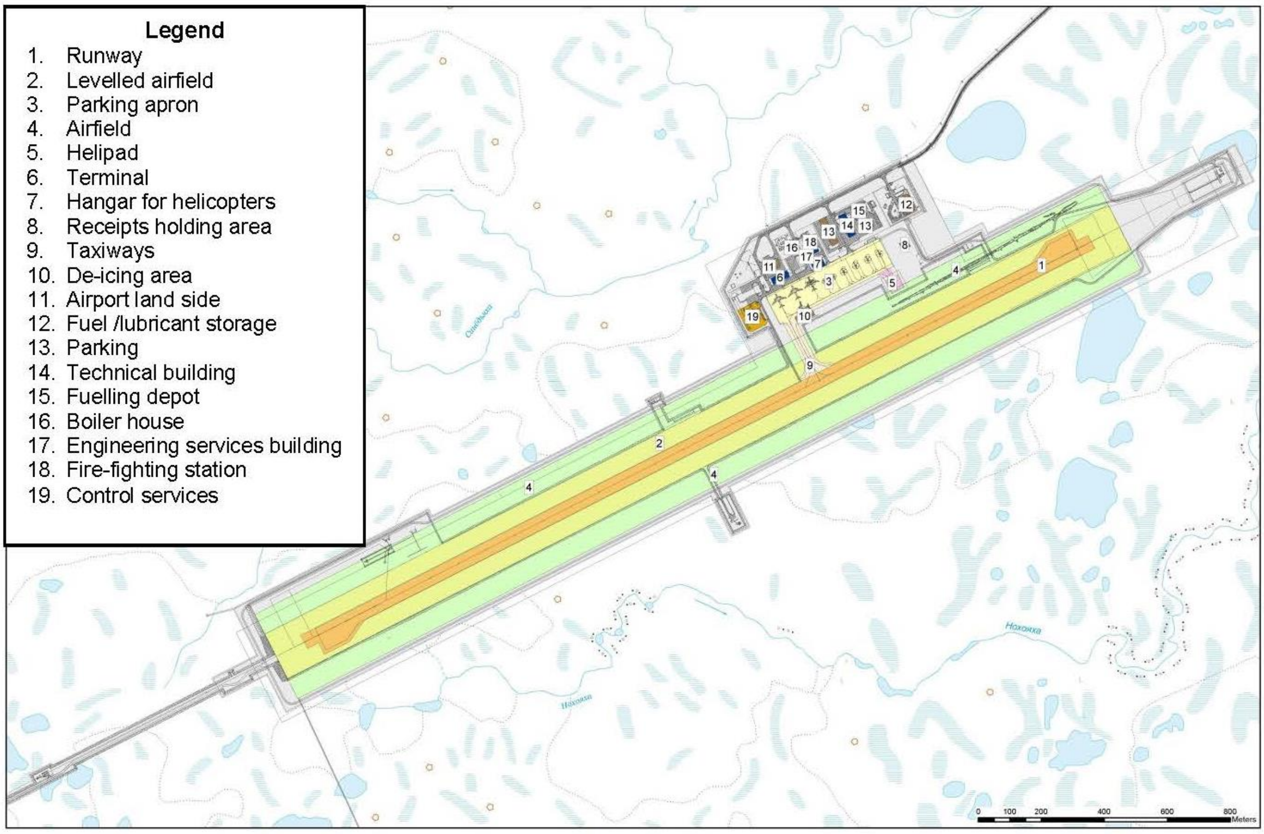
The airport will be designed and constructed with the following specifications:

- Runway length of 2,704m and a width of 46m with a shoulder reinforced to 10.5m on both sides.
- Helicopter pad of 42x40 meters size.
- A taxiway which connects the runway with an apron.
- An apron of sufficient size to accommodate three IL-76-TD/ Boeing 737 type aircraft with extra space for helicopters.
- An aircraft de-icing area.
- A cargo storage area.

- Obstacle limitation surfaces[4] in line with ICAO requirements (see Figure 4.8).
- A fire station.

A plan of the airport is proved in Figure 4.13 below.

Figure 4.13 Airport Plan Layout



The airfield pavement will comprise reinforced concrete pre-stressed slabs (PAG-18 type)[5] .

A sanitary sewer system will be provided, with outflow coming from buildings to storage tanks and further transportation to treatment facilities at Sabetta (see Section 4.8.3 below). During the operational stage storm water from the following areas will be directed for treatment on site prior to discharge: bunding around the fuel tanks in the fuel depot, filling station and boiler tanks.

Discharge from the de-icing area will be diverted through conduits equipped with block valves and directed to the collection reservoirs of the de-icing liquid. Collected waste de-icing fluid will be sent the wastewater treatment facility at Sabetta (see Section 4.8.3 below).

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[4] Obstacle limitation surfaces define the volumes of airspace around and above an airport that must remain free of obstacle for the protection of aircraft in normal flight

[5] GOST 25912.2-1991 reinforced concrete pre-stressed slabs PAG-18 for aerodrome pavement construction.

A number of methods are available for de-icing of the runway, taxiways, the apron and the helicopter pad. The preferred methods will be determined in accordance with applicable regulations and standards during certification and preparation for operation.

It is planned to deliver aviation fuel to the airport warehouse from the upper fuel depot, located 4km from the airport, by motor transport.

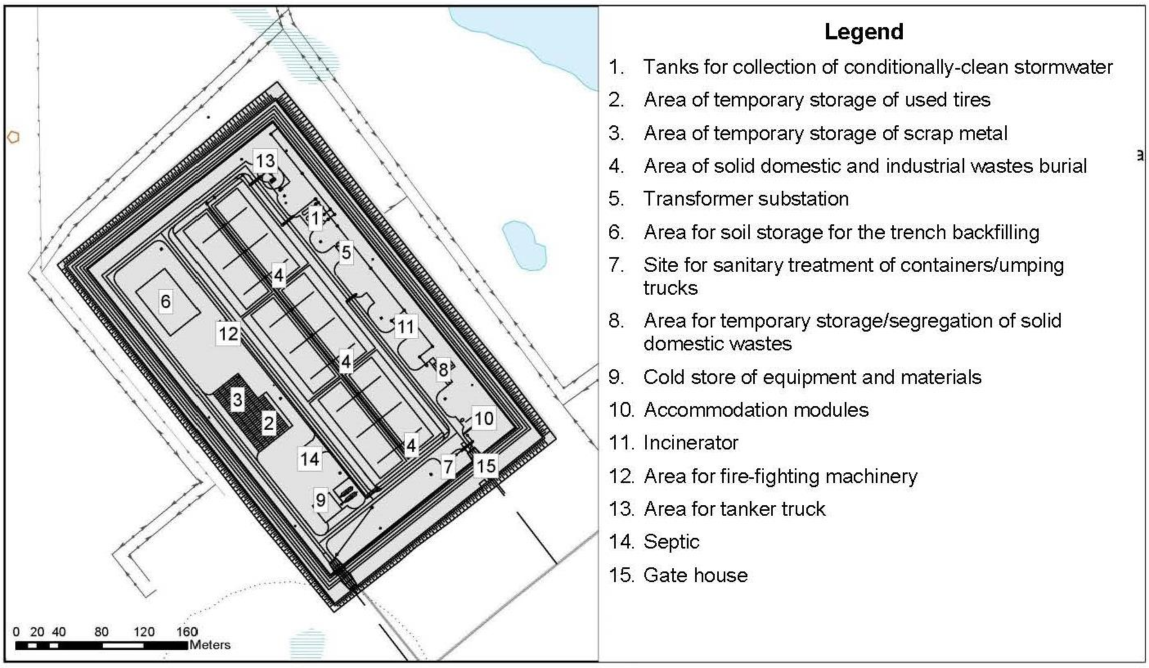
The first fixed-wing aircraft flights at the airport are planned to commence in Q4 2014. In the interim, personnel are required to travel to the site by helicopter.

4.8 OTHER PROJECT INFRASTRUCTURE

4.8.1 WASTE MANAGEMENT

The Project will have its own fenced waste management facility, known as the Solid Industrial and Domestic Waste (SIDW) facility. The SIDW facility includes a dedicated landfill complete with separate drums for disposal of solid domestic and category IV industrial waste, to be located west of the LNG complex (see Figure 4.2). A plan of the SIDW facility site is shown in Figure 4.14 below.

Figure 4.14 SIDW Facility Plan Layout



The landfill will be constructed and managed in line with good international industry practice in a manner that prevents contamination of the surrounding soils and water resources i.e. lined drums with leachate collection and treatment. Two wells will be installed to monitor groundwater conditions.

The waste management facility will also include three incinerator units (KTO-50 type) equipped with a system for incinerating the exhaust gas capable of incinerating combustible wastes. Most of the domestic waste will be incinerated.

Process wastewater will be treated in a water treatment plant prior to disposal by injected into suitable subsurface horizons using deep well injection technology, as this is considered to have the lowest potential environmental impacts. Domestic / sanitary wastewaters will be treated and discharged in the Gulf of Ob (see Section 4.8.3). The landfill will be commissioned in 2014. In the interim wastes will be transferred to licensed landfill sites located in Salekhard or temporarily stored until the landfill/deep well injection facilities have been constructed and are ready to receive Project wastes.

In addition to Project wastes, there are considerable volumes of legacy wastes from previous oil and gas exploration and production activities in the area. Yamal LNG has commissioned specialist waste contractors to collect this waste and transfer it to existing recycling facilities or licensed landfills located in the city of Surgut via the Ob River. Some early construction wastes will also be disposed under licence to these waste management facilities.

Waste management practices will be defined in the Project's Environmental and Social Management Plans.

4.8.2 WATER ABSTRACTION AND TREATMENT

Water intake at the initial stage of construction will be performed from an existing source in the Sabetta settlement (Glubokoye Lake). After this initial period, abstraction from the Glubokoye will cease and water will then be abstracted from an artificial pond ('Pit 202') near Sabetta. Satellite contractor camps will be supplied with water for potable, sanitary and technical needs from Pit 202. Water will be transported from Sabetta to construction sites by road tankers (which will be heated in winter). Для водоснабжения объектов п.Сабетта и ряда других объектов (Верхний склад, аэрпорт и др.) будет использоваться вода из озера без названия (бассейн Обской губы Карского моря), бывший гидронамывной карьер №202. Для водоснабжения временных городков EPC-подрядчиков будет использоваться вода из озер без названия (бывшие гидронамывные карьеры №201 и 212). Для производственного водоснабжения, в т.ч. для нужд бурения, будет использоваться вода из озера б/н, расположенного в п.Сабетта вблизи погранзаставы. To reduce technical water consumption it is planned to use closed loop systems for drilling mud.[6]

Alternative water supply sources at remote well site may include use of local artificial pits as necessary. водные объекты, расположенные вблизи кустов скважин.

In the future, to coincide with operations phase water demands (domestic water and production fire-fighting water demand), the construction of a unit for surface water intake from the Gulf of Ob is envisaged as a source of water supply for the Project that will comprise:

- water treatment and desalination facilities, including a 3,450 m³/day capacity water treatment plant;

[6] Group project for construction of production wells 3700 m deep for facilities VI (layers ТП 5 ÷ТП 12), VII (layers ТП 13 -ТП 14-15), VIII (layers ТП17 ÷ТП 19) in South-Tambey gas field". Design documentation. Section 6 "Construction management plan". 70/11/-YLNG-346-Э-ПОС.

- water supply pump station;
- a 4,400 m^3/hour capacity fire water pump station with fire water reserve tanks;
- separate water supply systems for domestic and drinking water, for plant and fire water, independent firewater supply system.

The water intake facilities will be equipped with a fish protecting device to prevent entrainment of fish and shellfish. A water treatment system, inclusive of filtration, coagulation processes and a desalination unit is also planned. Power for the desalination unit will be from the main power plant. Brine from the desalination unit will be comingled with treated sewage/domestic water prior to discharge to the Gulf of Ob (see also Section 4.8.3 below).

4.8.3 WASTEWATER TREATMENT PLANT

During the construction phase, effluents are being collected by a domestic household sewage system at the Sabetta settlement and are directed to a biological treatment unit with subsequent discharge of treated water. Treatment capacity will be expanded as construction proceeds. For Project facilities outside of Sabetta, domestic household effluents will be collected in sealed metal 0.5m^3 containers and transferred to the sewage treatment plant. В связи с вводом в эксплуатацию новых объектов и увеличением численности персонала, находящегося в п.Сабетта, предусмотрено строительство и ввод в эксплуатацию новых очистных сооружений хозяйственно-бытовых сточных вод (КОС-1000) с выпуском очищенных сточных вод в Обскую губу (для этапа строительства). На этапе строительства также предусматривается использование очистных сооружений подрядных организаций и временного городка.

During the operations phase, sanitary, process and potentially contaminated wastewaters will be collected at the project facilities via drainage systems prior to treatment at dedicated wastewater treatment facilities. A number of wastewater treatment facilities are to be developed for the operations phase at the following locations:

- The Sabetta accommodation site
- Near to the LNG site (see Figure 4.4 for location)
- MOF
- Airport
- Upper fuel store

Further details on the wastewater treatment facilities are provided in Chapter 9, and a brief summary of each of the above wastewater facilities is provided in turn below.

4.8.3.1 WASTEWATER TREATMENT FACILITIES AT SABETTA

Sewage and wastewater treatment facilities will be developed at Sabetta with a total capacity of 1,000 m^3/day for sanitary wastewater and process wastewater (this will comprising four lines with a capacity of 250 m3 each and will be delivered in the form of assembled block-structured modules). Sewage will be subject to complete biological treatment and treated waters will meet the Project Standards defined in Appendix 2. Treated and disinfected (by UV treatment) wastewater is to be discharged to the Gulf of Ob via a common outfall at a distance of 650 m from the shore. В п.Сабетта предусмотрено также строительство и ввод в эксплуатации установки очистки поверхностных и близких к ним по составу производственных сточных вод производительностью 150 м3/сут. Очищенные промливневые и хозяйственно-бытовые сточные воды будут смешиваться, потом сбрасываться в Обскую губу

4.8.3.2 WASTEWATER TREATMENT FACILITIES AT THE LNG SITE

A complex of wastewater treatment facilities will be developed near the LNG facility capable of accepting and treating all types of effluents from the LNG Plant and its infrastructure facilities. The treatment facility will comprise:

- four sanitary wastewater storage tanks with a capacity of 200 m^3 each;
- block-structured module with a capacity of 1600 m^3/day designated for sanitary wastewater treatment (a mechanised grate, a sand trap and a biological treatment block);
- three accumulator tanks with a capacity of 5,000 m^3 each for accumulation of process wastewater/stormwater;
- block-structured module with a capacity of 6,000 m^3/day designated for treatment of process wastewater and stormwater (settling, flocculation, flotation, filtration);
- three treated wastewater storage tanks with a capacity of 5,000 m^3 each;
- pump station.

The biological treatment block will consist of two treatment lines with a capacity of 800 m^3/day each. Each line will comprise a primary settling tank, a sectional aeration tank and a secondary settling tank. After treatment, wastewater will be sent to a fine treatment block (e.g. three pressure filters with carbon sorbent) and further to a UV-disinfection plant.

A process wastewater/stormwater treatment plant is designed to ensure compliance of these effluents to the standards set. This plant consists of a mechanical treatment unit, a pressure flotation unit, a fine treatment and after-treatment unit, a disinfection unit and a sludge dewatering unit. Treated sanitary, process wastewater and stormwater will be mixed and prepared for - injection to deep formation.

4.8.3.3 WASTEWATER TREATMENT FACILITIES AT THE MOF

Industrial wastewater from the main sea port facilities will be discharged via drains to a drainage pump station and further to an accumulator tank, and finally to treatment facility at the MOF fuel berth. Industrial waste water includes:

- waste water from washing of details unit at oil spill response complex building
- waste water from washing of booms (after oil spill response)
- bilge water from vessels and oil-carrier

The wastewater treatment facility at the MOF will comprise mechanical treatment (gravity thickening), electric coagulation, duplicative gravity thickening, filtration and ultraviolet disinfection.

Sanitary waste waters from the seaport will be collected are sent to the wastewater facilities for treatment and then will be discharged into Ob Bay

4.8.3.4 WASTEWATER TREATMENT FACILITIES AT THE AIRPORT

Wastewater from vehicle washing operations at the airport will be treated at a block-structured treatment plant with a capacity of 1.5 m^3/hour. The plant will consist of a settling tank with a thin-layer coalescing module, an oil sorption boom and a sorbent filter. This plant will also receive melt/stormwater from the potentially contaminated areas of the airport (including a bunded fuel storage site, a fuel-servicing station and a boiler-house). Treated wastewater will be reused for washing vehicles.

Sanitary and de-icing wastewaters from the airport will be collected and sent to the wastewater facilities at Sabetta for treatment.

4.8.3.5 WASTEWATER TREATMENT FACILITIES AT THE UPPER FUEL STORE

A treatment facility with a capacity of 200 m^3/day will be installed at the upper fuel store for the treatment of melt/stormwater from potential contaminated areas. The treatment facilities will be capable of treating effluents with oil and other impurities and treated water will be discharged в озеро б/н, расположенное вблизи Верхнего склада ГСМ.

Sanitary wastewaters from the upper fuel stoe will be collected and sent to the wastewater facilities at Sabetta for treatment.

4.8.4 OTHER UTILITIES INFRASTRUCTURE

Other infrastructure will include:

- **Roads.** Intra-field roads will be constructed within the licence area to provide access to Project facilities. Roads will be designed with a width of 4-6 meters. Roads within the main facilities will typically be constructed with concrete slabs, while interconnecting roads and roads for the well pads will be made of earth and gravel mixtures.
- **Transmission lines.** Electrical power will be distributed to the Project facilities in the Licence Area via a network of elevated transmission cables.
- **Transport, Fire Station and Fuel Storage depot**. Depots for fuel storage, transport services and a fire station will be constructed near to the LNG accommodation camp.

4.9 ASSOCIATED AND OUT-OF-SCOPE FACILITIES

4.9.1 ASSOCIATED FACILITIES

The Project will be dependent on a fleet of LNG carriers and condensate tankers[7] for the export of the LNG and condensate. Ice-breaking LNG carriers and condensate tankers will be specifically designed to operate in the thick ice conditions prevalent in the waters surrounding the Yamal Peninsula and proposed shipping routes. However, the vessels will not be financed as part of the Project nor will they be operated by Yamal LNG and are therefore considered to be Associated Facilities within Golf of Ob (or only between the seaport and the point at which the shipping route

[7] The Project will require 4 LNG carriers per train and a single condensate tanker.

intersects with the Northern Sea Route) as defined by the International Finance Corporation (IFC)[8]. During operations Yamal LNG will nonetheless require that the LNG carrier and condensate tanker owners strictly adhere to international maritime regulations.

In terms of the seaport, the Company will only fund and be responsible for the construction of certain land-based port infrastructure and the LNG trestle (see below for details). The main offshore activities, including dredging of the approach channel, turning areas and a 35 nautical mile navigational channel will be the responsibility of the federal authorities. During the operations phase the seaport will serve the Yamal LNG needs, although the seaport will also be available for use by other activities/enterprises. The facilities that are constructed by YLNG will be operated and maintained by Yamal LNG. At the same time there is a seaport captain hired by the Federal State Unitary Enterprise for Seaport Management “Rosmorport” and the crew which are responsible mostly for safety, navigation and logistics management in the seaport. The existing agreement between Yamal LNG, and the Federal State Unitary Enterprise “Rosmorport” stipulates that responsibility for the seaport be split between Yamal LNG and Rosmorport as follows:

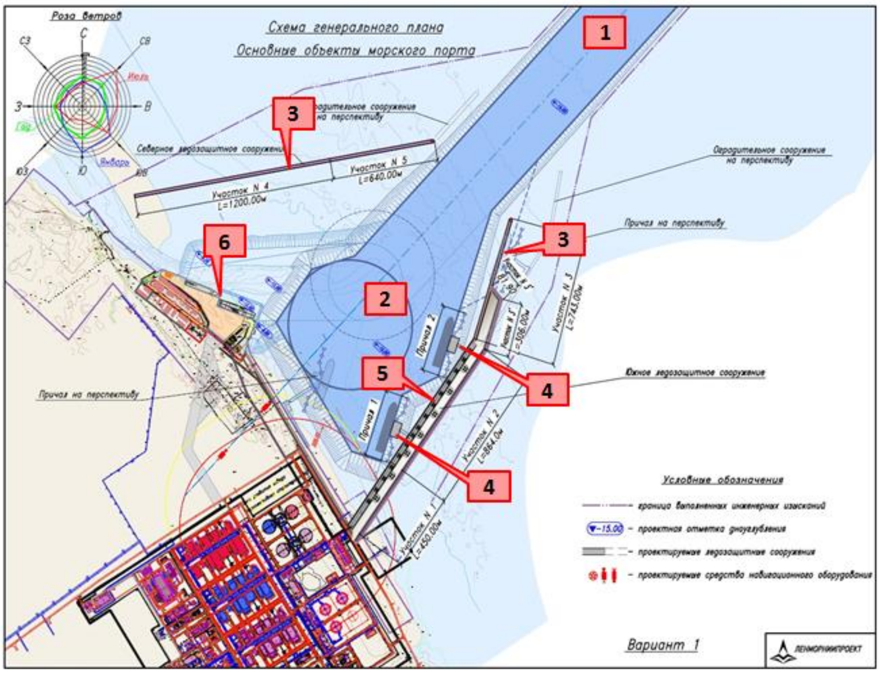
a) Yamal LNG provides design and construction of the following port infrastructure:
   - Berths for handling of LNG and gas condensate.
   - The LNG trestle for the transfer of condensate and LNG.
   - Berth for roll-on cargoes.
   - Fleet-port berth.
   - Storage area.
   - Administrative and general activity zone.
   - Utility networks and communication lines.

b) The federal authorities (during construction) and Rosmorport (during operations) are responsible for the following facilities:
   - Navigation and approach channels with operating waters, including capital dredging and mine clearance (mine clearance has already been completed in conjunction with the Russian Northern Fleet) for the MOF and main seaport.
   - Maintenance dredging if required.
   - Ice protection structures.
   - Vessels traffic control system and navigating aids.
   - Buildings for marine service divisions.

The marine facilities are shown in the Figure 4.15 and Figure 4.16 below (see also Section 4.5).

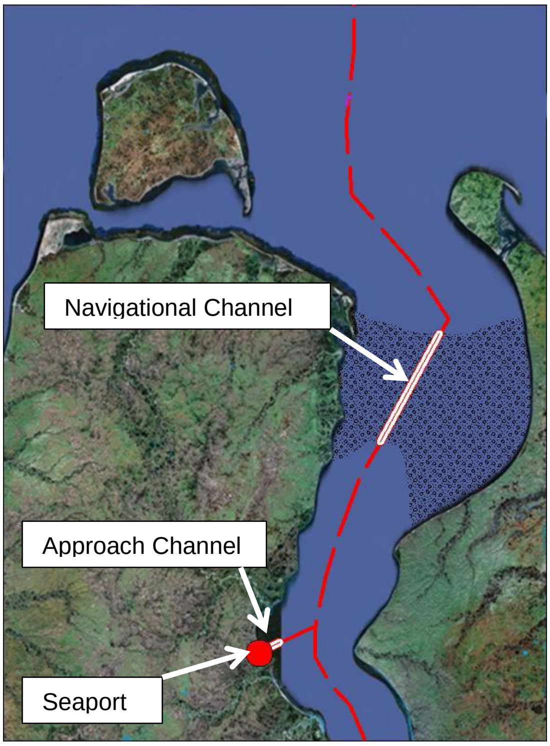
[8] In accordance with IFC Performance Standard, Associated Facilities are those activities and facilities that are not part of the financed project and would not be conducted, built or expanded if the Project was not carried out, and without which the Project would not be viable.

Figure 4.15 Port facilities, berth and harbour



Key
1. Approach channel;
2. Turning circle;
3. Ice protection area;
4. Offloading berths;
5. Offloading LNG trestle;
6. Modules offloading facilities

Figure 4.16 Approach and Navigation channels



Other Associated Facilities include those used for the supply of raw materials (e.g. borrow pits and quarries, including facilities developed solely for the Project needs and the existing facilities and structures where a significant proportion of their output will be utilised by the Project).

4.9.2 OUT-OF-SCOPE ACTIVITIES

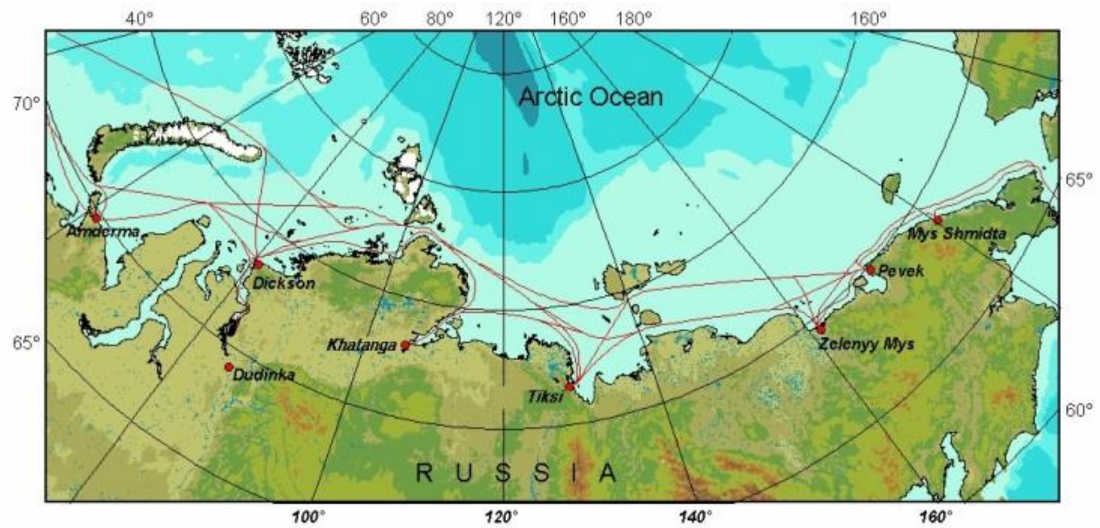
A description of activities that will not be addressed by the ESIA, typically because they fall outside of the Project's Area of Influence and YLNG's control, is provided below.

Due to their strengthened hulls, ice breaking vessels are typically much heavier than non-ice breaking LNG carriers and therefore uneconomical for use outside of ice conditions. It is therefore anticipated that LNG cargoes will be transferred to non-ice breaking vessels in northern Europe before continuing onward journeys to buyers. The location for these cargo transfers is currently unknown and likely to change periodically depending on market conditions. However, regardless of the actual location, the transfer of cargo will be the responsibility of the transshipment facility and both the transfer operations and the transshipment facilities themselves are considered to be outside of the scope of the ESIA.

The transfer of condensate from ice class tankers to non-ice class tankers is not envisaged. However, if it should become necessary at a later date, the transfer of condensate between vessels would similarly be considered outside of the scope of the ESIA.

The transport of LNG and condensate during the operational phase along existing shipping routes, including the Northern Sea Route (see Figure 4.17 below), is considered to be outside of the scope of this ESIA.

Figure 4.17 Northern Sea Route[9]



The operation of licensed landfill facilities currently receiving Project and non-Project related legacy waste is also considered to be outside of the scope of the ESIA.

[9] International Northern Sea Route Programme, http://www.fni.no/insrop

4.9.3 SUMMARY OF THE PROJECT, ASSOCIATED FACILITIES AND OUT OF SCOPE FACILITIES/ACTIVITIES

Project activities/facilities that form the Funded Project comprise the following shore-based facilities and activities within the Licence Area:

Table 4.9.1 Components of the Funded Project

Element	Components
Gas field development facilities	• Well pads, wells and associated facilities (see Section 4.3.1) • Gas gathering pipeline network (see Section 4.3.2)
LNG facilities	• Pre-processing treatment facilities (see Section 4.3.3) • LNG facilities, including: o LNG process trains (see Section 4.3.3) o LNG and Condensate storage and loading facilities (see Section 4.3.3) o Flare systems (see Section 4.3.4)
Power plant	• 380MW gas-fired power plant (see Section 4.3.5)
Supporting infrastructure	• Intra-field roads and bridges (see Section 4.8.4) • Electrical transmission lines (see Section 4.8.4)) • Water abstraction and treatment facilities (see Sections 4.8.2 and 4.8.3) • Fuel storage areas (see Section 4.8.4) • Waste management facilities (SIDW landfill and incinerators) (see Section 4.8.1) • Worker accommodation facilities (see Section 4.6)
Airport	• See Section 4.7 (note that this will be initially owned and operated by Yamal LNG branch, but ownership and operations may ultimately transfer to Regional Government or another Company)
Seaport	• Seaport facilities constructed and operated by Yamal LNG comprise (see also Section 4.5 and Figure 4.8): o Offloading LNG berth o Offloading LNG trestle o Onshore port facilities and infrastructure

Associated facilities and activities comprise:

Table 4.9.2 Associated Facilities

Element	Components
Seaport and navigation channels	• Seaport facilities constructed by the Federal authorities and operated by Rosmorport comprise (see also Section 4.5 and Figures 4.8 and 4.14): o Navigation channel (including dredging) o Approach channel (including dredging) o Operational seaport area (including dredging) o Ice barriers o Vessel traffic control systems and navigation aids o Buildings for marine service divisions
Project shipping	• Shipping (LNG carriers and condensate tanker movements) are considered as Associated Facilities (and therefore considered in this ESIA) only between the seaport and the

Table 4.9.2 Associated Facilities	
Element	**Components**
	point at which the shipping route intersects with the Northern Sea Route.

Out of scope activities and facilities that are not addressed in this ESIA are summarized below:

Table 4.9.3 Out of Scope Activities and Facilities	
Element	**Commentary**
Vessel construction	• All vessels will be built at existing yards and are therefore considered out-of scope
Project shipping	• LNG carriers, condensate tanker and ice-breaker movements outside of the Gulf of Ob (defined at the intersect with the Northern Sea Route) are considered out-of-scope • Transshipment facilities • Cargo receiving ports
Aircraft	• Aircraft movements outside of the landing and take-off cycle
Waste facilities	• Remote waste reception / recycling facilities (as these already exist and are not considered as Associated Facilities

4.10 AREA OF INFLUENCE

4.10.1 INTRODUCTION

The Area of Influence (AoI) will include areas both directly and indirectly affected by both the funded Project and Associated Facilities within and beyond the Project's Mining Allotment Area and License Area (these areas are shown on Figure 4.18 and cover approximately 974 km^2 and 2,047km^2 respectively).

Figure 4.18 Mining Allotment Area (Grey) and License Area (Red)

The direct and indirect AoI are discussed in turn below.

4.10.2 DIRECT IMPACTS

4.10.2.1 FUNDED PROJECT

The areas directly affected by the funded Project include those affected by the direct physical impacts from the well pads, gathering pipelines, connecting roads, main seaport (also see below in relation to the seaport as an associated facility), main LNG facilities, workers' accommodation camp, airports and other auxiliary facilities such as the waste treatment facilities, which are all within the Project's Mining Allotment Area. Small sections of the Mining Allotment Area will also be used to source construction materials, both from dry quarries and via the dredging of sandy material from lake beds.

Direct impacts from the construction and operation of the funded Project may extend beyond the Project's battery limits (fence line of the Project facilities), for example in relation to noise, light and air pollution emissions. The assessment of the spatial extent of such impacts is considered in Chapter 9 and, based on these assessments, are generally not considered to extend beyond the Mining Allotment Area. The main potential exception to this is noise impact from aircraft during approach and landing to the airport. Significant noise disturbance impacts from approaching/departing aircraft are considered to be within the Licence Area.

4.10.2.2 ASSOCIATED FACILITIES

Associated Facilities are defined in Section 4.9. The AoI of the direct impacts related to the different Associated Facilities are as follows:

- Seaport:
    - Physical footprint of the seaport facilities (see Sections 4.4 and 4.5)
    - Noise and sedimentation impacts zones around construction and dredging zones (seaport area, approach channel, navigation channel and dredge disposal sites – see Section 4.5 and Figures 4.19, 4.20 and 4.21 and respectively). The physical extent of these zones is assessed in Chapter 9, and significant impacts will take place according to the assessments within a range of 10 km from the dredging areas and dredge disposal site.
    - Permanent exclusion zones around the seaport area (construction and operation) and temporary exclusion zones around offshore construction equipment (primarily associated with dredging)

Figure 4.19: Location of spoil disposal area for seaport dredging

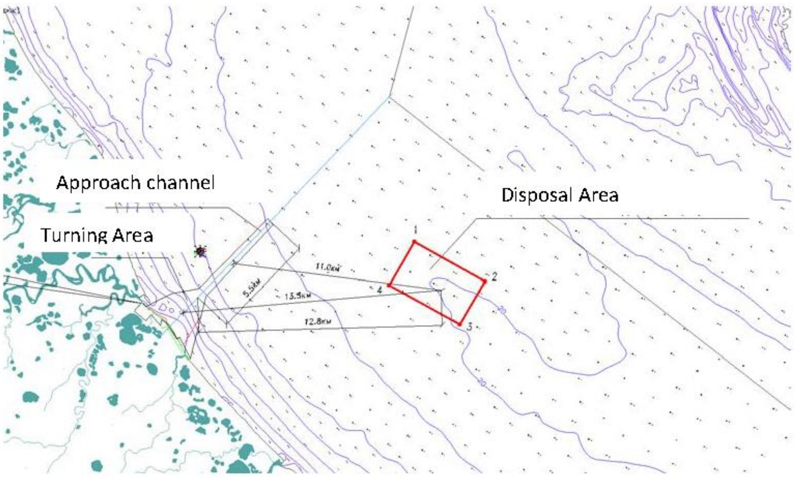


Figure 4.20 Sea route within the Gulf of Ob

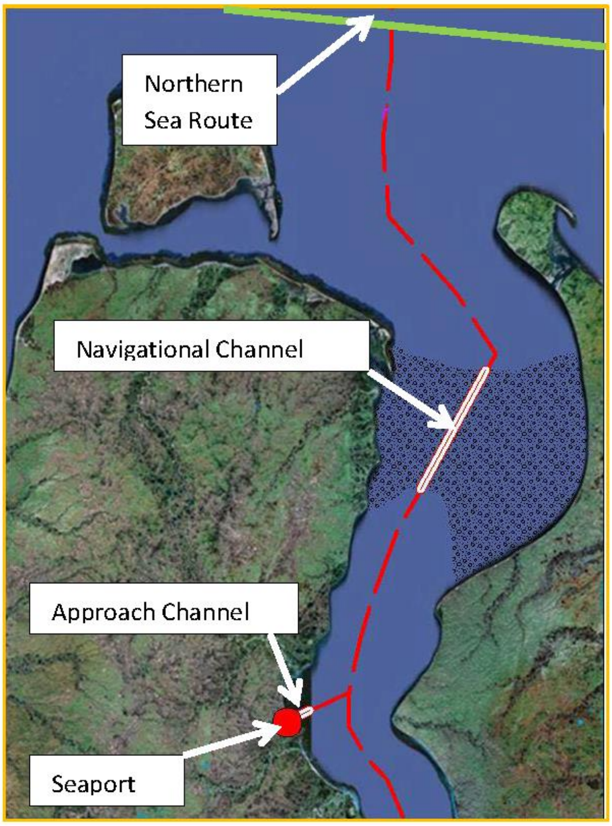
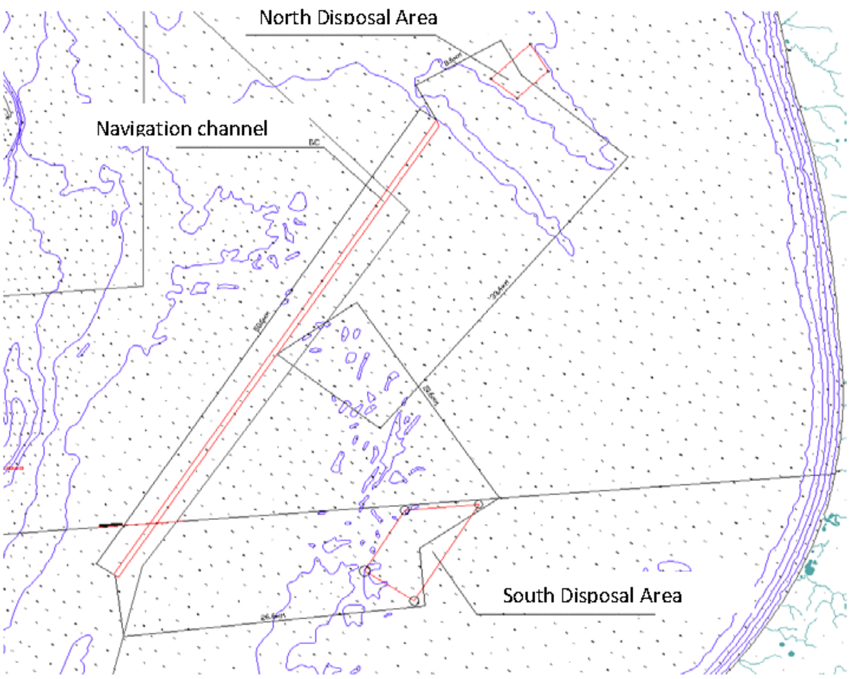


Figure 4.21: Location of spoil disposal areas for navigation channel dredging



- Shipping (from Sabetta to the junction with the Northern Sea Route – see Figure 4.20)
    - Shipping, including ice-class LNG carriers Ice-breaking by ice-class LNG carriers is assessed in Chapter 9 as the primary source of potential impact in terms of physical break-up of ice (localized to the shipping route) and noise (underwater/ice noise impacts primarily associated with certain cetaceans and potentially extending over several tens of kilometers as described in Chapter 9, although the potential impacts in the Gulf of Ob itself are reduced by it being a fast ice zone with low probability of marine mammal presence during the ice period).

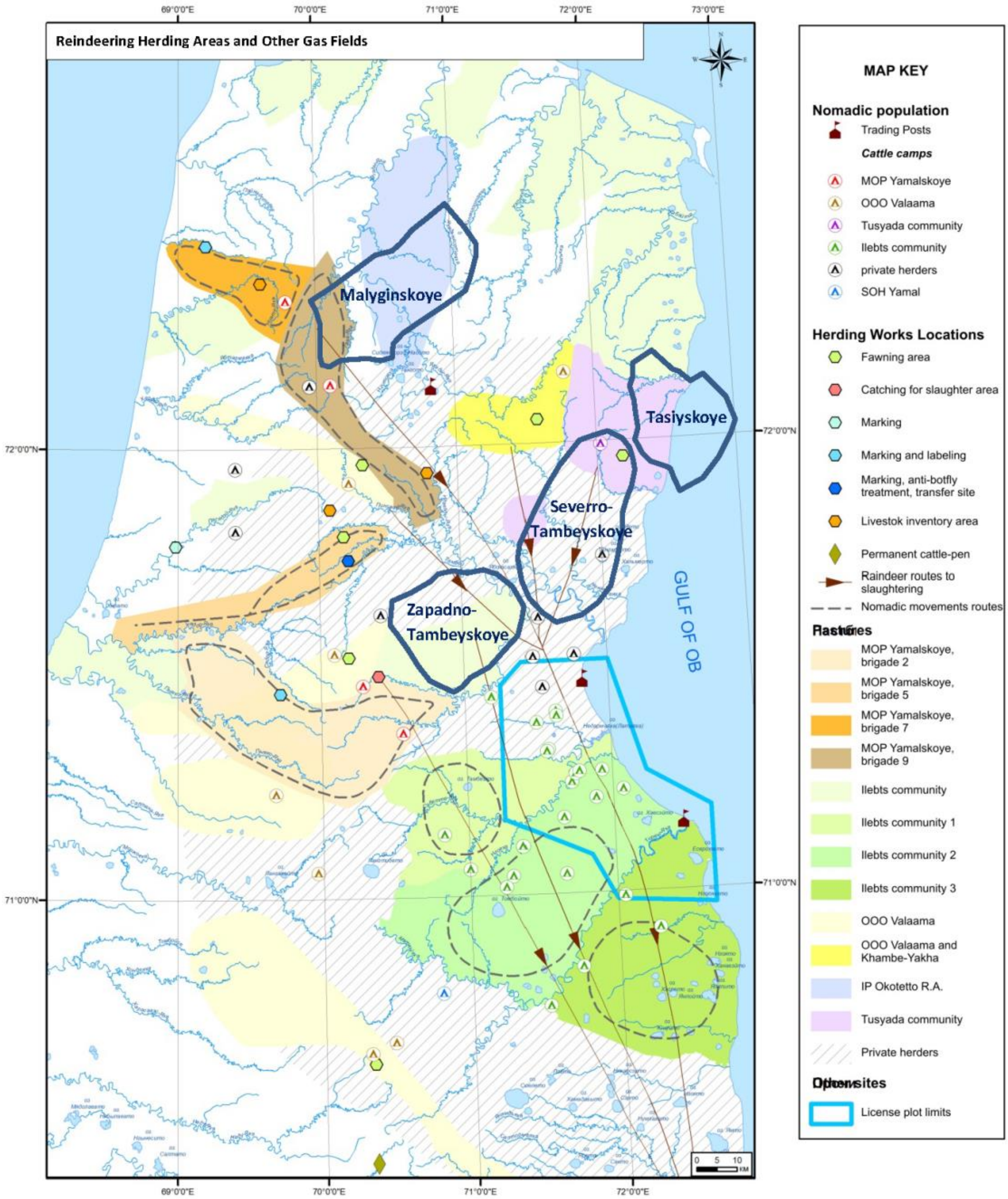
4.10.2.3 SOCIAL IMPACTS

In terms of human receptors, the following accommodation camps and settlements are included in the direct area of influence:

- Within the Project licence area:
    - Sabetta worker accommodation camp for shift-based personnel, located circa 6 km to the south of the main LNG site (the camp is the Project facility and will be used both during the construction and operational phases);
    - Project's accommodation facility (camp) for the LNG operations personnel, to be situated in close proximity and westward of the main LNG site, about 1200m from the boundary of the LNG site;
    - A number of temporary mobile camps set up by some of the construction contractors accommodating up to 1,800 workers in total; and
    - Tambey village/factoria, located at 30-km distance to the north of the main LNG site facilities.
- Outside the Project licence area:
    - Village Seyakha, some 90 km to the south of the licence area boundary and 120km from the main LNG site. The impact receptors are mainly nomadic reindeer herders that use the licence area periodically as part of their traditional migrations and who are either formally registered in Seyakha for their domicile.

The inter-settlement territories, i.e. the areas of open tundra surrounding the abovementioned settlements outside their formal boundaries, are also considered to be part of the Project direct Area of Influence. This is primarily due to these territories being actively used by the indigenous nomadic population on their traditional routes of seasonal migration/transhumance. The migratory reindeer herder routes also traverse the Yamal LNG licence area (see Figure 4.22 below).

Figure 4.22: Nomadic reindeer herders and their migration routes in and close to the Licence Area



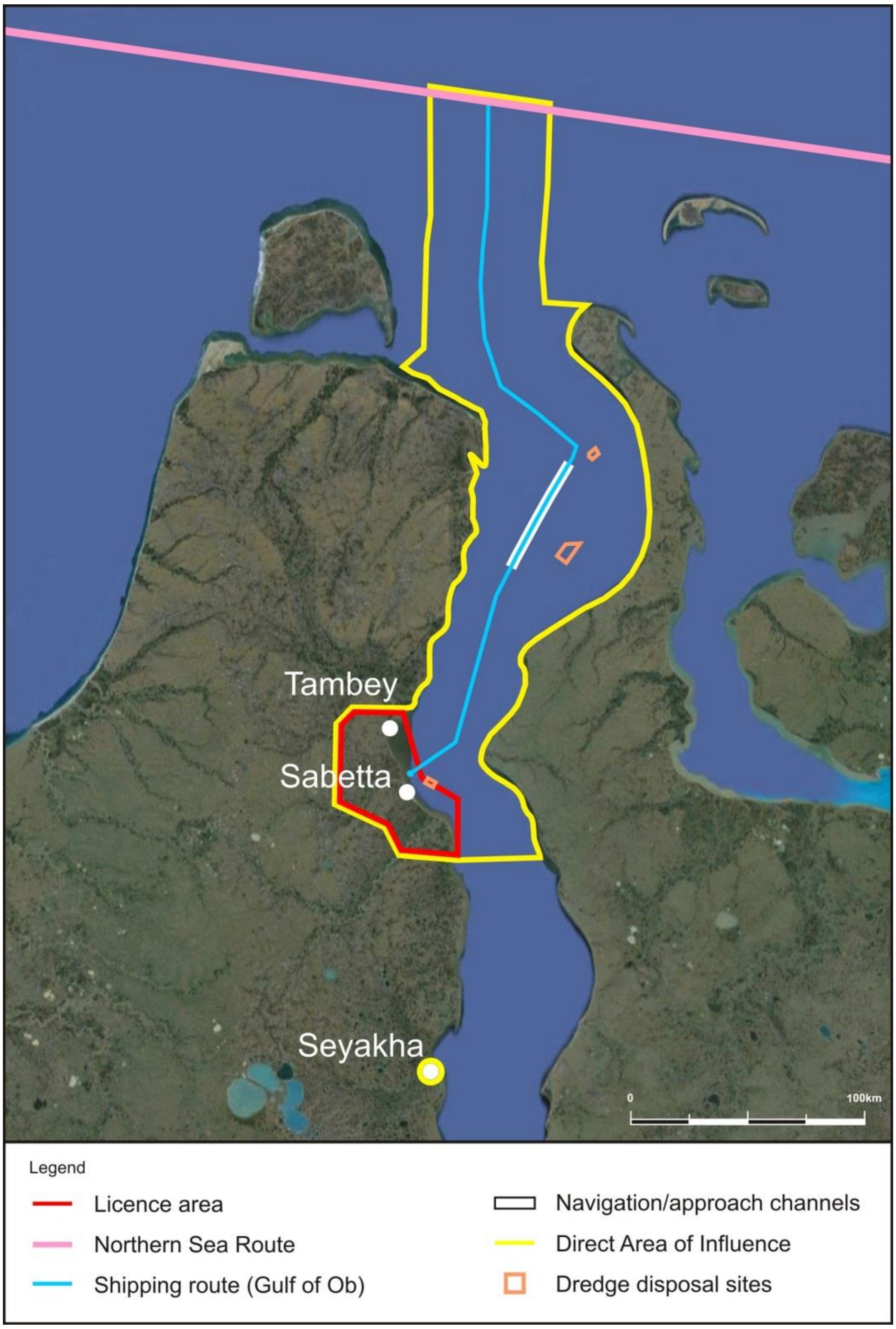
4.10.2.4 SUMMARY

Based on the above considerations the AoI for the direct impacts considered within the ESIA is as follows and is also shown in Figure 4.23.

- The Project License Area

- The waters of the Gulf of Ob from a point 10km south of Sabetta seaport northward to its mouth.
- The shipping route from the mouth of the Gulf of Ob to the intersect with the Northern Sea Route (depending on the ice conditions, the route can be varied within a strip approximately 50 km wide).
- Seyakha village.

Figure 4.23 Direct Area of Influence



It should be noted that:

- Different impact types will affect different portions of the AoI
- The AoI has been conservatively determined and therefore:
    - Not all portions of the assume AoI will be subject significant impacts
    - The majority of the AoI (and indeed the Licence Area and the Mining Allotment Area) will remain available to its current users.

4.10.3 INDIRECT IMPACTS

In addition to direct impacts, the Project will also have indirect impacts beyond the direct AoI, including:

- Neighbouring areas (and their existing users) subject to increased reindeer grazing pressure in the event that any reindeer are displaced from the direct AoI (Licence Area) - see also Figure 4.22.
- Potential impacts (including positive effects) on region-wide social support structures (including health and education facilities).
- Socio-economic benefits to nearby communities and settlements within the Yamalsky District (including beneficiaries of Yamal LNG-funded social development programmes), affecting, among others, YarSale and Salekhard (see Figure 4.24 for the location of these settlements),

Yar-Sale village, which is the administrative centre of Yamalsky District, is excluded from the Project's directArea of Influence due to the considerable distance between this settlement and the Project Site – some 460 km to the south of the licence area boundary. Potential impacts on the Yar-Sale community are therefore examined from the perspective of indirect influence by the Project (e.g. employment and business opportunities, effects on regional infrastructure etc.).

Tazovsky District which is situated on the eastern side of the Gulf of Ob and that does not have the contiguous overland border with Yamalsky District (i.e. neighbouring the latter across the Gulf of Ob water area) also falls within the Project's indirect Area of Influence. This is mainly due to the potential impacts on users of the water of the Gulf of Ob from offshore works (primarily Associated Facilities).

Figure 4.24: Location of regional communities

4.10.4 CUMULATIVE IMPACTS

Cumulative impacts may occur over wider areas than the direct AoI where Valued Ecological Components (VECs) are identified that may be affected by both the Project within the Project's direct AoI and also by other developments outside of the Project direct AoI. These impacts, and there potential extent, are described and assessed in more detail in Chapter 13, although in general terms, cumulative impacts have been considered within the Yamal peninsula and the Gulf of Ob.

4.11 MITIGATION IN DESIGN

Yamal LNG has designed the Project with in accordance with Good International Industry Practice (GIIP) using modern technologies. By taking this approach environmental and socio-economic impacts will be minimised. Some key elements of mitigation in design are summarised below.

Design element	Environmental/social benefit/mitigation
Well pads	
Application of horizontal directional drilling	Reduction of footprint through drilling of multiple

Design element	Environmental/social benefit/mitigation
	wells from a relatively small number of well pads
Gathering pipelines	
Above ground installation of pipelines on supports	Avoid warming impacts on permafrost from warm gas
Power plant	
DLN technology	Minimise NO_X emissions
Waste heat recovery	Improved energy efficiency resulting in lower emissions and fuel use
LNG facility design	
Air cooled LNG process	Minimise water usage and avoids discharge of cooling water
Gas turbines with DLN technology	Minimise NO_X emissions
Recovery of BOG and use as fuel gas	Improved resource usage and reduced emissions
Floating roof design for condensate storage tanks	Reduced VOC/GHG emissions
Minimisation of flaring	Reduced atmospheric and noise emissions
Vapour recovery on condensate loading	Reduced VOC/GHG emissions
Full containment of storage tanks	Prevention of contamination in event of ruptures/spillages
Accommodation	
Dedicated closed, dry (alcohol-free) accommodation camps	Minimises potential impacts to social communities
Fly-in/fly-out workforce	Minimises impact outside of licence area
Waste facilities	
Provision of dedicated waste management facilities	Reduces waste transport impacts and minimises pressures on existing third party waste facilities

Design element	**Environmental/social benefit/mitigation**
General construction techniques	
Structures built on piled foundations	Protection of permafrost against warming affects
Piling undertaken using auger piling techniques	Reduced noise impacts

These measures are discussed more fully elsewhere in the ESIA in the analysis of alternatives (Chapter 6) and impact assessments (Chapters 9 and 10).

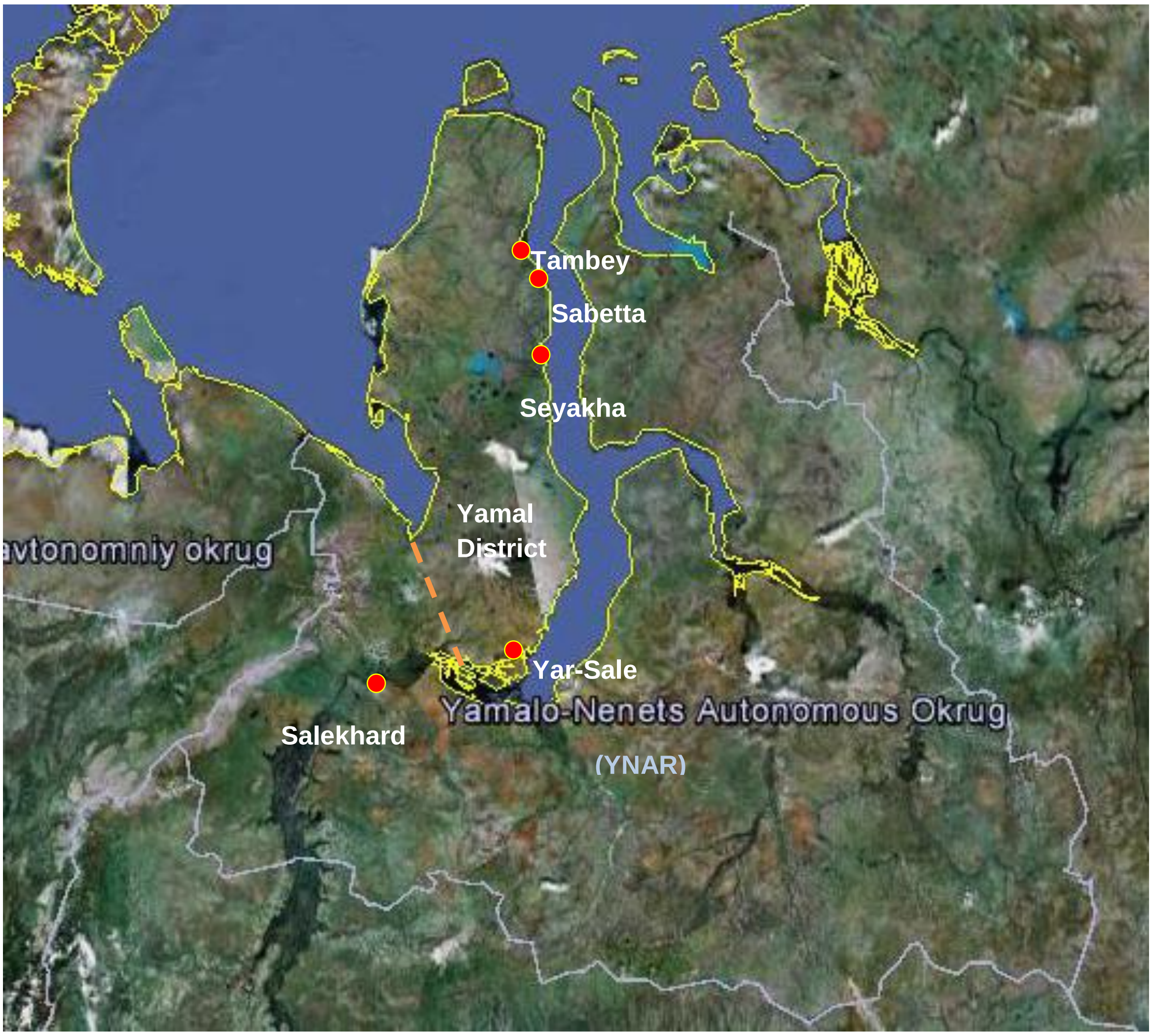
5 STAKEHOLDER ENGAGEMENT

5.1 INTRODUCTION

This chapter includes a presentation of stakeholder consultations (i.e. disclosure and consultation activities) carried out for the Yamal LNG Project as part of the overall ESIA process. The ESIA consultation activities are being conducted in accordance with a Stakeholder Engagement Plan (SEP) that has been prepared at the beginning of the International ESIA process and that is a standalone document.

The Project is located in the north-eastern section of the Yamal Peninsula and the nearest settlements to the Project are Tambey Factoria and Seyakha village (see Figure 5.1).

Figure 5.1: Map of the Yamal-Nenets Autonomous Region – Populated Areas



Engagement with stakeholders is of key importance in ensuring that potential adverse impacts are identified and managed, and that benefits to the community stemming from the Project are enhanced. Initiating the engagement process at the early stage of the Project, together with the adoption of appropriate communication mechanisms, helps to ensure:

a) the timely public access to all relevant information; and

b) that stakeholders are provided with an opportunity to input into the Project design, the identification and assessment of impacts and measures for impact mitigation and enhancement (in the case of beneficial effects).

The SEP remains a live document, and will be updated regularly in order to incorporate stakeholders' opinions throughout the Project duration.

The consultation chapter covers the following key sections:

- Identification of the key stakeholders including any disadvantaged or vulnerable groups (Section 5.2);
- Consultation and stakeholder engagement activities undertaken to date (Section 5.3);
- Current and future engagement activities (Section 5.4);
- Free, Prior and Informed Consent (FPIC) Process (Section 5.5)
- Resourcing and responsibilities to ensure effective implementation of the SEP (Section 5.6);
- Public grievance procedure (Section 5.7);
- Monitoring, reporting and staff training (Section 5.8).

A brief summary of each of the above sections is provided below.

5.2 IDENTIFICATION OF KEY STAKEHOLDERS

The first stage of ESIA consultation is to identify the key stakeholders that have been or will be affected by the Project. For the purposes of effective and tailored engagement, the Project stakeholders have been categorised into the following key groups:

- Affected Parties – persons, groups and other entities within the Project Area of Influence (see Chapter 5) that are directly affected (actually or potentially) by the Project and/or have been identified as most susceptible to change associated with the Project. Affected parties should be closely engaged in the identification of impacts and their significance, as well as in decision-making process on mitigation and management measures;
- Other Interested Parties – individuals/groups/entities that may not experience direct impacts from the Project but who consider or perceive their interests as being affected by the Project and/or who could influence the Project and the process of its implementation in some way; and

- Disadvantaged or Vulnerable Parties – persons who may be disproportionately impacted or further disadvantaged by the Project relative to other groups due to their vulnerable status[1], and for whom special engagement efforts may be required to ensure their equal representation in the consultation and decision-making process associated with the Project.

A comprehensive list of stakeholders at the local, regional, Federal and international levels has been identified in the SEP.

5.3 CONSULTATION ACTIVITIES UNDERTAKEN TO DATE

Yamal LNG has facilitated communication of its on-going and forthcoming activities both internally within the Company and to its external stakeholders. Yamal LNG's internal communications are to disclose information on the Project's activities to Yamal LNG and Contractors' personnel and staff.

The Company's external engagement is intended to build an effective relationship with key external stakeholders (including affected communities), and is further described below.

5.3.1 EXTERNAL ENGAGEMENT

The Yamal LNG external engagement process includes the following key consultation activities:

- Public hearings on planned project activities;
- Regional engagement (Okrug-level);
- Local engagement;
- The Engagement and Support Programme for Yamalsky District Indigenous Population;
- Compensation agreements.
- Foundation for the development of Yamal rural territories.

These activities are further described in turn below.

5.3.1.1 PUBLIC HEARINGS

Consultation in the form of statutory public hearings has been used as the primary method of involving the communities residing in the Project Area of Influence. The primary purpose of the public hearings has been: a) to maintain regular and frequent dialogue with the communities; b) keep them informed about the Project developments, planned activities and the associated potential impacts; and c) to ensure that the communities can provide input during the development of the Project mitigation measures.

The following consultation activities have been undertaken to date as part of the Yamal LNG Project development:

[1] Vulnerable status may stem from an individual's or group's race, colour, sex, language, religion, political or other opinion, national or social origin, property, birth, or other status. Other factors such as age, ethnicity, culture, literacy, sickness, physical or mental disability, poverty or economic disadvantage, and dependence on unique natural environment and natural resources should also be considered.

- A public hearing to support the release of the Declaration of Intent for the Yamal LNG Project "Production of liquefied natural gas from the South Tambey Gas Condensate Field in the Yamal Peninsula", held in Yar-Sale on 27 May 2010;
- A public hearing on the project design documentation for the construction of seaport facilities in Sabetta, including a shipping approach channel in the Obskaya estuary, held in Seyakha on 6 December 2011;
- A public hearing on the project design documentation for the worker camp facilities for the development of the South Tambey Gas Condensate Field, held in Seyakha on 19 December 2011;
- A public hearing on the OVOS for drilling of production wells (3,550m and 4,350m depth) at the South Tambey Gas Condensate Field, held in Seyakha on 20 March 2012;
- A public hearing on the project design documentation for the construction of the Facility for production, processing, gas liquefaction, and export of liquefied natural gas and gas condensate from the South Tambey Gas Condensate Field, held in Seyakha on 13 August 2012;
- A public hearing on the test dredging programme in the northern section of the Obskaya estuary, held in Seyakha on 13 August 2012;
- A public hearing on the test dredging programme in the northern section of the Obskaya estuary, held in Tazovsky settlement on 16 August 2012;
- A public hearing the project design documentation for the construction of early seaport and main seaport facilities in Sabetta, including a shipping approach channel in the Obskaya estuary, held in Seyakha on 11 December 2012;
- A public hearing the project design documentation for the construction of early seaport and main seaport facilities in Sabetta, including a shipping approach channel in the Obskaya estuary, held in Tazovsky settlement on 13 December 2012;
- A public hearing on the corrected project design documentation for the construction of early seaport and main seaport facilities in Sabetta, including a shipping approach channel in the Obskaya estuary, held in Seyakha on 19 November 2013;
- A public hearing on the corrected project design documentation for the construction of early seaport and main seaport facilities in Sabetta, including a shipping approach channel in the Obskaya estuary, held in Tazovsky on 21 November 2013;
- Public hearing on state ecological expertise for technical documentation for technology of use of drilling mud decontaminated in thermal desorption unit for construction soil, including its environmental impact assessment, held in Seyakha on 26.08.2014.

A summary of the key concerns and suggestions raised by participants during these consultations, as well as actions undertaken by the Company as a result of the issues raised are provided in the SEP. A summary of the issues raised is also summarised in Table 5.1 below for completeness.

Table 5.1: Summary of Key Concerns and Suggestions Raised during Project Public Hearings (May 2010 – August 2012)	
Nature and dates/ location of engagement	**Key concerns and suggestions raised**
Public hearing on Declaration of Intent for the Yamal LNG Project Yar-Sale settlement, District Centre for Culture and Arts, 27 May 2010	Land take and associated impacts on traditional land use, including on reindeer grazing areas. Potential impacts on subsistence fishing. Effects of linear infrastructure (pipelines, access roads) on traditional migration routes of local reindeer herders. Availability of reindeer crossings on the linear infrastructure facilities. Potential impacts of contractor activities on areas in traditional use by reindeer herders. Availability of job opportunities and professional training for the local indigenous population, particularly for the youth. Use of local construction materials. Code of conduct for Project personnel, including prohibition of the use of firearms and dogs. Environmental monitoring of the development. Bilateral Cooperation Agreement between the Project and local administration. Support and assistance to the local indigenous population (fuel and food supply, availability of flights to Seyakha settlement). Compensation schemes for affected population.
Public hearing on the OVOS for early seaport facilities in Sabetta village, including shipping approach channel in the Obskaya estuary Seyakha settlement, Village centre of culture 06 December 2011 (Note that this is an associated facility to the Project)	Availability of job opportunities and training for the local indigenous population, particularly for the youth. Preferential recruitment of local population. Regular reporting on the activities being undertaken. Rehabilitation of disturbed lands. Organisation of a fish hatchery for sturgeon and muksun in the Novy Port area. Observance of all environmental safeguards during construction and further implementation of works. Include within the scope of seaport works dredging of the local rivers to allow the receipt of dry cargo vessels, specifically at the request of local herders. Develop response measures in case of emergencies in the open sea area. Future prospects of gas supply to the local indigenous settlements.

Table 5.1: Summary of Key Concerns and Suggestions Raised during Project Public Hearings (May 2010 – August 2012)

Nature and dates/ location of engagement	Key concerns and suggestions raised
	Disposal of wastes. Compensation for damage to marine resources, particularly fish.
Public hearing on the OVOS for the worker camp at the South Tambey Gas Condensate Field Seyakha settlement Village centre of culture 19 December 2011	Cleaning of the Project area from wastes left as a result of activities by the previous subsoil resource user contractor. Rehabilitation of disturbed lands. Temporary access roads during construction and associated impact on agricultural lands. The use of existing winter roads and passages, as well as the responsibility for their maintenance. Maintenance and repair of the summer road/passage. Future prospects of gas supply to the local indigenous settlements. Availability of job opportunities and professional training for the local indigenous population, particularly for the youth. Preferential recruitment of local population. Regulation/restriction of alcohol sales in Sabetta village. Assistance to local indigenous population with fuel supply and diesel generator, as well as with transportation to remote areas of reindeer herding and availability of helicopters for local residents' needs (to facilitate access to medical and educational facilities). Reindeer crossings on the linear infrastructure facilities (transport routes and pipelines). Carrying out the environmental monitoring with participation of stakeholders. Compensation for any damages sustained. Housing programme for the indigenous population.
Public hearings on the OVOS for drilling of production wells (3,550m and 4,350m depth) at the South Tambey Gas Condensate Field Seyakha settlement Village centre of culture	Environmental and safety precautions during implementation of the project. Potential impacts on fish as a result of drilling. Taking into account interests of the local indigenous population, including gathering up-to-date information about sacred worship and burial sites. Compensation for any damages sustained. Opportunities for socio-economic development, including for herders.

Table 5.1: Summary of Key Concerns and Suggestions Raised during Project Public Hearings (May 2010 – August 2012)	
Nature and dates/ location of engagement	**Key concerns and suggestions raised**
20 March 2012	Reindeer crossings on the linear infrastructure facilities. Rehabilitation of disturbed lands after the completion of the works. Future prospects of gas supply to the local settlements. Refrain from using pits for drilling waste and using alternative solutions for disposal, e.g. capsulation of drilling waste.
Public hearing on the OVOS for construction of the Facility for production, processing, liquefaction, and export of liquefied natural gas and gas condensate from the South Tambey Gas Condensate Field Seyakha settlement, Village centre of culture 13 August 2012	Provision for mitigation measures to reduce environmental risks of the Project Land use: to take into account and avoid negative impact on reindeer crossings and migration areas Ways of compensation of impact on fish stock (penalties, juvenile fishes release, etc.) Ways of interaction with local indigenous population (compensations, development, education, etc.) Noise levels during spring-summer periods and proposed measures to avoid noise impacts on fawning, bird arrival, spawning season Plans for village development, youth education, labour opportunities.
A public hearing on the test dredging programme in the northern section of the Obskaya estuary Seyakha, village cultural centre 13 August 2012 *(NB: this public hearing included discussion of certain associated facilities of the Project)*	Potential risks and hazards associated with the operation of LNG Plant. Proposed compensation measures for damage to marine resources. Methods of engagement with indigenous communities. Plans for village development, youth education, labour opportunities.

Table 5.1: Summary of Key Concerns and Suggestions Raised during Project Public Hearings (May 2010 – August 2012)

Nature and dates/ location of engagement	Key concerns and suggestions raised
A public hearing on the test dredging programme in the northern section of the Obskaya estuary Tazovsky, settlement cultural centre 16 August 2012 (NB: this public hearing included discussion of certain associated facilities of the Project)	Job opportunities for the local population. Prevention of hydrocarbon spills. Environmental care. Support for the tundra indigenous population. Regulation/restriction of alcohol sales in Sabetta.
A public hearing the project design documentation for the construction of early seaport and main seaport facilities in Sabetta, including a shipping approach channel in the Obskaya estuary Seyakha, village cultural centre 11 December 2012 *(NB: this public hearing included discussion of certain associated facilities of the Project)*	Conservation of fisheries used by indigenous communities. Health of indigenous nomadic and semi-nomadic population. Strict compliance with environmental laws and regulations during the construction and operation phases. Ways of compensation of impact on fish stock.
A public hearing the project design documentation for the construction of early seaport and main seaport facilities in Sabetta, including a shipping approach channel in the Obskaya estuary Tazovsky, traditional culture centre	Ban on hunting and fishing for contractor personnel. Prevention of hydrocarbon spills into the Ob estuary. Performance of construction works strictly within the designated areas. Continuous monitoring of the state of marine resources with participation of local NGOs. Compliance with environmental laws and regulations.

Table 5.1: Summary of Key Concerns and Suggestions Raised during Project Public Hearings (May 2010 – August 2012)	
Nature and dates/ location of engagement	**Key concerns and suggestions raised**
13 December 2012 *(NB: this public hearing included discussion of certain associated facilities of the Project)*	Delivery of cargos for the construction of important social infrastructure. Construction of fuel stations for indigenous population. Job opportunities and medical services for the local communities. Education opportunities for young indigenous people and subsequent employment with the Company. Establishment of a fish hatchery for sturgeon and muksun in the district.
A public hearing on the corrected project design documentation for the construction of early seaport and main seaport facilities in Sabetta, including a shipping approach channel in the Obskaya estuary Seyakha, village cultural centre 19 November, 2013	Building relationship with IP, establishment of a special entity for communication with nomadic and half-nomadic communities Proposition to administration of Yamal'skiy district to disclose the results of the hearing to media Environmental protection and monitoring of environmental conditions Compensation to local fishery industry Construction of a fish farm Illegal fishing practiced by personnel associated with the Project Infrastructure development in Seyakha (road construction, housing development and so on)
A public hearing on the corrected project design documentation for the construction of early seaport and main seaport facilities in Sabetta, including a shipping approach channel in the Obskaya estuary Tazovsky, traditional culture centre 21 November 2013	Issue of increasing/decreasing of compensation payments *No propositions were made during the hearing*

Table 5.1: Summary of Key Concerns and Suggestions Raised during Project Public Hearings (May 2010 – August 2012)	
Nature and dates/ location of engagement	**Key concerns and suggestions raised**
Public hearing on state ecological expertise for technical documentation for technology of use of drilling mud decontaminated in thermal desorption unit for construction soil, including its environmental impact assessment, Seyakha, village cultural centre 26 August 2014	Drilling mud decontamination methods and technology Potential for organization of student construction brigades in 2015 Properties of drilling mud *No propositions were made during the hearing*

5.3.1.2 REGIONAL ENGAGEMENT

As part of Yamal LNG's regional (Okrug-level) engagement activities, a series of meetings were undertaken in October 2012 with the following regional stakeholders:

- YNAO regional authorities based in Salekhard
- head of the Yamalsky District municipal administration
- representatives of the NGO representing the indigenous peoples of the North
- head of the reindeer breeder commune "Ilbets"; and
- staff of the regional ethnographic museum.

All the meetings took place in the city of Salekhard. The main purpose of these meetings was to describe the nature of the Project and to inform the stakeholders of ESIA process (including development of the SEP). A summary of the regional engagement activities are provided in SEP.

5.3.1.3 LOCAL ENGAGEMENT

During 9-12 December 2012, a series of local-level meetings were conducted in the vicinity of the Project licence area. The meetings comprised discussions with representatives of the local nomadic population, indigenous communities and reindeer breeding enterprises as well as other stakeholders, i.e. the municipal authorities (Administration of the Yamalsky District, including the Administration for natural resource use regulation, Department for Labour and Social Security and the Employment Centre) and the local NGO (Yamalsky District public association of Indigenous Peoples of the North "Yamal").

Discussion topics during these meetings included Project information, key potential impacts, and local opportunities for collaboration and support. A summary of the local engagement activities are provided in SEP.

A number of meetings with indigenous peoples communities were conducted as part of ethnological field studies performed during the period from May through August 2013[2]. Meetings were carried out in the Yar-Sale and Seyakha settlements, as well as in the factorias of Tambey and Vanuy-Yakha. This included expert interviews with representatives of the local administration, heads of local communities and reindeer-breeding enterprises. A group of experts also visited some nomadis reindeer herder camps located at that time in the vicinity of the Tamboy-To Lake and upstream of the Sabetta River mouth (a nomad camp of the Ilebts Commune). With the help of a guide (one of the local elders) they held several in-depth interviews with the reindeer herders. The results of the studies were presented at a meeting in June 2013 with representatives of the local administration, reindeer-breeding enterprises and indigenous communities. Discussion topics included potential Project impacts on fauna and vegetation, changes of migration routes, installation of reindeer crossings, and potential decrease in amount of fish.

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[2] "Research of Traditional Nature Use and Ethno-Cultural Environment within the Area of Influence of the South Tambey Gas Condensate Field Development Project. South Tambey License Area", "Yamal LNG" JSC, Moscow-Sabetta-Petersburg 2013, prepared by FRECOM

5.3.1.4 ENGAGEMENT AND SUPPORT PROGRAMME FOR YAMALSKY DISTRICT INDIGENOUS POPULATION

In addition to the engagement activities carried out as part of the statutory public review process, the Company has launched the “Engagement and Support Programme for Indigenous Population of the Yamalsky District” in cooperation with the Municipal Administration of Yamalsky District and the Yamalsky District Public Association of Indigenous Small-Numbered Peoples of the North “Yamal”. The purpose of the Programme is to enable the Company to provide active contribution in supporting the local indigenous communities and in preservation of their history, culture, traditions and the way of life. The Programme is also aimed to improve living conditions and the quality of life of the local population through creating opportunities for development and the implementation of targeted social programmes.

5.3.1.5 COMPENSATION AGREEMENTS

The Company has established a compensation framework based on the agreements with the YNAO Regional Administration and the Yamalsky District Municipal Administration. Details of compensation agreements are described in SEP.

5.3.1.6 FOUNDATION FOR THE DEVELOPMENT OF YAMAL RURAL TERRITORIES

As part of its external engagement, the Company funding contributes to the activities by the non-governmental Foundation for Development of Yamal Rural Territories aimed at modernisation of the Seyakha rural settlement and the implementation of the programme for development of Seyakha settlement for 2011-2015. Further details are provided in the SEP.

5.4 CURRENT AND FUTURE ENGAGEMENT ACTIVITIES

This section describes a summary of the ESIA consultation activities and processes that will be implemented during the lifetime of the Project.

5.4.1 ENGAGEMENT AND DISCLOSURE METHODS

The Project will use various engagement and information disclosure methods according to international best practice (IFC Standards) to ensure that different stakeholder groups are fully consulted and involved in ESIA decision-making process. The Project will use the following key consultation methods:

- Public consultations and focus group discussions
- Household visits
- Focus groups discussions and round table workshops
- Site tours to Project assets

The main method of information disclosure and consultation to date has been public disclosure and public hearings on the OVOS documentation and the related environmental action plans as required by the statuary review process. The formal consultation process required by the RF regulations has been completed. However, in the event that significant changes in the Project design documentation at any time in the future, the Company will continue to apply similar approaches to disclosure of any additional ESIA/OVOS materials.

The Project disclosure process will include the dissemination of the following reports:

- Environmental and Social Scoping Report (Scoping Report) [3];
- International ESIA Package:
  - International ESIA Report;
  - Stakeholder Engagement Plan (SEP), and
  - ESIA Non-Technical Summary (NTS).

A summary of the stakeholder engagement and disclosure methods that have been used throughout the ESIA process, and will be used for further consultation and disclosure activities are provided in Table 5.2.

Table 5.2: Stakeholder Engagement and Disclosure Methods

Stakeholder Category	Project Information Disclosed	Means of communication/ disclosure
Local population engaged in traditional activities within the Project Licence Area, including: - nomadic indigenous population (both individual reindeer herding households and commune members), utilising the area for their traditional activities; - reindeer breeding enterprises whose migration routes traverse the Project Licence Area; - Population in Tambey Factoria; - Residents of the village of Seyakha.	• SEP (initial draft) and Scoping Report. • Draft ESIA package (ESIA, SEP (updated version), Non-Technical Summary of the ESIA (NTS).; • Public Grievance Procedure[4]; • Provision of regular updates on Project development. • Finalised ESIA package.	Formal notices to the public. Electronic publications and press releases on the Yamal LNG Project web-site. Dissemination of printed copies at designated public locations. Press releases in the local media. Consultation meetings. Information leaflets and brochures. Separate focus group meetings with vulnerable groups, as appropriate.

[3] During disclosure of the scoping report in 2013, Yamal LNG received a set of comments from an international environmental NGO and these comments were given due consideration during the development of the ESIA. .

[4] See the description of the Public Grievance Procedure in Section 9 of the Stakeholder Engagement Plan.

Table 5.2: Stakeholder Engagement and Disclosure Methods

Stakeholder Category	Project Information Disclosed	Means of communication/ disclosure
Non-governmental and community based organisations	• SEP (initial draft) and Scoping Report • Draft ESIA package (ESIA, SEP (updated version), Non-Technical Summary of the ESIA (NTS); • Public Grievance Procedure; • Provision of regular updates on Project development; • Finalised ESIA package.	Formal notices to the public. Electronic publications and press releases on the Yamal LNG Project web-site. Dissemination of printed copies at designated public locations. Press releases in the local media. Consultation meetings. Information leaflets and brochures.
Government authorities and agencies	• Draft SEP and Scoping Report; • Draft ESIA package (ESIA, SEP (updated version), Non-Technical Summary (NTS); • Provision of regular updates on Project development; • Finalised ESIA package; • Additional types of Project information if required for the purposes permitting and statutory reporting.	Dissemination of printed copies of the Scoping Report and SEP to the municipal administrations (district and village) in Project Area of Influence. Dissemination of printed copies of the ESIA package and NTS to the municipal (district and village) administrations in Project Area of Influence. Project status reports. Meetings and round tables.
Related businesses and enterprises	• ESIA package (ESIA, SEP), and ESIA Non-Technical Summary; • Public Grievance Procedure; • Updates on Project development and tender/procurement announcements.	Electronic publications and press releases on the Yamal LNG Project web-site. Information leaflets and brochures. Procurement notifications.
Project Employees, including both Yamal LNG and contractors' employees	• ESIA package (ESIA, SEP), and ESIA Non-Technical Summary will be made available through Company's internal document database; • Employee Grievance Procedure; • Updates on Project development.	Staff handbook. Email updates covering the Project staff and personnel. Regular meetings with the staff, including representatives of contractor personnel. Posts on information boards in the offices and on site. Reports, leaflets.

5.4.2 DISCLOSURE TIMEFRAME

The ESIA disclosure package will be made available (in both Russian and English language) for public review for the period of 60 days.

The disclosure of the reports listed above will be undertaken within the following timeframe:

- Making the SEP and Scoping Report available for public review and for discussion with the nomadic communities in the Project locality, and subsequently with a wider range of stakeholders – Q1 2013.

- Consultation meetings in Project affected communities[5] to present and discuss main findings of the Scoping Report, as well as to discuss the planned process of stakeholder engagement based on the SEP – with the nomadic communities in the Project locality, and further consultations with a wider range of stakeholders – Q1 2013.
- Placement of the International ESIA package in the public domain (as described in Section 5.4.1) – Q3 2014.
- 60-day disclosure period for the aforementioned International ESIA package – Q3-Q4 2014.
- Public consultation meetings in Project affected communities and with other stakeholders to present and discuss findings of the International ESIA – Q3 2014.
- Addressing stakeholder feedback received on the entire disclosure package by the Company - Q3-Q4 2014.
- Publication of the final suite of the disclosure materials, including the International ESIA and its NTS and the SEP – Q4 2014.

5.4.3 VENUES FOR ESIA DISCLOSURE

Free printed copies of the ESIA report (including the ESAP and ESMP), NTS and the SEP in Russian will be made accessible for the general public at the following locations:

- Yamal LNG's Project offices in the city of Salekhard;
- Yamal LNG's public reception office in Sabetta;
- Post office premises in Seyakha village (with the provision of free public access);
- Yamal LNG's public reception office in Yar-Sale settlement (at the premises of Yamalsky District Public Association of Indigenous Small-Numbered Peoples of the North "Yamal");
- Office of the Yamalsky District Municipal administration in Yar-Sale settlement.

Electronic copies of the Scoping Report, International ESIA, the NTS and SEP will be placed on the Project web-site: www.yamalspg.ru. This will allow stakeholders with access to Internet to view information about the planned development and to facilitate their involvement in the public consultation process.

Upon completion of the public disclosure period and receipt of all comments on the ESIA package from the stakeholders, the ESIA materials will be revised accordingly, with the subsequent disclosure of the finalised ESIA documentation.

5.4.4 ON-GOING STAKEHOLDER ENGAGEMENT

The Company will continue to actively engage with its stakeholders throughout the Project lifecycle. The Company will also initiate public consultations in relation to any future environmental and social impact assessment studies in case of expansion, modernisation and variations to the

[5] Taking into account the nomadic lifestyle of the local population, the meetings will be primarily organised during the periods when migrating reindeer herders' congregate in the local settlements.
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proposed Project activities, as required. Further details about the Company's on-going engagement activities are available in SEP.

5.5 FPIC PROCESS

Throughout the Project lifecycle the Company is committed to an informed consultation and participation process (ICP) which requires in-depth exchange of views and information, organised and iterative consultation, leading to the incorporation of stakeholders' views in the decision-making process.

As stipulated by IFC PS 7, ICP forms a basis for obtaining Free, Prior and Informed Consent (FPIC) of the affected communities of Indigenous Peoples who are likely to be subject to various Project impacts. There is no universally accepted definition of FPIC, however, it assumes good faith negotiation between the Company and the affected indigenous communities and a mutually accepted process of negotiations and agreements that should be documented.

In order to fulfil the requirements for consultations to be 'free, prior and informed', as well as to ensure obtaining FPIC of affected IPs, a range of engagement methods have been applied by the Company. These methods are summarised in the Table 5.3 below; however, more detailed description is given in the SEP.

Table 5.3: Actions performed to demonstrate FPIC

Consultation Method	Notification	Evidence of the Agreement
Public hearings as a part of formal review process of Project's planned activities (OVOS)	Announcements in the media	Register of comments Minutes of meetings reflecting the voting process
Working sessions with representatives of IP NGOs, IP communities and breeding enterprises, informal talks with IP representatives	Advance letters of request for a meeting	Minutes of meetings Field notes Video/audio recordings
IP herder camps visits	Prior personal agreements with households	Questionnaires Field notes Video/audio recordings
Engagement and Support Programme for Indigenous Population of the Yamal District	Agreed schedule for work sessions with all the parties involved	Signed agreement on planned activities
Public hearings on Seyakha rural settlement development programme	Announcements in the media	Minutes of meetings reflecting the voting process

By quarter 3 2014, Yamal LNG completed the first round of activities related to preparation of the Indigenous Peoples Development Plan (IPDP) and formal obtaining of Free, Prior and Informed Consent (FPIC) of Yamal District Indigenous Peoples. Starting from October 2013 the following actions related to IPDP elaboration and the obtaining of FPIC have been executed:

- Research on traditional land use and ethno-cultural environment of indigenous peoples in the Yamal LNG project area of influence;

- Historical and cultural research of the land allotted to the Yamal LNG project;
- The Advisory Board consisting of the representatives of Yamal LNG, regional and Municipal authorities, NGOs and indigenous organizations has been established;
- Three rounds of consultation with indigenous peoples of Yamal District were implemented:
  - March 2014: nomadic families were informed about the status of Yamal LNG Project, intention to develop IPDP, creation of the Consultative Council, and the work of Public Liaison Offices. In total 593 reindeer herders participated in the consultations.
  - April 2014: finding out indigenous people's opinions concerning the support measures currently provided by YLNG and issues which have not been sufficiently covered by the current programs. 24 authorized representatives have been elected by 160 nomadic families carrying out their traditional activities within the area directly and indirectly impacted by Yamal LNG project for further cooperation with the YLNG.
  - May 2014: IPDP draft has been presented to the 24 authorized representatives of indigenous peoples. All comments and proposals were included in the final version of the IPDP. The process of FPIC Declaration consideration by indigenous communities and their authorized representatives was initiated.

During the second meeting of the Advisory Board held on June 27th 2014, decisions were made: to approve IPDP and commence signing of the FPIC Declaration. By July 7th 2014, all Declarations of FPIC to the Yamal LNG Project and IPDP realization were signed by the 24 authorized representatives.

5.6 ROLES AND RESPONSIBILITY

The Company has direct and overall responsibility for the implementation and regular update of the SEP, including the undertaking and supervising of engagement with all stakeholders. The Company's department for public relations is responsible for all stakeholder consultations. Stakeholder engagement activities are coordinated by the Project's Environmental and Sustainability Manager.

5.7 PUBLIC GRIEVENCE MECHANISM

The Company has developed and implemented a Grievance Procedure to effectively address affected communities' concern and complaints in a timely manner. The Company uses the following methods to address incoming complaints:

- an online facility for placing any stakeholder feedback on the Yamal LNG corporate website: www.yamalspg.ru;
- dedicated telephone number enabling contact with the designated Company staff;
- information leaflets on the Public Grievance Procedure with an accompanying grievance form; and
- suggestion boxes installed in the Project's public reception office in Seyakha and Mys Kamenniy villages that were established in Q1 2013.
- E-mail: vopros@yamalspg.ru
- Public liaison offices in Salekhard, Yar-Sale and Sabetta
- Filling in Public Enquiry Form and sending in by snail mail

Further details about the Company public grievance mechanism is provided in the SEP (Section 9).

5.8 MONITORING, REPORTING AND TRAINING

The SEP will be periodically revised and updated as necessary in the course of Project implementation. Monthly reports on enquiries and grievances received from stakeholders will be submitted to the Company senior management. The Company will provide information on its public engagement activities to the external stakeholders, at least with an annual frequency. Regular monitoring of the Company's stakeholder engagement methods will be conducted through establishing KPIs.

The Company will provide training on consultation activities for the staff who will be involved in public consultation and addressing grievances.

6 PROJECT ALTERNATIVES

6.1 BACKGROUND

The basis for the development of the hydrocarbon fields of the Yamal Peninsula was set out in the “Program of Comprehensive Development of the Yamal Peninsula and the Adjacent Water Areas”, which was drawn up by OJSC “Gazprom” and the Administration of the Yamal-Nenets Autonomous Okrug in 2007. The program established three industrial areas, each of which is associated with a group of oil and/or gas fields:

- the Bovanenkovo industrial area;
- the Tambey industrial area; and
- the Southern industrial area.

The Tambey industrial area comprises six fields, including the South Tambey gas condensate field. The different development options considered for this field are described in this Chapter.

Opportunities for wider stakeholder input and comment to the Project development have been allowed through normal Russian Federation public hearing processes. In addition, the outline project alternatives made available for stakeholder comment in the Scoping Report.

6.2 THE ‘NO PROJECT’ ALTERNATIVE

The ‘no project’ alternative considers the outcomes should the Project not go ahead. In this case, not developing the Project would mean that the large reserves of the the South Tambey Gas Condensate Field (see Chapter 4, Project Description for full details) would remain unexploited. This would result in:

- The loss of a resource development project of both national economic importance and international energy resource importance.
- Failure to capitalise on previous well development in the field that has resulted in up to 80% of the reserves having already been explored and being ready for commercial production. This may lead to increased pressure to capitalise on other, less well developed, fields either in the Yamal region or elsewhere in the Russian Federation.
- Failure to meet the requirements of the Resolution of the Russian Federation’s Government # 1713-R “On the Comprehensive Plan of Development of LNG Production in the Yamal Peninsula” dated October 11, 2010.
- The loss of regional development and inward investment opportunities associated with the Project in the Yamal region.

In addition, as part of the development Project, disused facilities on the site and contamination associated with previous oil and gas exploration and production activities (by previous operators) in the field will be removed and reinstated respectively by Yamal LNG. Without this Project it is uncertain whether such remediation works would be undertaken.

The ‘no project’ option would avoid the potential adverse environmental and social impacts identified in Chapters 9 and 10 of this ESIA report. However, the economic, social and environmental benefits of the Project associated with the aspects identified above, coupled with the international demand for gas, are compelling.

6.3 PRELIMINARY OPTION DEVELOPMENT AND SCREENING

Following a decision to proceed with the Project, the identification of preliminary high-level development options for the Project included consideration of:

1. Methods for the export of gas reserves, and in particular either:
   a) Gas pipeline transport of natural gas to end users
   b) Export as LNG via carriers.

2. For LNG export, the following sub-options were considered:
   a) Geographic location of LNG facilities either in:
      i. the Yamal peninsula
      ii. remote locations nearer to ice-free conditions.

   b) Development of LNG facilities as either:
      i. Offshore facilities
      ii. Near-shore coastal facilities on barges
      iii. Onshore facilities.

   c) LNG Export by either:
      i. Loading jetty
      ii. Offshore single point mooring.

Each of these high-level options is discussed below.

6.3.1 GAS PIPELINES VERSUS LNG

The option of delivering natural gas from the South Tambey Gas Condensate Field to international consumers via the construction of gas pipelines was subject to economic and technical appraisal, which included consideration of existing and forecast demand for natural gas in key markets (Asia-Pacific, USA, Europe and other regions). A summary of the environmental as well as technical, economic and logistical advantages and disadvantages of the gas pipeline and LNG options is provided in Table 6.1 below.

Table 6.1: Summary of Comparison of Export Options

Aspect		Gas Pipeline	LNG
Environmental	Advantages	Typically lower overall GHG emissions than LNG	Relatively limited physical footprint
	Disadvantages	Very extensive physical footprint including linear developments (pipelines & compressor stations) with associated environmental and social impacts	Need for port development & dredging

Table 6.1: Summary of Comparison of Export Options			
Aspect		**Gas Pipeline**	**LNG**
Technical, economic & logistical	Advantages	Running costs	Greater access to all global markets
	Disadvantages	Limited access to some global markets Longer construction period Maintenance of extensive pipeline system	Shipping in ice conditions

The absence of access to existing pipeline networks for the delivery of gas to the identified markets, and the extremely long distances required for new pipeline networks, rendered this option uneconomical and technically/logistically challenging. In addition, the development of pipelines over such extensive distances would lead to a range of potential environmental and social impacts.

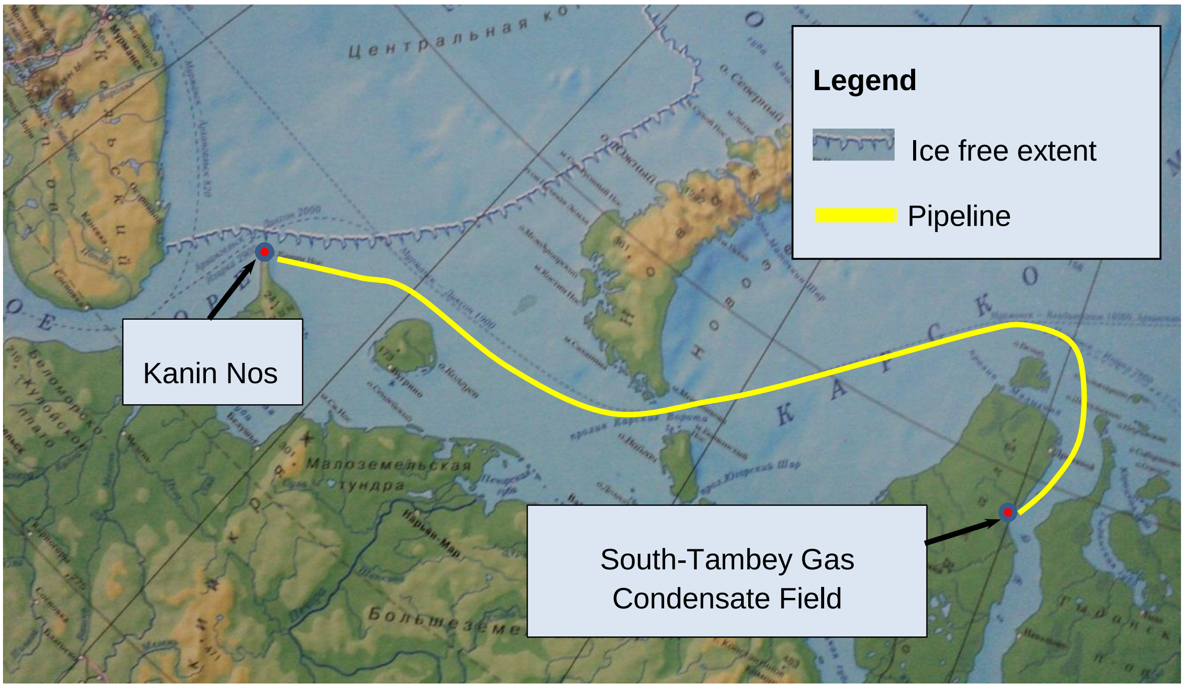
The economic and technical review revealed that the development of an LNG production facility was both economically viable and technically feasible. It was therefore decided to further explore LNG development options for the Project.

6.3.2 LNG DEVELOPMENT OPTIONS

Remote (from Yamal) locations versus Yamal Peninsula

The sea around the Yamal peninsula is ice bound for 7-8 months per year. The potential for transporting gas from the South Tambey Gas Condensate Field by pipeline to a remote LNG plant located near to year-round ice-free seas was therefore considered. Based on review of the extent of year-round ice-free conditions, a potential remote location for the LNG plant west of Yamal was identified in the north of the Kanin peninsula off the Barents Sea (see Figure 6.1). There are no potential year-round ice free ports east of the Yamal peninsula.

Figure 6.1: Ice Free Sea Extent in the Region



A potential LNG plant at Kanin Nos cape would be linked to the South Tambey Gas Condensate Field via an offshore gas pipeline (sample route shown on Figure 6.1).

However, this option has a number of significant disadvantages:

- The option to readily export LNG eastward is removed (without very extensive shipping distances).
- Major infrastructure will be require at both Kanin Nos (the LNG plant) and in Yamal (a major compressor station to transport the gas to the LNG plant), resulting in significant land take in two separate locations.
- The required offshore gas pipeline between the field in Yamal and the LNG plant in Kanin Nos would be approximately 975km in length. This would result in:
  - Potential environmental impacts over an extensive marine area (including during construction).
  - Significant impact on construction costs and time schedules.

Overall, it was concluded that construction of a remote LNG plant on the Kanin Nos cape was not a preferable option in terms of cost, schedule or environment considerations.

Offshore versus onshore LNG facilities

The conceptual design for LNG production, including both the required pre-processing in a complex gas treatment plant (CGTP) and the LNG process itself, has considered the following placement alternatives, which were subject to technical and engineering review:

- Offshore placement away from the shore utilising either

  - a concrete gravity base structure (GBS); or
  - an artificial island.
- Near-shore placement in the coastal area, utilising concrete or steel barges.
- Onshore placement of facilities, utilising either:
  - modular component assembly on piles (where modular/pre-fabricated units are constructed offsite and then transported to site); or
  - 'stick build' construction methods (i.e. construction and fabrication onsite).
- For the CGTP facilities, offshore and near-shore options were dismissed on the basis of:
  - Offshore – excessive cost with limited identified benefits.
  - Near-shore – complex barge structures would be required, and construction would require large volumes of excavation and backfill as well as extensive piling.

Therefore, an onshore location for the CGTP was assessed to be the preferred option.

For the LNG facilities a summary of advantages and disadvantages of the different options is summarised below in Table 6.2.

Table 6.2: Comparison of Onshore, near-shore and offshore LNG

Option	Advantages	Disadvantages
Onshore – stick build	• No large module transport	• Large camp site required • Large labour requirements • Climate impacts on construction • Schedule risks • Difficult ground works • Construction in local Arctic environment (rather than pre-fabrication in controlled environmental conditions)
Onshore – modular build	• Shorter installation time • No ice load • No personnel accommodation issues • Allow multiple yards (fabrication areas) • Schedule • Easy start-up • Logistics • Proven technology and engineering solution	• LNG tanks stick built • Large module transport • Offloading jetty and associated channel dredging required (unless offshore mooring – see below)

Table 6.2: Comparison of Onshore, near-shore and offshore LNG

Option	Advantages	Disadvantages
Offshore - GBS	• In field installation time • Commissioning in yard • Low labour requirements • Controlled environment	• Ice load problems • Personnel accommodation issues • Cost (significant higher CAPEX compared to onshore options) • Multiple platforms required with significant footprint • Extended overall schedule • Reduce expansion flexibility • Offshore pipeline required (including trenching requirements) • Size of required facilities would be novel/unproven
Offshore – artificial island	• Reduced ice-load problem	• Piling requirements • Long installation time • Materials availability • Offshore pipeline required (including trenching requirements) • Significant offshore footprint
Near-shore	• Installation time • No ice load • No settlement issues • Easy start-up	• Complex barge requirements • Large excavation and backfill required • Trestle/bridge or dredging to offloading jetty • Large transit barges • Number and size of piles • Cutting of shore line (coastal processes) • Channel dredging required (unless offshore mooring – see below)

Based on the feasibility studies undertaken, onshore modular build construction of the LNG Plant was determined to be the most technically viable solution.

Export loading via jetty versus offshore mooring

The following options for LNG loading were considered for an onshore LNG production facility:

- Loading jetty
- Offshore single point mooring.

A summary comparison of the two options is provided below in Table 6.3.

Table 6.3: Comparison of LNG loading options		
	Jetty	**Offshore mooring**
Advantages	• Short distance for LNG pipeline from LNG plant to loading point • Provide structures for loading/unloading facilities for other materials	• Reduced need for dredging of shipping channel • Limited footprint
Disadvantages	• Need for shipping channel dredging • Physical footprint in coastal region	• Technical complexities for extended cryogenic LNG pipeline from LNG plant to loading point • Impracticability in ice condition

Following detailed review, the option of a jetty development was selected as the preferred option. The principal difficulties with the offshore mooring point option relates to the technical issues with the length of the required cryogenic LNG pipeline to the mooring and technical impracticalities of operating an offshore mooring loading facility in ice conditions.

6.4 DETAILED OPTION APPRAISAL

6.4.1 OVERVIEW OF LOCATION ALTERNATIVES

Three possible onshore CGTP/LNG development location options in the Yamal peninsula region were developed for further appraisal. Each of these is summarised below and shown in Figures 6.2 to 6.4, and an overall location plan is given in Figure 6.5.

Option 1 (Kharasavey cape)

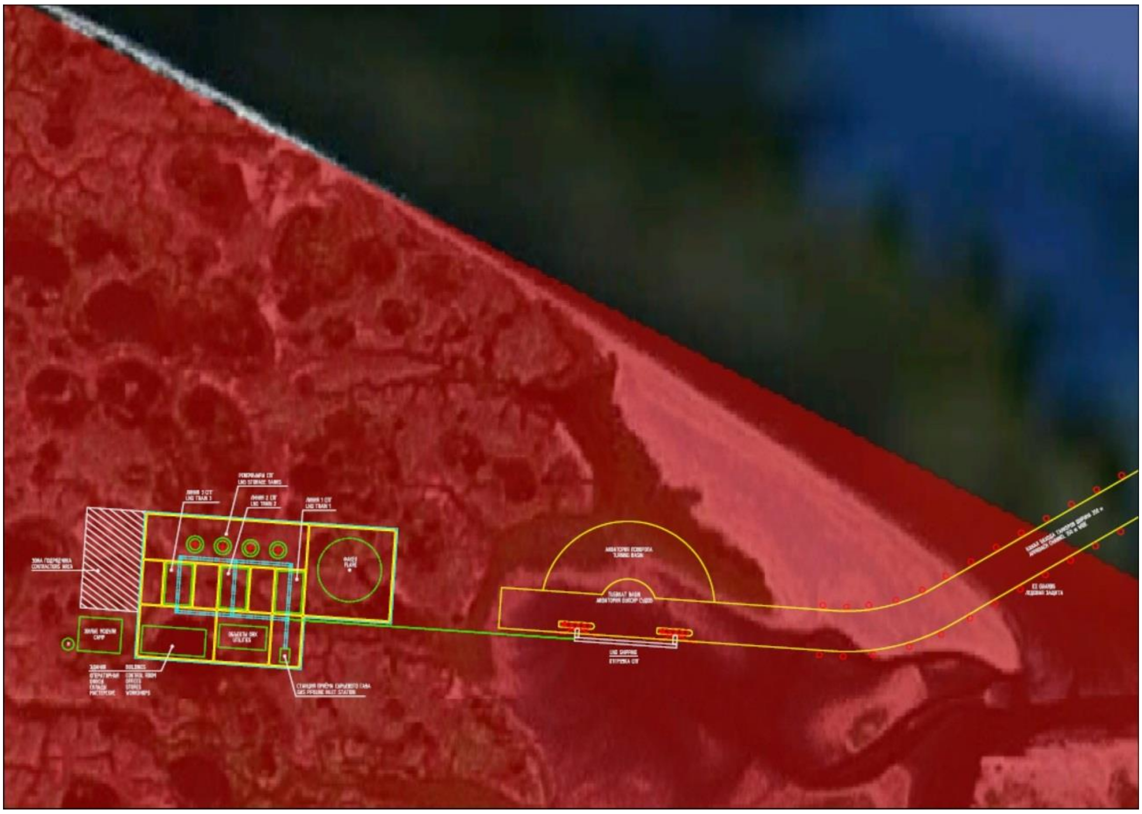
The LNG Plant located on an area in the western shore of the Yamal Peninsula near the Kharasavey cape. Gas from the South Tambey Gas Condensate Field is gathered in a pipeline network and pre-processed at a CGTP in the field area and then transported westward to the LNG Plant via an approximately 170km long gas pipeline. For layout of LNG Plant and jetty see Figure 6.2.

Figure 6.2: Layout of Option 1 at Kharasavey Cape

Option 2 (Drovyanoy cape)

LNG Plant located on an area in the north-eastern shore of the Yamal Peninsula near the Drovyanoy cape. Gas from the South Tambey Gas Condensate Field is gathered in a pipeline network and pre-processed at a CGTP in the field area and then transported northward to the LNG Plant via an approximately 195km long gas pipeline. For layout of the LNG Plant and jetty see Figure 6.3.

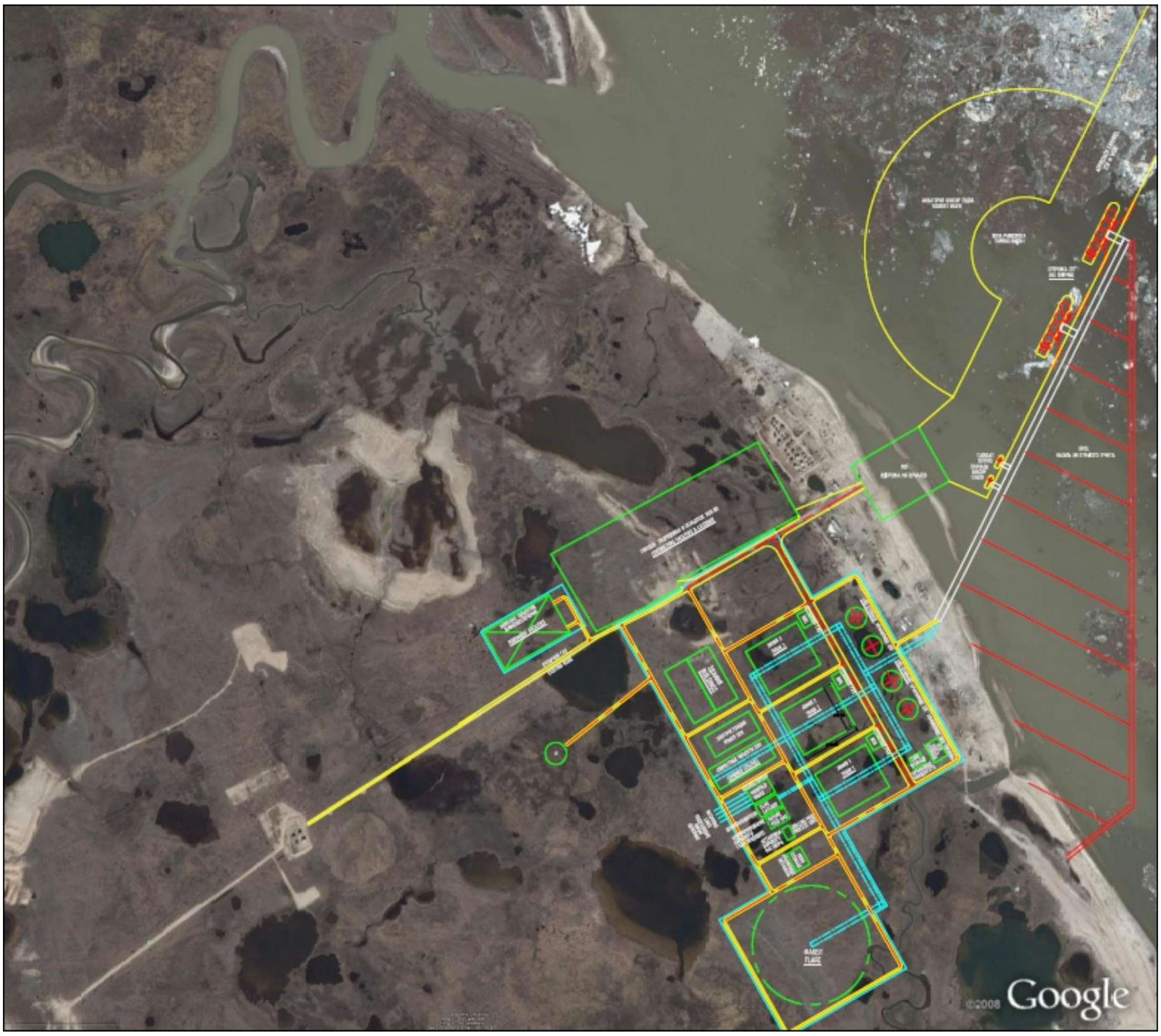
Figure 6.3: Layout of Option 2 at Drovyanoy Cape



Option 3 (Sabetta)

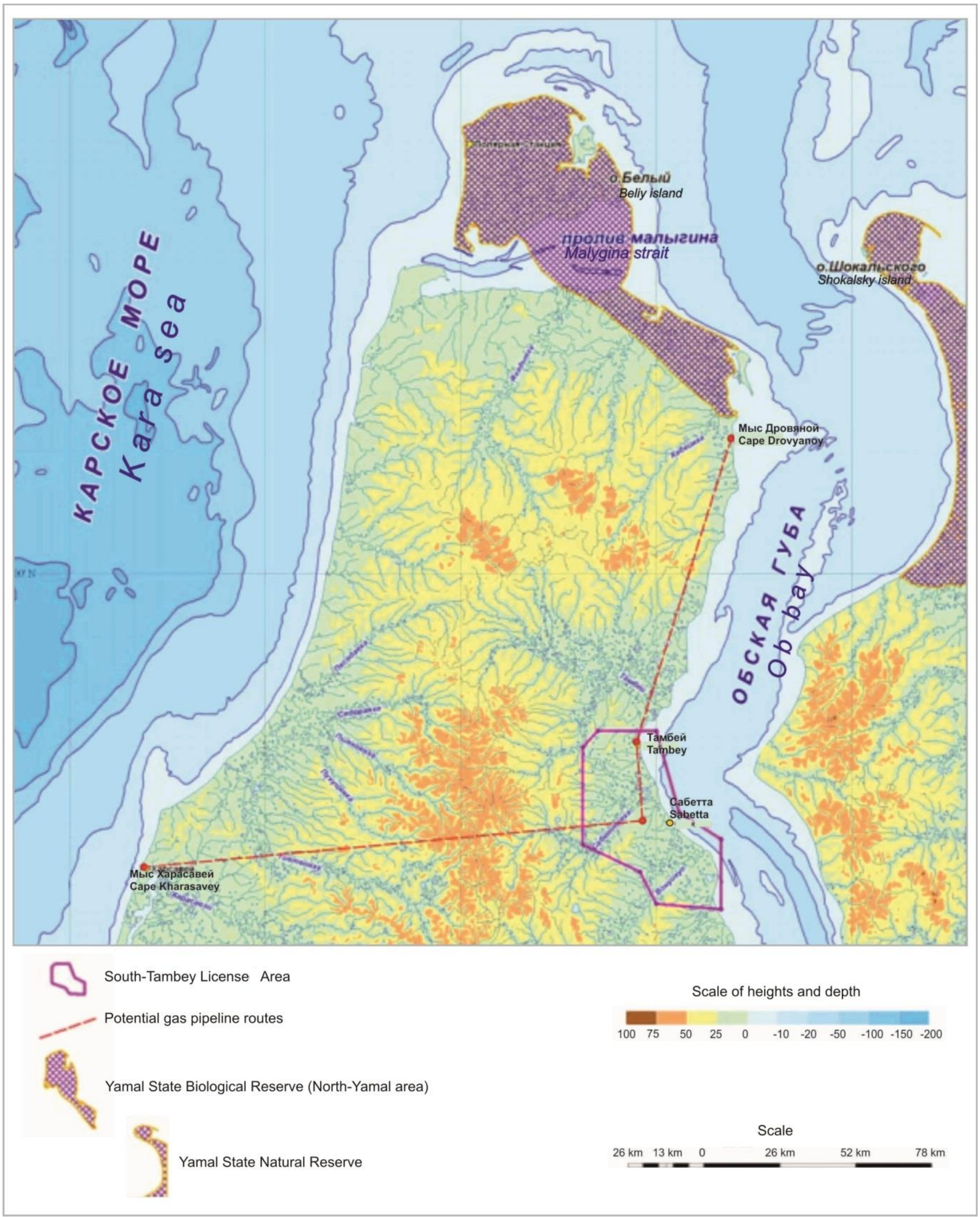
Combined CGTP/LNG located in an area on the eastern shore of the Yamal Peninsula near Sabetta, in the near vicinity of the South Tambey Gas Condensate Field. Gas is gathered in a pipeline network within the field area. For the layout see Figure 6.4.

Figure 6.4: Layout of Option 3 at Sabetta



The locations for each of these options are shown on Figure 6.5 below.

Figure 6.5: Site Alternatives on Yamal Peninsula (not to scale)



6.4.2 ENVIRONMENTAL CONSIDERATIONS

The following environmental factors were considered in the assessment of the three LNG location alternatives within the Yamal peninsula (assessement present in this section was conducted by ZAO “Ecoproect”, 2010):

- Atmospheric emissions
- Seawater environment
- Onshore surface waters
- Landscape and soil cover
- Flora
- Aquatic organisms and Ichthyofauna (aquatic biota)
- Fauna (especially birds and mammals)
- Shore line vulnerability to oil pollution
- Integral environmental vulnerability of adjacent marine areas.

In addition, consideration was also given to the following criteria:

- The presence of specially protected environmental zones
- The availability and accessibility of existing infrastructure.

The comparison of the three location alternatives against each of the above aspects is provided in turn below, and a summary assessment is provided in Table 6.4.

- **Atmospheric emissions**

  Options 1 and 2 would require gas from the South Tambey Gas Condensate Field to be transported by pipeline to the proposed LNG facilities/shipping ports at Kharasavey Cape and the Drovyanoy Cape respectively. In order to transport the gas over these distances (170km and 195km respectively), an associated compressor station would be required in the South Tambey Gas Condensate Field. Such a compressor station would not be required for Option 3. Therefore Options 1 and 2 would lead to greater levels of atmospheric emissions during operation than Option 3.
- **Seawater environment**

  An important criterion in terms of potential impacts on the marine environment is the extent of dredging required to enable vessels to reach the seaport. This in turn depends on the seawater depth on the approach to the three port location options. The length of the shortest distance from shore to the 10m bottom contour has therefore been assessed for the three LNG location options as follows:
  - Option 1 Kharasavey cape - 5.2km
  - Option 2 Drovyanoy cape - 19km
  - Option 3 Sabetta - 3.5km.

  Therefore, Option 3 would require the least initial dredging (the extent of maintenance drilling required for the Sabetta option is the subject of detailed modelling as part of the detailed design for this option[1].

[1] Preliminary modelling studies in the navigation channel and the seaport area/approach channel and reported in the “Sedimentation study and numerical modeling of siltation in the Sea Channel and Sabetta Port and Sabetta Access Channel of Yamal LNG”, Porteco, 2013.

- **Onshore surface waters**

  Pipelines and other required linear structures may impact negatively on surface waters that they cross, especially during construction. These include negative impacts on hydrology and water quality at the crossing location, and the drainage or waterlogging of adjacent areas if surface flow conditions are altered. Such impacts can be mitigated by the use of appropriate construction methods (e.g. aerial spans for pipelines and bridges for roads), but nonetheless residual impacts and risks are likely to remain. The pipeline transport systems required for Options 1 and 2 mean that these options would require the following number of additional surface water crossings compared to Option 3:

  - Option 1 Kharasavey cape - 30 crossings
  - Option 2 Drovyanoy cape - 52 crossings.

  Option 3 would require only a limited number of surface water crossings (relative to the other options) in the South Tambey Gas Condensate Field for the gas gathering pipeline network and associated road infrastructure for the well developments. (Micro-alignment of the pipeline network system is also undertaken for the preferred option in order to avoid specific river sensitivities.) The lowest risk of negative impact from surface water crossings is therefore provided by Option 3.

- **Ecosystems**

  The sensitivity of the natural ecosystems potentially affected by each of the three options was also used as an evaluation criterion. The pipeline route to the Kharasavey cape crosses approximately 55km of vulnerable natural complexes that would be restorable over a period of more than 14 years. The pipeline to the Drovyanoy cape would cross approximately 23km of similarly vulnerable areas. By comparison, the establishment of an LNG Production Facility and shipping port near Sabetta would not require the construction of a trunk pipeline and hence this option has a lesser effect on vulnerable habitat.

- **Flora**

  The vulnerability of plant associations potentially affected by the three options was used as an evaluation criterion. In Option 1, 148.3 km of the pipeline to the Kharasavey cape crosses highly unstable plants associations. The pipeline to the Drovyanoy cape (Option 2) includes 91.7km of similar areas. Establishing an LNG Production Facility and shipping port near Sabetta does not require the construction of a trunk pipeline and hence this option has a lesser effect on plant cover.

- **Aquatic organisms and Ichthyofauna (aquatic biota)**

  The presence of sensitive fish habitats and species, and more especially species included in the Red Book of the Russian Federation, in the waters near the LNG shipping terminals locations was used as an evaluation criterion. The most significant species in the region is the Siberian sturgeon, which is designated as ‘threatened’. The Siberian sturgeon is known to be found near the Drovyanoy cape (Option 2), but not near Kharasavey (Option 1). It may also occur also in coastal waters of the Gulf of Ob near Sabetta (Option 3), although it has not been recrded in the Licence Area (see Chapter 7).

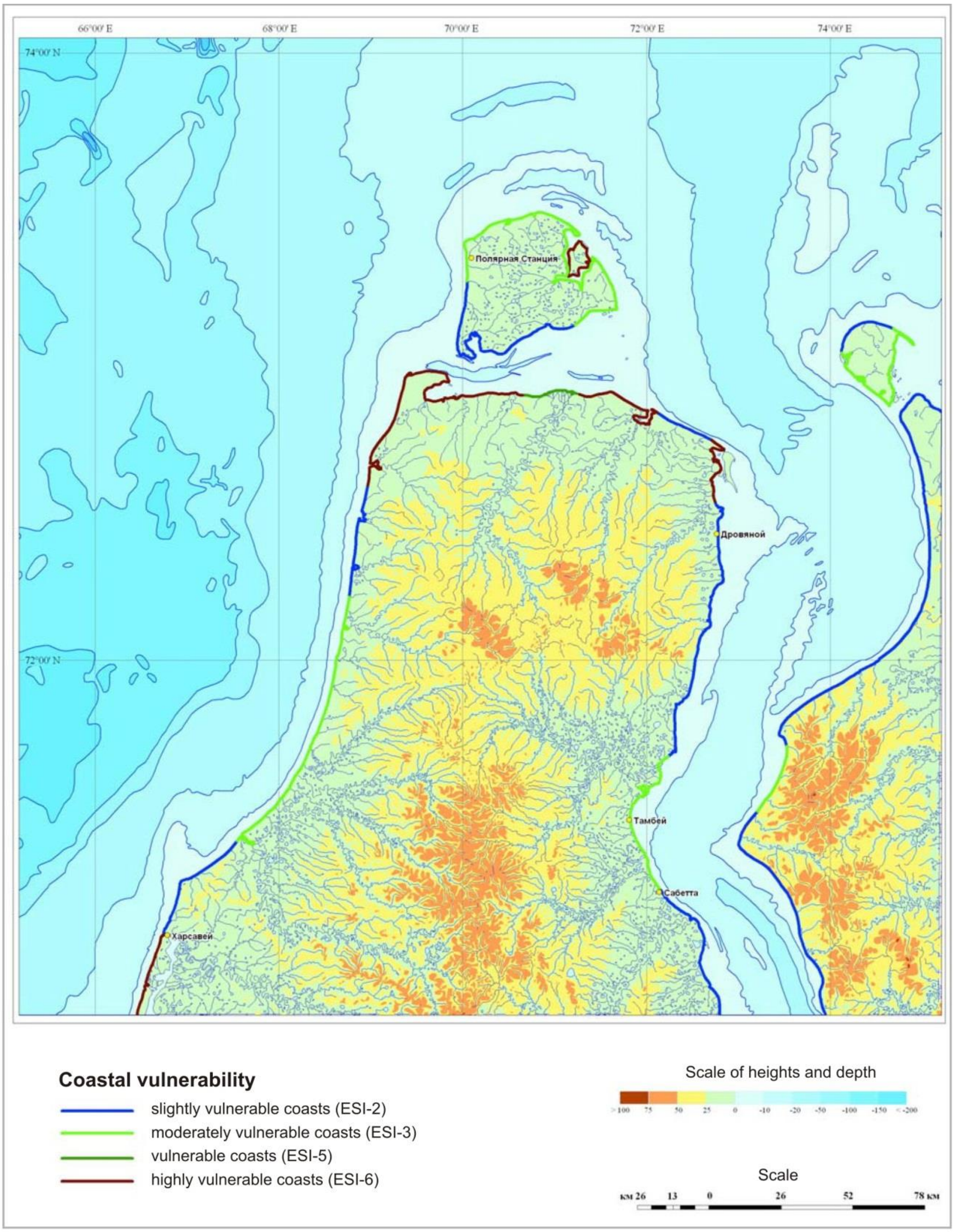
- **Terrestrial Fauna and Marine Mammals**

  The presence of sensitive faunal species in proximity of the three location options was used as an evaluation criterion. Special attention was given to marine mammals on the basis that 4 out of 5 marine mammals included in the Red Book of the Russian Federation may be found in the waters around the northern coast of the Yamal peninsula. Of the three options, marine mammals are less numerous in waters off Sabetta (Option 3). Cetaceans are more numerous near Kharasavey Cape (Option 1), and both cetaceans and pinnipeds are more numerous near Drovyanoy Cape (Option 2).

- **Shore line vulnerability to oil hydrocarbon pollution**

  The index of environmental susceptibility (accepted by the International Petroleum Industry Environmental Conservation Association), is shown in Figure 6.6. Based on review of this data, the shores near Kharasavey Cape (Option 1) and Drovyanoy Cape (Option 2) are relatively more susceptible than the shores near Sabetta (Option 3).

Figure 6.6: Coastal Sensitivity Index



- **Integral environmental vulnerability of adjacent marine areas**

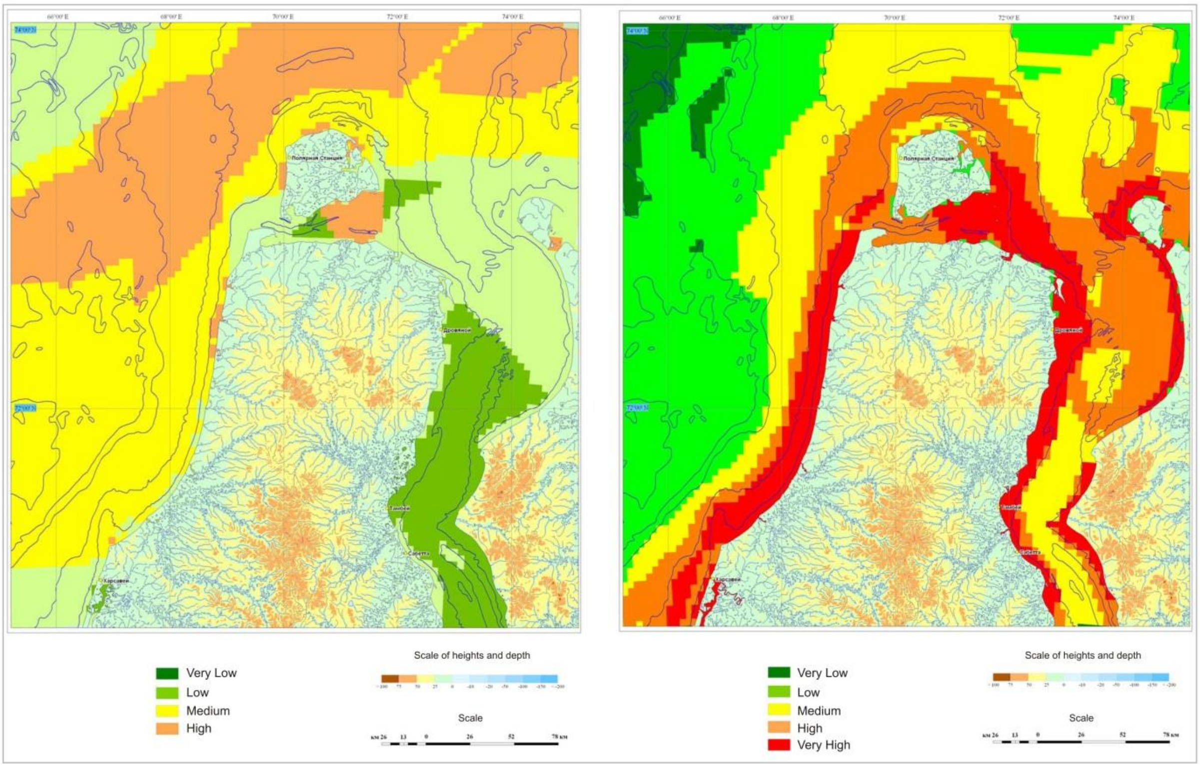
  The assessment was based on the compilation of integral vulnerability maps on the basis of GIS and thematic mapping for following parameters:

  - Specially protected natural reservation
  - Phytoplankton vulnerability

- Zooplankton vulnerability
- Benthos vulnerability
- Ichthyofauna
- Birds
- Pinniped and cetaceans
- Semi-aquatic mammals.

The presence and size of areas whose integral environmental vulnerability is particularly susceptibility were reviewed (see Figure 6.7). In summer time the seaward width of the most susceptible areas for the three locations are: Drovyanoy Cape (Option 2) - 23km, Kharasavey Cape (Option 1) - 13km, and Sabetta (Option 3) - 6km.

Figure 6.7: Coastal Vulnerability Mapping in Winter (left) and Summer (right)



- **Special protection areas**

  The distance of designated special protection areas from the three LNG location options was used as an evaluation criterion. The distances are summarised below:
  - Option 1 Kharasavey cape is approximately 34km from the southern area of the Yamal wildlife preserve.
  - Option 2 Drovyanoy cape is approximately 8km from the northern area of the Yamal wildlife preserve (see Figure 6.5).
  - Option 3 Sabetta is approximately 140km from the northern area of the Yamal wildlife preserve, and approximately 180km from the southern area of the Yamal wildlife preserve.

A summary of the above option appraisal was undertaken using a simple 3-point scoring system. For each aspect, the option identified as having the least impact was given 1 point, the option with the next lowest impact was given 2 points, and the most impacting option was given 3 points. Where two or more options had broadly similar impacts they were awarded the same score. The results of this assessment are presented in Table 6.4 below.

Table 6.4: Results of ranking of facilities location

Criteria	Characteristics	Options, points		
		1 Kharasavey	2 Drovyanoy	3 Sabetta settlement
Atmospheric emissions	Gross discharge into the atmosphere	2	2	1
Sea waters adjacent to the LNG Shipping Facilities	The length of the shortest way from the shore to 10m bottom contour	2	3	1
Onshore surface waters	The quantity of water bodies crossed by the pipelines	2	3	1
Ecosystems	The nature complexes restorability	3	2	1
Flora	The resistance level of plants associations	3	2	1
Aquatic biota	The presence of fish, included in The Red Book, in the water areas	1	2	2
Terrestrial fauna and marine mammals	The concentration of pinnipeds and cetaceans	2	3	1
Shore line vulnerability to oil hydrocarbons pollution	The index of environmental susceptibility, accepted by IPIECA	2	2	1
Environmental integrity of adjacent sea area	The size of areas with the most susceptibility level	2	3	1
Specially protected environmental areas	The distance from the LNG production facility to the borders of the specially protected environmental zones	2	3	1
Points in total:		**21**	**25**	**11**

Overall it is concluded that the location of the LNG facilities in Sabetta (Option 3) represents the best option from an environmental perspective. A primary differentiator for Option 3 is that it does not require the construction of trunk gas pipelines. However, even if those factors on which the pipeline construction has the greatest impact (atmosphere emissions, onshore surface waters, ecosystems and flora) are discounted, the results of the assessment in the table above would still identify Option 3 as the preferred location.

6.4.3 NON-ENVIRONMENTAL CONSIDERATIONS

A summary of the key non-environmental (technical, economic, social and logistical) relative advantages and disadvantages of the three-options is provided in Table 6.5 below.

Table 6.5: Non-Environmental Aspects Comparison

	Option 1 Kharasavey Cape	Option 2 Drovyanoy Cape	Option 3 Sabetta
Advantages	• Some existing infrastructure • Remote location location with no requirements for physical re-settlement	• Shortest export shipping distances • Remote location location with no requirements for physical re-settlement	• No trunk pipelines (cost and schedule benefits, and reduced risk of impact to reindeer herder migration routes) • Some existing infrastructure • Remote location location with no requirements for physical re-settlement
Disadvantages	• Costs/time schedule of trunk pipeline • Increased potential for trunk pipeline to cross/affect reindeer herder migration routes • Pipeline compressor required • Ice ridging (shipping impacts) • Split locations for CGTP and LNG Plant • Dredging requirements (including potential impacts to fisheries)	• Limited existing infrastructure • Pipeline compressor required • Costs/time schedule of trunk pipeline • Increased potential for trunk pipeline to affect reindeer herder migration routes • Greatest area on maintenance channel dredging likely (including potential impacts to fisheries) • Split locations for CGTP and LNG Plant	• Dredging requirements (including potential impacts to fisheries)

6.4.4 OVERALL OPTION APPRAISAL

On the basis of the overall assessment of alternative locations within the Yamal peninsula, it was determined that Option 3, the development of the LNG, CGTP and export facilities near Sabetta represents the preferred development option.

6.5 DEVELOPMENT OF PREFERRED OPTION

The preferred development option has been identified as the development of the LNG plant, seaport and other associated facilities near Sabetta on the eastern coast of Yamal and in close proximity to the South Tambey Gas Condensate Field. Within this development option further refinement of the Project design was assessed in terms of the following key elements:

- Location of a disposal site for dredged materials
- Sources for water supply
- Waste disposal options
- Gas compression and LNG technology cooling medium alternatives

Each of these is discussed separately below.

6.5.1 ALTERNATIVES FOR DREDGE SPOIL DISPOSAL

Dredging activities will be the responsibility of FSUE “Rosmorport” (Rosmorport) and, as such, are considered to be an associated activity i.e. an activity that is not under Yamal LNG’s direct control (see Chapter 4, Section 4.9). Nevertheless, Yamal LNG will seek to exert influence over dredging activities and alternative dredging strategies are considered below.

One of key issues during the Project implementation is disposal of approximately 17 million m^3 of spoil from dredging of the approach channels to the seaport. Two main alternatives for disposal of dredged materials were considered:

- Land-based site for disposal
- Water area of the Gulf of Ob.

These are discussed below.

Land-based site for disposal

There are no suitable existing onshore facilities for the disposal of dredge material in the vicinity of the Project, and therefore a new onshore disposal site would need to be developed. Such a disposal site would need to occupy approximately 4,000 hectares, based on consideration of specific local conditions, soil grading of dredging area and side stability requirements.

The following elements would be required to develop the disposal site:

- creation of a road highway network to deliver construction materials to the site
- arrangement of earth banking and deposal sites
- settling vessels/ponds
- construction of a system of slurry pipelines
- development of a withdrawal system for clarified water.

A light berth with spoil storage facilities would be constructed with pile support in the near-shore coastal area. Dredged material would be transported from the dredging areas by the dredging vessels and deposited into the storage berth. The deposited spoil would then be pumped via slurry pipelines to an onshore disposal site. The main environmental factors of this option are as follows:

- Withdrawal of land resources
- Impacts to terrestrial flora and fauna at the disposal site

- Impacts on water resources and marine flora and fauna from the construction of the berth.

Offshore disposal site

The environmental considerations for an offshore disposal site in the Gulf of Ob primarily relate to sedimentation impacts on the seabed (e.g. smothering of benthic communities) and generation of suspended sediments.

Selection of the preferred disposal option

Overall, the potential environmental impacts are assessed to be more extensive for land-based disposal than offshore disposal. As an illustration of this a comparison of the environmental damage calculations (in rubles and as required under Russian permitting procedures) for the two options is provided in the Table 6.6.

Table 6.6: Environmental damage for the different alternatives of dredged ground disposal (M rubles)

Natural environment component or pollution source	Land-based site for disposal	Water area of the Gulf of Ob
Terrestrial fauna	115.00*	0
Fish resources	559.853*	1,714.207 **
Waste disposal	17,546.280*	0
Water resources	404.144*	173.576*
Total for construction period	**18,625.277***	**2,039.093**

* Calculations taken from design document “Construction of Seaport nearby Sabetta settlement at the Yamal peninsular, including shipping channel (Early works facilities)”, “Eco-Express-Servis Ltd”, 2011.

** Calculations taken from “Calculation of damage to water bioresources” in design document “Construction of Seaport nearby Sabetta settlement at the Yamal peninsular, including shipping channel (Early works facilities and Main facilities)”, “Pi Petrokhim-Technologiya Ltd”, 2013.

On the basis of the above assessment, the disposal of dredged material within an allocated offshore site in the Gulf of Ob has been identified as the preferred disposal option.

Detailed information on the methods for environmental damage calculations for land-based dredge disposal is present in Book 8, “Construction of Seaport nearby Sabetta settlement at the Yamal peninsular, including shipping channel”, “Eco-Express-Servis Ltd”, 2011.

Total environmental damage calcualtions are based in four calculations:

- damage to the terrestrial fauna
- damage to fish resources due to negative impact upon food reserves (zooplankton and zoobentos)
- disposal of the dredged sediments to an on-shore site as class IV waste
- impact upon surface water quality by suspended soilids and chemical pollutants.

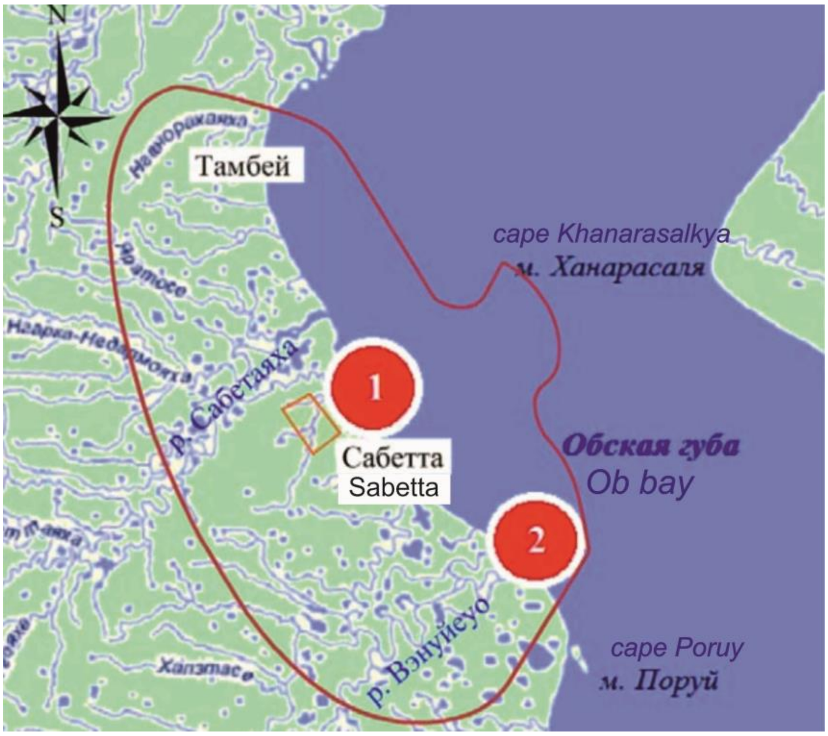
Detailed information on damage to fish resourses for offshore disposal option is presented in “Calculation of damage to water bioresources” documentation of Design “Construction of Seaport nearby Sabetta settlement at the Yamal peninsular, including shipping channel”, “Pi Petrokhim-Technologiya Ltd”, 2013.

The approach is based upon calculation of fishery losses due to impact upon zoobentos and plankton with subsequent calculation of amount of sturgeon, whitefish and peled young fishes needed to breed for losses compensations. So damage to fish resourses in the Table 6.6 above is actually operational costs for fish breeding compensation measures.

6.5.2 ALTERNATIVES FOR PORT LOCATIONS

Initially 2 alternatives for the precise port location in the Sabetta region were considered – nearby the Sabetta settlement itself and nearby the Cape Poruy (see Figure 6.8).

Figure 6.8 : Alternative port locations (not to scale)



Criteria of the alternatives assessment are presented in Table 6.7.

Table 6.7: Criteria for the port location assessment		
Criteria	**Alternative 1 – Sabetta**	**Alternative 2 – Cape Poruy**
Safety from drifting ice	Provided	Not provided
Distance to isobaths 15 m	7.5km	4.3km
Existing infrastructure	Present	Not present

Table 6.7: Criteria for the port location assessment

Criteria	Alternative 1 – Sabetta	Alternative 2 – Cape Poruy
Topographic conditions for construction	Favourable	Unfavourable
Length of pipeline for LNG transportation	Not required	App. 50km

Based on the above assessment, the Sabetta settlement location was selected as the most favorable option for the majority of the considered criteria and was therefore selected as the preferred location.

6.5.3 CHOICES FOR WATER INTAKE FOR WATER SUPPLY

Approximately 1,900m^3/day of water will be required by the Project for drinking and process usage. The production capacity of the existing water intake from the Glubokoye Lake is 240m^3/day and it will therefore be necessary to develop other water supply sources. The following alternative additional water supply options have been considered:

- Surface water intake from the rivers and lakes in the area of Sabetta settlement;
- Water intake from groundwater wells;
- Water intake from the Gulf of Ob.

These options are assessed below:

- **Onshore surface water abstraction**

  Engineering/hydrological surveys has revealed that the lakes and rivers of the construction area located within 4 km from the Sabetta settlement (Sinedyakha, Salyamlekambadayakha, Sabetayakha, Venuymueyakha), are frozen over and the rivers have no flow during winter period.
- **Groundwater abstraction**

  Analysis of underground horizons has revealed that they cannot provide the required water volumes. The construction area lies in a permafrost area and the underground waters (the first water-bearing horizon) lie close to the water surface (from 0.1 to 0.3m) and cannot be used for drinking. The waters of the deeper horizons (600-900m) are highly mineralised and contain increased amount of hydrogen sulfide, and so cannot be used for drinking water.
- **Water abstraction from the Gulf of Ob.**

  Water abstraction from the Gulf of Ob could supply the required volumes of water, but desalination would be required.

Based on the abovementioned alternatives, water abstraction from the Gulf of Ob (with desalination) is identified as the only feasible option.

6.5.4 SOLID WASTE DISPOSAL

There are currently no available non-hazardous waste disposal facilities in the near vicinity of the Project licence area. Options for the disposal of non-hazardous waste include the following, and a summary of the comparative assessment is provided in Table 6.8 below:

- Temporary storage of wastes on the Project site prior to transport to existing municipal waste facilities at the regional level.
- Development of a dedicated Project landfill within the Project licence area for the disposal of non-hazardous Project wastes.
- Incineration of waste.

Table 6.8: Comparison of different solid waste management options

Option	Advantages	Disadvantages
Transport to remote landfill	• No requirement for waste facilities on site, reducing on-site impacts	• Requirement for temporary on site storage and transport of waste • Long transport distance (including logistical issues associated with the need for sea transport of wastes)
On site landfill	• Reduced requirements for temporary waste storage • No requirements for waste transport	• Additional footprint in Project licence area • Landfill construction in permafrost
Incineration	• Reduces volume of waste • Ability to deal with selected non-hazardous wastes • No requirements for transport	• Potentially significant air emissions

The over-riding determining factor in rejecting the remote landfill option is the logistical difficulties of waste transport given the available infrastructure and climatic conditions in the region. In particular, the use of off-site waste facilities would require wastes to be shipped very large distances by sea to the existing third party waste facilities, leading to significant costs and atmospheric emissions associated with shipping. Following review of the above aspects, the preferred solution for non-hazardous waste management is a combination of on-site landfill and incineration.

6.5.5 WASTE WATER DISPOSAL

Wastewater will be treated in water treatment plant prior to disposal. Disposal options for the treated wastewater have been evaluated and the preferred option for process waters from the LNG plant is injection into suitable subsurface horizons using deep well injection technology, as this is considered to have the lowest potential environmental impacts. Other waste waters, including treated sanitary wastewaters from the Sabetta waste water unit, will be discharged in the Gulf of Ob after appropriate treatment (see Chapters 4 and 9 for further details).

6.5.6 DRILLING WASTE DISPOSAL

Yamal LNG has given consideration to the disposal of drilling wastes (muds and cuttings) by injection into suitable subsurface horizons using cuttings reinjection technology. Design studies and economic evaluation were undertaken to substantiate the feasibility of re-injecting these wastes and, in particular, geological field studies to assess the suitability of the sub-surface reservoirs in the South Tambey Gas Condensate Field. Following these studies, it was determined that the well formations were not technically suitable for drilling wastes injection. There are also inconsistences in the RF legislation on the approval process for the underground disposal of waste muds that make this a less attractive option. Instead drilling waste will be treated as follows:

- Drill cuttings will be separated from the muds using centrifuges so that the muds can be re-circulated for re-use.
- Solid wastes (after centrifugation) will be disposed to lined pits at the well pads.

The re-use of muds under this approach minimises the volume of waste water and muds that needs to be produced and disposed of. Additional information on drilling wastes treatment is described in Chapter 4.

6.5.7 LNG TECHNOLOGY COOLING MEDIUM ALTERNATIVES

Air and water cooling options were assessed for the LNG process. Overall the water cooled option was discarded due to:

- Availability of water resources (see also Section 6.5.3 above)
- Protection of process equipment and piping from the potential freezing of seawater in arctic conditions
- Environmental impacts of heated water discharge to arctic environment
- Chlorination required for a water-cooled system and its resultant environmental impact.

While air cooled systems may generate additional noise (compared to water cooled systems), these impacts can be adequately mitigated through design.

The process of options analysis described in this chapter has resulted in the Project design which is presented in the Project Description (Chapter 4). Other detailed elements of the LNG technology and processes are refined through the FEED and EPC stages of design and key elements of environmental and social mitigation in design are described in Chapter 4.

7 ENVIRONMENTAL BASELINE

7.1 INTRODUCTION

This section of the ESIA provides environmental baseline information related to the Project Area of Influence and describes the current status and value of the environmental setting. This characterisation is essential for the assessment of the Project's potential impacts and the subsequent development of appropriate mitigation measures. The baseline also provides the basis on which the effectiveness of mitigation measures can be assessed.

The main source reference documents used for the preparation of this chapter are listed below:

- Environmental-engineering study reports for following facilities:
    - Base camp (Sabetta expansion area, utility lines/routes, Sabetta camp, high voltage line and upper fuels and lube oils store), (by URALSTROIPROECT in 2010)
    - Well clusters (by FRECOM in 2011, and 2012)
    - Seaport (by LENMORNIIPROECT and INSTITUT YUZHNIIPGIPROGAS, OOO'FRECOM" in 2011)
    - Seaport (by Proectnyi institute "Petrochimtechnologiya", 2012)
    - Airport (FRECOM in 2011)
    - LNG plant (by FRECOM in 2012)
- Final Report on the Intergrated Assessment of Biodiversity and Rare Species in the Project Area in the YNAO (FRECOM 2013)
- OVOS reports:
    - Base camp (URALSTROIPROECT, 2010)
    - Seaport (LENMORNIIPROECT, OOO"ECO-EXPRESS-SERVICE)
    - LNG plant (FRECOM" and "INSTITUT YUZHNIIGIPROGAS, 2012)
    - Landfill (TYUMENSKII NAUCHNO-ISSLEDOVATELSKII I PROECTNII INSTITUT NEFTI I GASA, 2012).

The baseline assessment of Valued Ecological Components (VECs) in the context of cumulative impacts is described in Chapter 13.

7.2 CLIMATE, METEOROLOGY AND AIR QUALITY

7.2.1 CLIMATE

7.2.1.1 GENERAL

The Project Licence Area falls within the Yamal Peninsula and the regional location is shown in Figure 7.2.1.

Figure 7.2.1: Regional location of Yamal Peninsula

The Yamal Peninsula's climate and that of the northern parts of the Gulf of Ob are largely determined by their high latitude within the Arctic Circle and the proximity of a cold sea. The climate of the Yamal Peninsula is slightly more temperate than that of the east- and mid-Siberian tundras, but it is nonetheless severe. It is characterised by:

- Harsh winters with a long period of snow cover and strong winds.
- Late springs and early autumns.
- Short, cold summers characterised by cloud cover.

Some years have no above zero temperature days at all.

Atmospheric circulation influences on the region in the winter include:

- Warming cyclonic Atlantic air masses; and
- Cooling anticyclonic activity formed over the mainland.

Conversely, in the summer, cyclones from the sea bring wet, cold air, while the influence of high pressure areas over Siberia result in dry and relatively hot weather.

Meteorological data are available from weather stations located at Tambey on the northern perimeter of the Project Licence Area, and Marresale located on the south-west coast of the peninsula. The climatic data presented in the sub-sections below are based on historical data from the Tambey weather station up to 2005[1] unless otherwise stated.

The harshness of the climatic conditions leads to a number human health issues in the local population, including relatively high rates of respiratory disease, and these issues are further discussed in Chapter 8.

7.2.1.2 INCOMING SOLAR RADIATION

Incoming solar radiation levels in the region are very uneven, due to polar days and nights. Solar radiation levels are also greatly affected by cloud cover levels, which vary considerably along the Kara Sea coast. The maximum incoming solar radiation levels occur in June, and the minimum levels in November. The sunniest month in the northern parts of the Gulf of Ob is April (typically 200-250 hours of sunshine). In December and January, the area experiences polar nights. In summer, the number of sunshine hours is relatively large (the monthly averages for June and July are 189 and 247 hours respectively). However, due to the predominance of cloudy days, direct solar radiation is reduced to 25-30%.

The overall solar radiation balance in the region is strongly affected by the albedo affects during ice-cover periods. The monthly and annual radiation balance is summarised in Table 7.2.1 below.

Table 7.2.1: Monthly and annual radiation balance (MJ/m^2) (Calculated values for Tambey)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
-60	-56	-42	11	144	321	346	192	51	-40	-61	-59	784

7.2.1.3 AIR TEMPERATURES

A summary of air temperatures within the Project Licence Area is provided in Table 7.2.2.

[1] "Construction Of Facility For Gas Production, Conditioning, Liquefaction And Shipment Of Lng And Gas Condensate From South-Tambey GCF Design Documentation" Section 8 Part 2, Yuzhniigiprogas Institute/FRECOM, 11.035.2-OOC-8.2, 2012.

Table 7.2.2: Air Temperature Summary at the Tambey

Month	Air Temperature (ºC)		
	Average	Maximum	Minimum
January	-24.6	1	-48
February	-25.8	0.3	-49
March	-25.0	1	-45
April	-15.9	6	-41
May	-7.2	6	-31
June	1.0	26	-13
July	5.5	30	-3
August	6.4	26	-3
September	2.3	20	-15
October	-5.8	10	-33
November	-15.9	3	-43
December	-21.7	1	-46
Annual air temperature	-10.6	-	-

7.2.1.4 SOIL TEMPERATURES

The Project Licence Area lies within a continuous permafrost zone. The permafrost thickness at the polar circle varies between 400-450 and 250-300 m. The temperatures of permafrost rocks are lowest in peatlands and highest in sandy soils; a difference in temperature as high as 3-4°C can occur between these soil types in the same area.

A summary of surface soil temperatures from Tambey is provided in Table 7.2.3, which presents both the mean and variance (σ^2) of the monthly average temperatures. The annual average soil surface temperature is -10.4°C and the monthly mean values range from +8.2°C (in July) to -27.1°C (in January).

Table 7.2.3: Mean monthly surface soil temperature – mean and variance (Tambey)

	Jan	Feb	Mar	Apr	May	Jun
Mean (°C)	-27.1	-25.5	-21.1	-18.5	-6.1	1.7
σ^2 (°C)	4.6	3.6	2.6	3.7	1.5	1.5
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mean (°C)	8.2	7.5	2.9	-5.3	-17.4	-23.7
σ^2 (°C)	1.1	1.6	1.2	2.3	4.6	4.0

Average soil thawing depths are 0.4 m in Arctic tundra and 0.5 m in moss-lichen tundra.

Further details on the characteristics of permafrost are provided in Section 7.3.

7.2.1.5 WINDS

An overview summary of mean monthly and annual windspeeds recorded at the Tambey weather station is provided in Table 7.2.4[2].

Table 7.2.4: Mean monthly and annual windspeeds, m/s (Tambey)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
5.7	6.0	6.1	5.8	6.2	5.2	5.2	5.6	5.4	6.4	6.2	6.1	5.8

Strong winds (≥15 m/s) are observed annually, with maximal windspeeds up to ≥40m/s. The 1, 5, 10 and 20 year maximum windspeed return periods are shown in Table 7.2.5. The mean (n) and maximum (N) number of days per month with windspeeds ≥15m/s are shown in Table 7.2.6.The occurrence of strong windspeed is distributed over the year, but such events are generally more prevalent between October and May.

Table 7.2.5: Maximum windspeed return periods (Tambey)

	Return Period (years)			
	1	5	10	20
Windspeed (m/s)	29	34	36	38

Table 7.2.6: Mean (n) and maximum (N) number of days per month windspeeds ≥15m/s (Tambey)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
n	5.5	6.8	6.4	5.6	5.3	2.9	2.6	2.8	2.6	8.0	7.1	8.6	52.9
N	18	11	13	10	10	10	7	6	7	18	13	16	79

Squalls also occur, leading to sharp, short-term increase in wind speed accompanied with a change in wind direction. Squall wind speed often exceeds 20-30m/s. Such phenomenon last for several minutes and occur mainly during thunderstorms.

Wind direction frequencies from the Tambey weather station are summarised in Table 7.2.7.

Table 7.2.7: Wind Direction (Tambey)[3]

Direction	Percentage (%)
N	15
NE	14
E	8
SE	11
S	13
SW	13
W	13
NW	13
Calms	4

[2] "Construction Of Facility For Gas Production, Conditioning, Liquefaction And Shipment Of Lng And Gas Condensate From South-Tambey GCF Design Documentation" Book 1, Report, Yuzhniigiprogas Institute/FRECOM, 2012.

7.2.1.6 HUMIDITY

Recorded relative humidity levels at the Tambey weather station are summarised in Table 7.2.8, which presents the mean and variance of the monthly average values. These show that relative humidity levels are typically high, with an annual average of 86%.

Table 7.2.8: Mean monthly relative humidity (%) – mean and variance (Tambey)

	Jan	Feb	Mar	Apr	May	Jun
Mean (%)	82	81	81	82	87	89
σ^2 (%)	5.7	5.5	6.9	5.6	2.7	2.7
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mean (%)	88	89	90	88	87	85
σ^2 (%)	3.7	2.6	1.7	2.7	2.8	4.5

Low relative humidity levels (30% and lower) are uncommon and have been reported at some locations on the Gulf of Ob coast only 1-2 times over the last 50 years.

7.2.1.7 PRECIPITATION

Summary precipitation data from the Tambey weather station are presented in Table 7.2.9 below in terms of monthly and annual average precipitation (mm) and the average number of days per month/year with rainfall in excess of 1mm. The data demonstrate that precipitation levels are relatively consistent throughout the year, with peak levels generally occurring between July and September.

Table 7.2.9: Average precipitation summary (Tambey – 1961-1990)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation (mm)	26	22	19	19	19	26	37	37	36	27	21	25	314
Number of days > 1mm	7	6	6	5	6	5	6	8	10	8	7	7	81

The spatial distribution of precipitation on the Yamal Peninsula demonstrates the following typical pattern:

- Precipitation levels increase from north to south.
- The lowest annual precipitation is reported on the west coast of the peninsula.
- The highest annual precipitation is in the south of the peninsula (476mm in Yar-Sale).

Snow cover has a major effect on the Yamal climate due to the duration of the winter (7.5 to 8 months) with around 40-46% of precipitation falling as snow or hail. Summary statistics for snow cover depths from Tambey (measured using gauging rods) are provided in Figure 7.2.2, which presents average snow depths over one-third month periods. These show that permanent snow cover typically lasts from late September until early June.

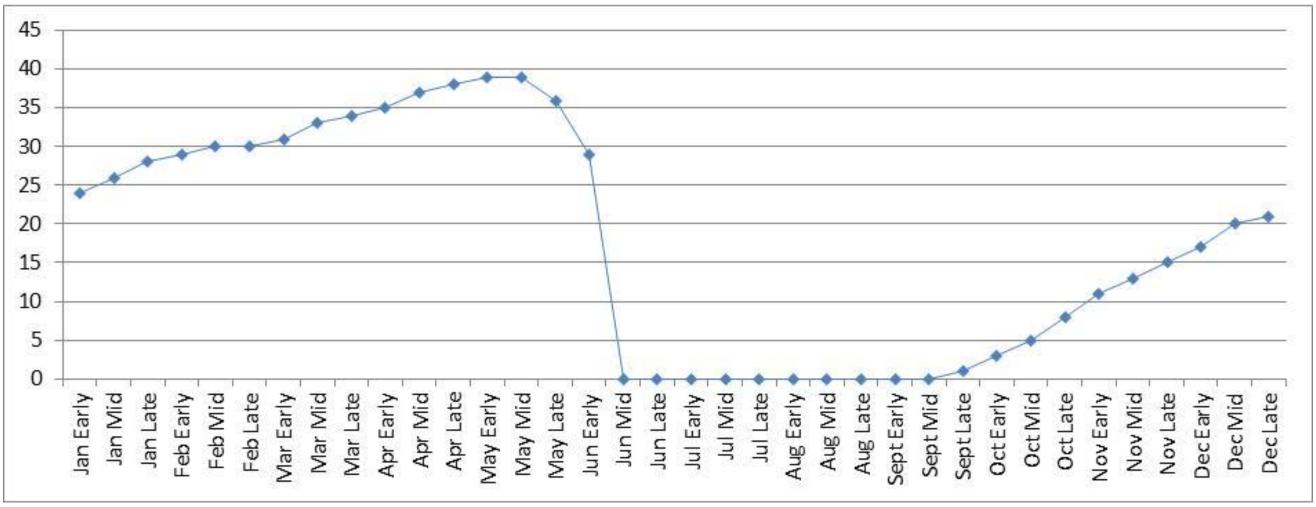


Figure 7.2.2: Average snow cover by 1/3 month period, cm (Tambey)

Snow cover is typically distributed very unevenly on the vast tundra expanses, as strong winds blow snow off elevated open spots, filling up depressions in the terrain.

7.2.1.8 SNOWSTORMS

Winter in the tundra is harsh due to high velocity winds and frequent snowstorms, which are often spontaneous and frequently result in blizzards. Snowstorms occur all the year around (on average occurring on over 100 days per year), save for July and August, and are most common in January (on average occurring on 15 days). The highest number of snowstorm days ever reported in a single year is 202 days. In the area of the seaport, there are on average 78 snowstorm days per year, with an average duration of 11 hours.

7.2.1.9 FOGS

High humidity levels and the proximity of cold seas with floating ice lead to frequent advection fogs, which are propelled to the coast from the ice edge. Typically up to 50 fog days are reported in a year on the mainland, rising to 76 days on the coast. The Gulf of Ob is reported to have 40 to 60 fog days per year, in some years this may reach 100 to 130 days. Fogs are most common between spring and autumn and are rarely observed in winter.

Fogs have a maximum duration of 69 hours in July, and a minimum duration of 3 hours in February. Average daily fog duration varies between 5 to 6 hours, and in some cases may last 2 to 4 days.

7.2.1.10 HOARFROST AND GLAZE ICE

It is characteristic of the Kara Sea to have hoarfrost (frozen dew) between October and May. On average there are 120-170 hoarfrost days per year over the sea and 80-100 days on the mainland. A rarer but more dangerous phenomenon is glaze ice, which usually forms at air temperatures from 0°C to minus 5°C. On an average, there are 5-10 glaze ice days per year in the region.

7.2.1.11 THUNDERSTORMS

The region is characterised by low thunderstorm activity, with only 4 thunderstorm days per decade.

7.2.2 AIR QUALITY

Overall, the Yamal peninsula is a largely un-developed area and hence levels of combustion products are expected to be low and specifically, the airshed in the Licence area is not considered to be degraded.

Primary sources of air pollution in Yamal-Nenets Autonomous Okrug (YNAO) include: motor transport, boiler-rooms of industrial enterprises that use solid and liquid fuels and hydrocarbon combustion products associated with the existing oil and gas industry.

The prevailing air quality pollutants include nitrogen oxides, carbon monoxide and hydrocarbons. Historically poor practices of past oil and gas extraction activities and transportation, as well as a large number of low capacity boiler-rooms in the region, have contributed to the emission of these pollutants. Motor transport accounts for about 80-85% of pollutants in gross emissions in YNAO.

Climatic characteristics and baseline data that determine the dispersion of pollutants in the atmosphere are provided by the Yamal-Nenets Centre for Hydrometeorology and Environmental Monitoring. This information is summarised in Table 7.2.10 (meteorological data) and Table 7.2.11 (background air quality pollutant levels).

Table 7.2.10: Meteorological data in the South-Tambey Gas Condensate Field

Name	Value
Atmospheric stratification ratio, A	160
Topography Ratio	1.0
Warmest month (July) average maximum temperature (°C)	9.4
Coldest month (January) average temperature (°C)	-29.1

Table 7.2.11: Background ambient air quality levels within the South-Tambey Gas Condensate Field (mg/m^3)

Pollutant	Background Levels (mg/m^3)	MAC (mg/m^3)
Nitrogen dioxide	0.056	0.2
Sulfur dioxide	0.011	0.5
Carbon monoxide	1.8	5
Suspended solids	0.140	0.5

During a 2007 study, air quality pollutant levels were measured in the vicinity of existing stationary sources near the proposed Project airport. The results showed the levels of sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxide (NO), and nitrogen dioxide (NO_2) to be within background levels. Insignificant levels of n-alcanes (hydrocarbons) were detected.

A feasibility study conducted in 2011 established that ambient air at well clusters 7, 25, 22, 41 and the liquefied gas storage site had low levels of n-alcanes, which showed the absence of hydrocarbon combustion products in the air. To add to that, levels had dropped considerably compared to 2005 as a result of finished drill works. The levels of other contaminants are given in Table 7.2.12.

Table 7.2.12: Contaminant levels in ambient air at study sites (mg/m^3)

Well	CO	NO	NO_2	SO_2
K-7/A/11	1.1	0.01	0.02	<0.05
K-25/A/11	1.4	0.02	0.01	<0.05
K-22/A/11	1.2	0.02	0.05	<0.05
K-41/A/11	1.2	0.02	0.01	0.06
S-1/A/11	1.4	0.01	0.02	<0.05
Assumed Background	***1.5***	***0.02***	***0.05***	***0.02***
RF Max Allowable Concentration	***5***	***0.4***	***0.2***	***0.5***

7.3 GEOLOGY, GEOMORPHOLOGY AND SEISMICITY

7.3.1 GEOLOGY

7.3.1.1 GENERAL STRATIGRAPHY

The geological profile of the South Tambey Gas Condensate field is represented by palaeozoic base formations and deposits of the mesozoic-cainozoic[4] sedimentary cover. These rocks are covered by relatively recent Quaternary deposits. The general geological sequence is tabulated below:

Table 7.3.1: General Stratigraphy

Geological Era	Description	Thickness (m)
Quaternary	Marine, lacustrine and aeolian sands/clays	250 - 300
Palaeogene	Marine facies (interbedded silt clays and sands containing organic matter and thin interlayers of brown coals).	>1,000
Cretaceous	Late Cretaceous: the lower section consists of heavy clay with interbedded siltstone and sandstone. The upper section contains interbedded silty clay and clay siltstone. Early Cretaceous: the lower section consists of marine deposits with a predominance of clay containing siltstone units. Then: siltstone with interbedded carbonaceous and clay. The upper section contains marine clay with sand interlayers followed by interbedded siltstone and clay.	
Jurassic	Marine sediments: sandstones interbedded with clays and siltstone.	
Triassic	Late Trias: Clays, marls and sandstones interbedded with kaolinized sandstones and siltstones. Middle Trias: Siltstone and sandstone with interlayers of calcareous clays, marls and siderites. Early Trias: Interbedded clay, marls and siltstones. The upper section consists of clays, marls and sandstones interbedded with kaolinized sandstones and siltstones.	
Carboniferous	Late Carboniferous: Conglomerates, sandstones, clay and calcareous shales, marls and limestones. Sand/shale sediments with interlayers of shell	

[4] Palaeozoic: Represented by rocks of Devonian and Carboniferous age. Mesozoic: Rocks of Triassic and Jurassic age. Cainozoic: Rocks/sediments of Palaeogene and Quaternary age.

Table 7.3.1: General Stratigraphy		
Geological Era	**Description**	**Thickness (m)**
	limestones. Early Carboniferous: Massive grey limestones. The upper section consists of conglomerates, sandstones, gritstone, mudstone and calcareous shales, marls and limestones, sand and clay sediments with shell limestone layers.	
Devonian	Late & mid Devonian: Greywacke conglomerates, sandstones, cherts and slates with thin limestone interlayers; rest unconformably on early Devonian sediments. Early Devonian: Reef and bioclastic slightly bituminous limestones.	

Rocks older than Quaternary age are only typically present at great depths and so have little relevance with respect to the assessment of environmental impact. Therefore, only the characteristics of the relatively shallow Quaternary deposits are described in detail.

7.3.1.2 STRATIGRAPHY OF QUATERNARY DEPOSITS

Northern Yamal, including the Project Licence Area, is overlapped by massive deposits of Quaternary age, with a thickness of 250 to 300m.

The stratigraphy of the Quaternary deposits and a description of their characteristics is given in Table 7.3.2.

Table 7.3.2: Stratigraphy of Quaternary Deposits			
Epoch	**Type of deposit**	**Description**	**Thickness (m)**
Holocene	Aeolian	Fine, wind-blown sands and silts.	The thickness of individual deposits varies across the Licence Area. Total thickness of quaternary deposits ranges between approximately 250 and 300m
	Lacustrine	Consist of peaty sands with interlayers and lenses of loams and clay sands.	
	Biogenic	Consist of peat-beds found in some parts of lagoon-marine terraces.	
	Alluvial	Very fine or fine-grained sands and sandy loams with interlayers of clay loams.	
	Marine	Brownish grey very fine and fine sands, loamy sands and clay loams.	
Pleistocene	Marine	Gravely / clayey sands.	
	Lagoonal	Clean or argillaceous sands interlaid with fine undulating or lentiform bedding.	
	Alluvial / marine	Organic silts	
	Alluvial / lacustrine	Sand and sandy loam	

Table 7.3.2: Stratigraphy of Quaternary Deposits			
Epoch	**Type of deposit**	**Description**	**Thickness (m)**
	Alluvial	Probably sand	
	Marine / Glacial marine	Silt, clay and sand	
	Glacial / Marine	Clay and clayey sand	
	Glacial marine / Tidal marsh	Silt, clay and sand	
	Lacustrine / Marine	Clay and silt	
	Lacustrine marine / marine	Sand, silt and cemented gravel	

7.3.2 GEOMORPHOLOGY

The Project Licence Area is a flat, unevenly broken depositional lowland plain, with an elevation of between zero and 25 m above sea level (masl). The plain is cut by river valleys. The biggest rivers in the area are the Sabettayakha and the Venuymuyeyakha (see Section 7.5 for further details).

From the surface down, the plain is composed of late Neo-Pleistocene and Holocene alluvial, lacustrine-alluvial, alluvial-marine and marine deposits (described above).

The topography of the plain is made up of land that forms a series of 'steps', each with a different elevation. These were formed by the deposition and/or erosion of sediments as follows:

(I) Second marine terrace (14 to 20masl);

(II) First marine lacustrine-alluvial terrace (7 to 12masl);

(III) Modern lagoonal-marine laida[5] (0 to 5masl):

- The lowest part of the laida is a gently concave waterlogged depression between the littoral bar and the surface of the first terrace, composed of sands covered by detritus and peat (0 to 3masl);
- Littoral bar composed of sands. This is asymmetric, with a ripply hummocky surface (3 to 5masl);
- Emerging spits and beaches (up to 3masl).

(IV) Modern alluvial systems:

- Alluvial systems of major rivers (often reworked by cryogenic processes);
- Minor river valleys.

The characteristics of each of the above 'levels' are described below.

[5] A low lying coastal plain that is submerged during high tides.

Level I: second marine terrace (14 to 20 masl)

The surface of the second marine terrace forms the highest level in the Project Licence Area. It is a flat undulating ridgy terraced upper-quaternary lagoonal-marine plain significantly broken by erosion.

The plain occupies the central and western parts of the Project Licence Area and forms an elevated interfluve between the valleys of the Sabettayakha and the Venuymuyeyakha Rivers (see Figure 7.5.1). It is composed of sands and has a gentle slope towards the Kara Sea.

The terrace is heavily broken by numerous valleys and ravines, particularly in the areas adjacent to the bordering rivers. Both sides of the terrace are dissected by numerous ravines (that are being actively eroded), gullies and hollows. The network of ravines is dense: the maximum width of divides varies from 500 to 600 m; their depth is 7 to 8 m. Steep slopes are covered by polygonal tundras. The biggest ravines are characterised by permanent and temporary streams, with distinct floodplains. Most of the terrace surface is practically even and relatively dry, although waterlogging occurs in places.

Level II: first marine terrace (7 to12 masl)

The topography of the second level is ridged and undulating, and is formed from mixed lagoon-marine deposits of sands and loamy sands covered by a peat layer.

The terrace surface is less broken but more waterlogged than that of the second terrace. The terrace forms a 10 to 15 km wide belt along the Kara Sea coast. This is divided into 0.5 – 2.0km wide fragments by the valleys of major rivers, which are further sub-divided by the valleys of smaller rivers (the Tolyang'yakha, the Madkoyekha and the Siler'yakha). Most ridges are sub-parallel to the Gulf of Ob shoreline.

Thermokarst formations, such as lakes and dry lake basins, are widespread. Thermokarst lakes are characterised by a variety of sizes (up to 1,200 m), shapes, features and stages of development. They are usually shallow (1 to 2 m deep) and tend to occur in clusters.

The size, shape and depth of dry lake basins are similar to watered hollows. The basin bottoms are flat, boggy, with open water surfaces and lakes. These occur at elevations of between 1.2 to 3.5 masl.

Level III: modern lagoonal-marine laida (0 to 5 masl)

The third elevation level is composed of lagoonal-marine Holocene deposits of sands and sandy loams that are occasionally overlapped by thin (0 to 5 m thick) loams. The surface is relatively flat, waterlogged and boggy. This forms a strip of land along the coast (a laida).

Most of the laida surface between 0-3 masl is a gently concave heavily waterlogged 1 to 2 km wide hollow between the littoral bar and the first lagoonal-marine terrace (see Figures 7.3.1 and 7.3.2). Most marginal areas are covered by waterlogged polygonal tundras. The bar blocks drainage of the main laida surface, so drainage can occur only via the estuaries of a few rivers (altogether 11 watercourses for a 40-km length of the shoreline). The hollow is associated with numerous lakes, including the biggest inland water bodies in the area: Haeseito, Pakalmyto, Yavhevto, and others (see Figure 7.5.1). The littoral bar is an elevated (3 to 5 masl) round-crested ridge-like surface composed of sands. The bar width varies from 100 - 300 m to 800-900 m. The bar has an asymmetric shape, with a flat waterfront and steeper back slopes.

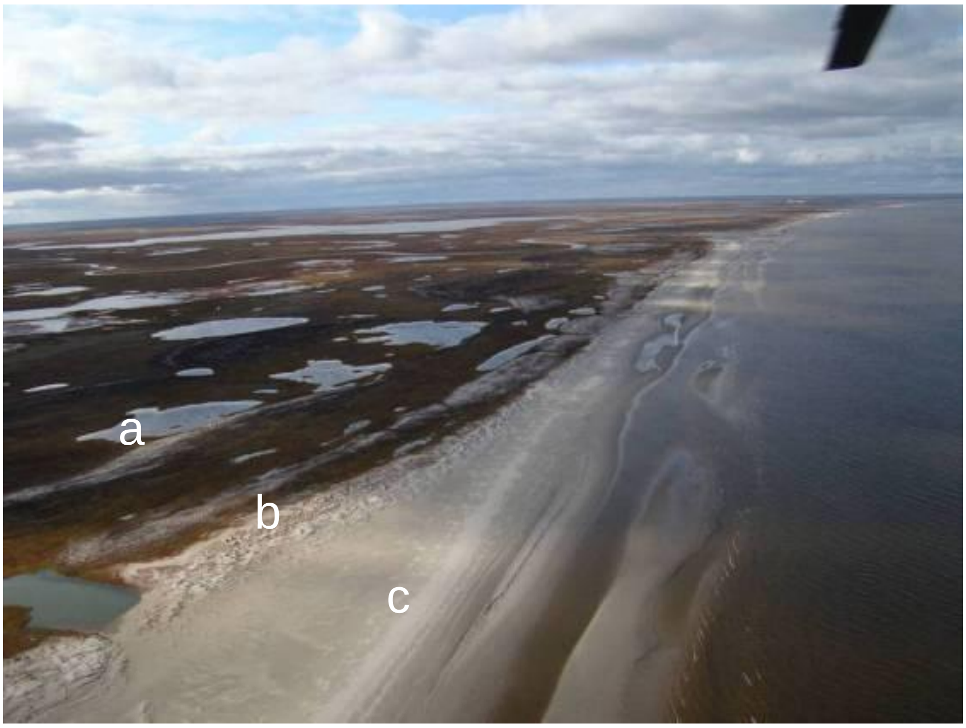


Figure 7.3.1: Lagoonal-marine laida a) - waterlogged surface; b) – the littoral bar; c) – spits and beaches

Modern spits and beaches form a coastal strip along the Gulf of Ob shoreline exposed to intensive reworking by waves and tides.

Figure 7.3.2: Waterlogged surface of laida (zone impacted by tides)

The beach is 30 to 200 m wide and there are a number of offshore bars. The beach is composed of medium-grained well-sorted sands. The surface is not sodded / turfed because of continuous exposure to wave action and tidal flooding (Figure 7.3.3).

Figure 7.3.3: Beaches of the Gulf of Ob in the area of Sabetta settlement

Spits are formed as a result of alongshore sediment movement, mainly near river estuaries.

Level IV: modern alluvial systems

The alluvial systems of the larger rivers consist of two major levels: emerging lower floodplains and upper floodplains reworked by cryogenic processes. These types of geomorphology are represented by the floodplains of the Sabettayakha and the Venuymuyeyakha rivers that traverse the Project Licence Area from west to east.

The width of the Sabettayakha floodplain is 5 km, and the Venuymuyeyakha floodplain is 10 km wide. The floodplains are stepped and distinctly divided into the riverside (prechannel) and rear 'backland' parts.

The lower prechannel floodplain is elevated to 1 to 1.5 m above the river water line, while the upper floodplain is up to 2.5 m high.

The prechannel floodplain occupies meander spurs and is characterised by surface ridges up to 0.5 m high. However, many of the lower ridges are less well defined and can be identified only by the configuration of plant communities. The seasonal depth of permafrost thawing can sometimes be as much as 2m.

Wide backland (rear) areas of floodplains have flat, occasionally polygonal surfaces. They are marked by circular thermokarst and oxbow lake basins. The seasonal thawing depth is typically not more than 60 to 90 cm. The valleys of smaller rivers traverse all elevation levels with varying depths of incision. The valleys have a trough-shaped cross profile and the beds are mostly occupied by waterlogged floodplains.

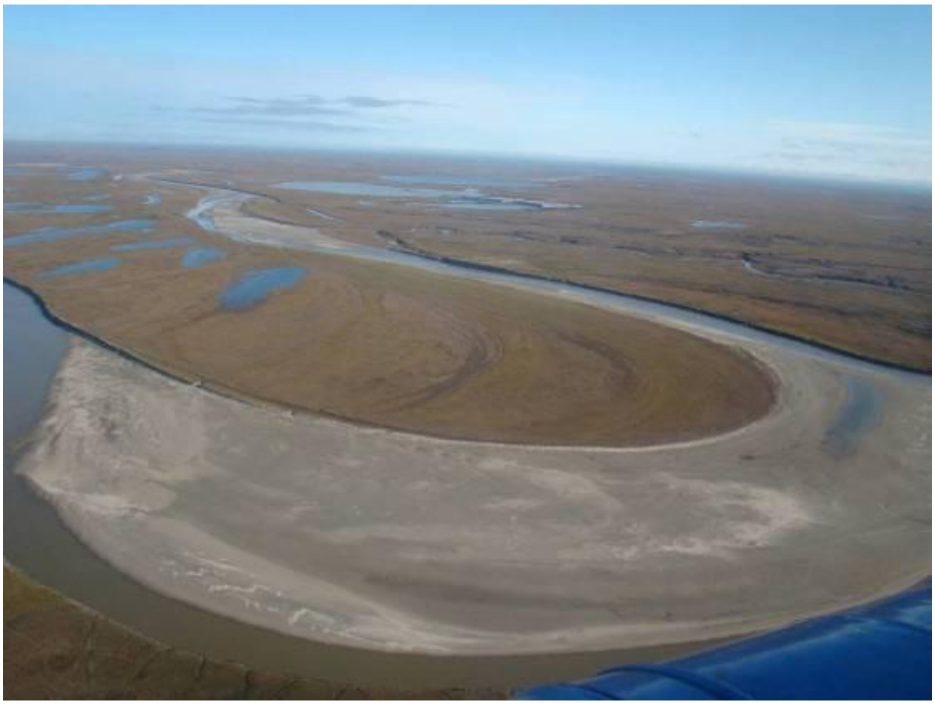


Figure 7.3.4: River floodplain

Offshore studies[6] have been undertaken into the sedimentation (accumulation) and erosion patterns near Sabetta harbour and at the location of the Navigation Channel. Near Sabetta, the studies indicate that in the nearshore mainly accumulation occurs, while in the area of the Approach Channel ice-berg plough marks are visible. Towards the centre of the bay erosion is found to occur. In the area of the Navigation Channel, two profiles were investigated running parallel along each side of the channel (west (profile 1) and east (profile 2)). This study identified areas of both accumulation and erosion within a one year study period (2011-2012) as follows:

- In the deep, most south-western part of the Navigation Channel, accumulation occurs (in the order of 60 cm in the one-year study period)
- The south-western flank of the shallow sill is characterised by sedimentation along profile 1 (order 25 cm per year) and characterised by erosion along profile 2 (order 20-40 cm per year).
- Along profile 2 the shallowest zone is characterised by erosion (order 10-20cm per year). Along profile 1, however, the shallowest zone is characterised by sedimentation (in the order of 10 cm per year).
- The most north-eastern flank of the shallow sill is characterised by erosion (in the order of 20 cm per year along profile 2).

[6] "*Sedimentation study and numerical modeling of siltation in the Sea Channel and Sabetta Port and Sabetta Access Channel of Yamal LNG*", Porteco, march 2013.

7.3.3 PERMAFROST

7.3.3.1 GENERAL

The Project License Area lies in the east Yamal peninsula permafrost region, a zone of continuous permafrost where thawing occurs only seasonally to relatively shallow depths. The continuous permafrost sheet is broken only under river beds, thermokarst lakes, and in the coastal zone of the Gulf of Ob.

Areas with the thickest permafrost layer are situated in the axial, most elevated part of the Yamal Peninsula. They form a wide sweep of perennially frozen ground stretching from the latitude of the Tambey Village across the northern and central Yamal.

7.3.3.2 PERMAFROST THICKNESS

The thickness of permafrost in the Project License Area varies from 20 to 350 m. The permafrost thickness slightly increases towards the rear of terraces, in areas where shallow waterbodies existed at the time the terrace deposits were laid down. On modern laidas and wide floodplains, the permafrost thickness increases to between 25 m 250 m.

The permafrost attains depths of 200 to 250 m in the upper (narrower) reaches of the floodplains of larger rivers. In the lower and middle reaches of rivers permafrost thicknesses of 25 to 45 m and 50 to 250 m are most common.

Smaller thicknesses (less than 50 m) are typical of the narrow strip of marine terraces adjacent to the seashore.

7.3.3.3 GROUND TEMPERATURE

The mean annual temperature of permafrost varies from -8 to 0°C inside taliks, with an average value of -5 to -6.5°C. Extremely cold permafrost with temperatures reaching -9°C is associated with the most elevated poorly sodded ground surfaces. Low temperatures (from -6 to -8°C) have been registered on the tops of drained watershed divides.

In poorly drained watershed areas the ground temperature is a little higher (from -5 to -7°C). On flat slopes covered with well developed (0.2 to 0.4 m tall) shrubs the ground temperature is -5°C, while on slopes without shrubs the temperature varies from -6 to -7°C. The highest temperature (-1 to -2°C) is observed in areas of snow accumulation, such as gullies, ravines, osier-beds (willow growth), over edges of dry lake basins and floodplains overgrown with shrubs. In river marshes (valley bogs), the mean annual temperature of permafrost is -5 to -6°C.

Temperatures of -3°C to -4°C are registered on the beach, spits, and in the littoral (intertidal) zone of the Gulf of Ob.

7.3.3.4 UNFROZEN GROUND

Occurrences of unfrozen ground (taliks) are predominantly only found under lakes and large river channels (the Venuymuyeyakha River – see section 7.5 and Figure 7.5.1). They occur as 'open' taliks in the middle and upper reaches and ‘through’ taliks in the lowest reaches. Through taliks are also common under the bigger lakes (the Yambuto and the Penadoto).

The quick melting of snow cover induced by floodwater plays an important role in the ground heat balance in the river valleys, creating favourable conditions for shrub growth. The snow cover in these areas is thicker and it has a warming effect that facilitates development of open taliks.

The thickness of open taliks is 2 to 3m in the upper reaches of rivers, ravines, creeks, runoff gullies / surfaces, and 13 to 14m in the middle stream and lower reaches of rivers with seasonal flow/ runoff.

In the valleys of small streams, where the accumulated snow (approximately 1.5m thick) is washed away by spring melt water, the permafrost temperature in some areas is higher than the ground temperature of surrounding valley sides. Open taliks occur under most of the thermokarst lakes.

Open taliks occupy only a very small percentage of the Project area, associated mainly with areas around the Gulf of Ob and larger rivers and lakes.

7.3.3.5 SEASONAL THAWING OF GROUND

The east Yamal peninsula region is characterised by seasonal thawing in the summer/autumn period. The thawing depth depends on:

- dispersiveness of soil;
- soil moisture (ice content);
- peat content;
- location in the relief;
- lithological composition;
- thickness of peaty layer; and
- type of vegetation.

The thickest seasonally thawed layer is characteristic of drained surfaces composed of sands and sandy loams, and less commonly with loams of a low moisture content. A thick seasonally thawed layer is also typical of spits and levees.

The most intensive thawing (0.7 to 1.5m) occurs in drained watershed areas composed of sandy soil and characterised by the domination of dwarf-shrub / moss / lichen and shrub/ lichen /moss tundras. The thickness of the seasonally thawed layer increases in areas of bare ground.

On poorly drained surfaces composed of sandy loam sediments overlapped by a layer of peat with a domination of herb vegetation, the thickness of the seasonally thawed layer varies from 0.5 to 0.8m. Even a thin (10 to 15cm) layer of peat reduces the thawing depth to 0.4 to 0.6m. Within peats, the thawing depth is 0.3 to 0.4m.

In areas composed of sandy loams and loamy soil, the thickness of the seasonally thawed layer decreases to 0.4 to 0.7m.

Variations in the thickness of the seasonally thawed layer occur across floodplains. Thicknesses between 0.3 and 0.8m are typical in marshes, and thicknesses between 1.0 and 1.5m prevail on sand spits. In laidas, the thickness of the seasonally thawed layer varies from 0.7 to 1.3m in drained (non-waterlogged) areas to 1.5m on sand beaches.

7.3.3.6 CRYOGENETIC TYPES OF PERMAFROST

The east Yamal peninsula region exhibits practically all cryogenetic types of permafrost in the upper 10m thick layer of soil. The upper section consists of genetically heterogeneous syncryogenic strata (freezing simultaneously with deposition of sediments) underlain by shallow epycryogenic genetically homogeneous deposits (frozen after deposition of the entire stratum). Massive syncryogenic formations are found in profiles of the third and second lagoonal-marine terraces, floodplains and laidas. Epycryogenic deposits are associated mainly with the bases of terraces or floodplains in the upstream reaches of rivers. The volumetric ice content of epycryogenic deposits is invariably high (40 to 45%).

The syncryogenic deposits are also characterised by considerable ice content. The volumetric ice content frequently reaches 50 to 65%. Particularly high ice contents are typical of peaty sandy loam-loamy sediments that are common across the region. Large sections of these organomineral formations are exposed in the Venuymuyeyakha river valley.

Seasonally frozen and perennially frozen mud soils are characterised by thin-layered and reticulate cryostructures. The high salinity of marine deposits facilitates the formation of thawed layers (layered permafrost). Layered cryostructures are most noticeable in the zone of widespread cryopegs, where ground with cryopeg inclusions remains thawed at temperatures of -4°C to -7°C.

7.3.3.7 CRYOGENESIS OF THE GULF OF OB

No evidence of frozen ground was found in test holes in the Gulf of Ob (exploratory boring was carried out from the seabed surface to the depth of 50 to 70m). It is, however, possible that masses of frozen ground may occur on littoral shallows (new formations).

7.3.4 EXOGENOUS PROCESSES

Exogenous processes, which result in morphostructural transformation of the surface in the License Area, consist of cryogenic, littoral, channel and aeolian processes. Cryogenic processes prevail, while processes associated with surface water and wind actions are less important.

7.3.4.1 CRYOGENIC PROCESSES AND PHENOMENA

Relevant cryogenic processes include: solifluction (flowing soil), congelifraction (splitting of rock by freeze-thaw action), nivation (cryoplanation), frost heave (congeliturbation/cryoturbation), thermokarst, lacustrine thermal abrasion and thermal erosion. These processes are further described below.

Solifluction

The solifluction processes are most widespread on southern valley slopes with gradients above 2-3°. The solifluction creates a specific terraced micro-relief of sandy loam slopes composed of clay sands and loams. The solifluction processes are most active on the slopes of minor valleys of the second lagoonal-marine terrace.

Congelifraction

The process of splitting or disintegration of rocks as the result of the freezing of the water contained within void spaces and fissures is a wide spread phenomenon in the License Area. Congelifraction leads to the formation of a polygonal micro-relief typical of the entire region. The congelifraction process is most active in the areas of modern accumulative deposits: laidas, river and lake floodplains and peat bogs.

In the north of the region, ice veins may occur in shallow (under 0.5m deep) lakes. The polygonal wedge ice influences processes of thermokarst, thermal erosion and differentiated frost heave.

Frost heave

Frost heave creates frost mounds that are typical of southern Yamal but are not common in the Licence Area. They rise above the surface of floodplains, laidas and dry lake basins, occurring both individually and in groups of 3 to 5 mounds. Mounds are oval in shape, their height is frequently over 8m and their diameter varies from 50 to 70m.

The frost heave is facilitated by freezing of enclosed taliks under drying lakes and dry lake basins. Some mounds may contain an ice or frozen-soil core occurring at depths from 3 to 15m or deeper. However, no frost mounds of considerable size were identified during field survey of the License Area[7].

Nivation

Nivation processes shape the profile of northern slopes, on which snow stays longer, resulting in freeze-thaw weathering and the formation of holes.

Thermokarst

Thermokarst processes are among the most intensive and potentially dangerous phenomena in the field area. The thermokarst process is the irregular thawing of frozen ground accompanied by heaving and melting of ground ice and the formation of a landscape of irregular depressions. The thermokarst processes are widespread in peat bogs on floodplains and low marine terraces. The type of thermokarst landform depends on the type of thawing ground.

[7] Construction Of Facility For Gas Production, Conditioning, Liquefaction and Shipment Of LNG and Gas Condensate From South-Tambey GCF, Geotechnical investigations for construction well cluster pads # 1, 2, 4, 6, 22, 26, 29, 35, 40, 41, 42. Technical report. Engineering-environmental investigations. Book 1. Prepared by OOO “Frecom” in 2012.

- Ravine systems are the result of ice thawing in polygonal flaws in combination with erosion processes.
- Thawing of large accumulations of segregation ice results in the formation of thermokarst lakes. The Project Licence Area is characterised by ongoing thermokarst lake formation processes, wherethawed depressions fill with water to create small or medium-sized lakes of a circular or oval shape.

Intensive thermokarst processes in the upstream reaches of the Seyakha, the Venuymuyeyakha and the Nurmayakha rivers have resulted in the extensive denudation of elevated surfaces. Late Pleistocene terraces with high ice content have been reduced to isolated residual hills surrounded by depressions / dry lake basins sunk to 15-20m.

A combination of thermokarst processes with underflooding results in excessive moistening. Some well clusters are potentially exposed to flooding during a high water period. Thermokarsts are discussed further in Chapter 9.3.3.

Thermal erosion and thermal abrasion

Thermal erosion and thermal abrasion processes are particularly intensive in areas of repeated cavern-lode (wedge) ice and subsurface ice, which is formed in persistent frost fissures in loose rock. The thermal erosion and thermal abrasion processes are particularly characteristic of disturbed localities, resulting in the comparatively rapid development of an extensive ravine system and the disintegration of the coastal parts of elevated terraces. Continued bank erosion through thermal erosion and thermal abrasion depends on the rates of delivery and removal of ground to/from the ravine base.

Low landforms, such as floodplains and laidas, are subject to intensive thermal abrasion and lateral erosion. Denudations caused by active thermal abrasion of banks have steep walls revealing thick lode (wedge) ice. The abrasion is stabilised if the washout of material is slow. In such areas, continued thermal erosion leads to the formation of isolated cone-shaped hills near the bench edge.

7.3.4.2 FLUVIAL (BANK AND CHANNEL) PROCESSES

Surges and tides are very important in the downstream reaches of rivers flowing into the Kara Sea. Intensive washing-out of the left bank of the Venuymuyeyakha River threatens the site of existing well #155 that is located in the water protection zone 30m from the river. The intensive washing-out here is evidenced by blocks of turf separated from the main floodplain cover.

A combination of wave action, tides and surges leads to the movement of alluvia and the formation of beaches and bars at different levels.

7.3.4.3 EOLATION

Disturbances to vegetative cover from strong winds facilitates the development of eolation on unsodden surfaces, mainly on the shore bar (beaches, floodplain and terrace benches), as well as in disturbed areas.

The Aeolian processes are most active in the area of well cluster sites #47, #39 (see Chapter 4) and in the territory of the LNG facilities (in the coastal area). The same sites are also exposed to bank processes. Sand blowouts are also observed near the edges of small rivers on elevated lacustrine-marine terraces where these are crossed by service corridors.

7.3.5 HYDROGEOLOGY

The published regional map of hydrogeological zoning shows the Project to be within the West Siberian complex artesian basin (Taz-Pur basin of order II). The artesian basin consists of two hydrogeological systems; the Upper System and the Lower System. These two systems are separated in the vertical profile by a very significant thickness of low permeability rocks (the Turonian-Eocene confining bed).

The upper hydrogeological system

This is represented by the quaternary (relatively modern) water-bearing system. The Quaternary deposits are almost entirely frozen due to permafrost, which extends to a considerable depth. As a result, underground water resources are extremely limited and influenced by zones of local thawing (taliks). Thawing only occurs in localised areas to a depth of around 1.5m to 2.0m. Perched groundwater is only present on a temporary basis during the warm season.

The permanently frozen ground below the zone of thawing will prevent any connection between groundwater in the thawed zone and deeper parts of the aquifer. However, groundwater in the thawed zone has the potential to discharge to surface water. Therefore, it is relevant in this instance to consider shallow groundwater as being part of the hydrological system. Further details on shallow groundwater are provided in Section 7.5.5.

Turonian-Eocene confining bed

This is a sequence of rocks, approximately 900 m thick, that are of a very low permeability (an aquifuge). This aquifuge isolates groundwater in the lower hydrogeological system from groundwater in the upper hydrogeological system.

The lower hydrogeological system

This lower system is located under the very thick Turonian-Eocene confining bed. The aquifers in the lower hydrogeological system are therefore also isolated from surface water and atmospheric precipitation.

The lower hydrogeological system is subdivided into several stratigraphic units.

Table 7.3.3: The lower hydrogeological system

Aquifer unit	Thickness	Characteristics
Marresal	up to 500 m	This is located immediately under the regional confining bed at a depth of approximately 900 m. Water-bearing strata: sandy siltstone, 10 to 40 m thick. Aggregate thickness: 100 to 150 m. Uneven distribution across the aquifer section explains

Table 7.3.3: The lower hydrogeological system		
Aquifer unit	**Thickness**	**Characteristics**
		variations in thickness. In the Project area, the aquifer is fully saturated.
Yarong	120 to 340 m	The system consists of low permeability marine clays with interbeds (occurring in the first tens of meters) of sandstones and siltstones.
Tanopchin - Lower Cretaceous	up to 1000 m	The deposits consist of sandstones and siltstones with carbonate-argillaceous cement, which form permeable layers in a sequence of siltstone clays and siltstones. Individual water-bearing strata and horizons: from 10-12 m to 50-60 m thick; Confining impermeable layers: from several meters to 40-60 m thick. This aquifer system is well researched due to the presence of commercial accumulations of hydrocarbons.
Upper Jurassic - Lower Cretaceous	up to and over 600 m	This unit consists of low permeability argillite clays of the Akha suite. These are the most ancient aquifers in the region. They were not fully surveyed because they were not penetrated by most of the wells.

7.3.6 SEISMICITY

The region is situated in the northern part of the West Siberian Plate and is characterised by low diffuse seismicity. According to the published seismic zoning map (Construction Standards and Regulations SNiP II-7-81), the magnitude of potential earthquakes will not exceed grade 5 on MSK'64 scale (with return periods of 500, 1000, 5000 years).

7.4 LANDSCAPES, TOPOGRAPHY AND SOILS

7.4.1 HISTORICAL LAND DISTURBANCE

The South Tambey gas condensate field was discovered in the mid-1970s. Since that time, extensive prospecting surveys and exploratory drilling operations have been performed by other past operators to estimate recoverable reserves. In total, 55 prospecting and exploratory wells have been drilled in the Project Licence Area. This historical activity has resulted in a legacy of disturbed and contaminated land (including a legacy of residual industrial wastes), and contaminated surface waters within the Licence Area. The extent of the these legacy issues has been studied by Yamal LNG through interpretation of ultrahigh resolution satellite imagery and field verification studies. The areas affected by historical activities are shown on Figure 7.4.1 (close-up of the areas around the central Project facilities) and Figure 7.4.2 (in the entire Licence Area).

The levels of disturbance/contamination are further discussed in Sections 7.4.3 (contaminated soils), 0 (legacy waste), 7.5.3 (surface water contamination) and 7.6.2.4 (vegetation loss/disturbance).

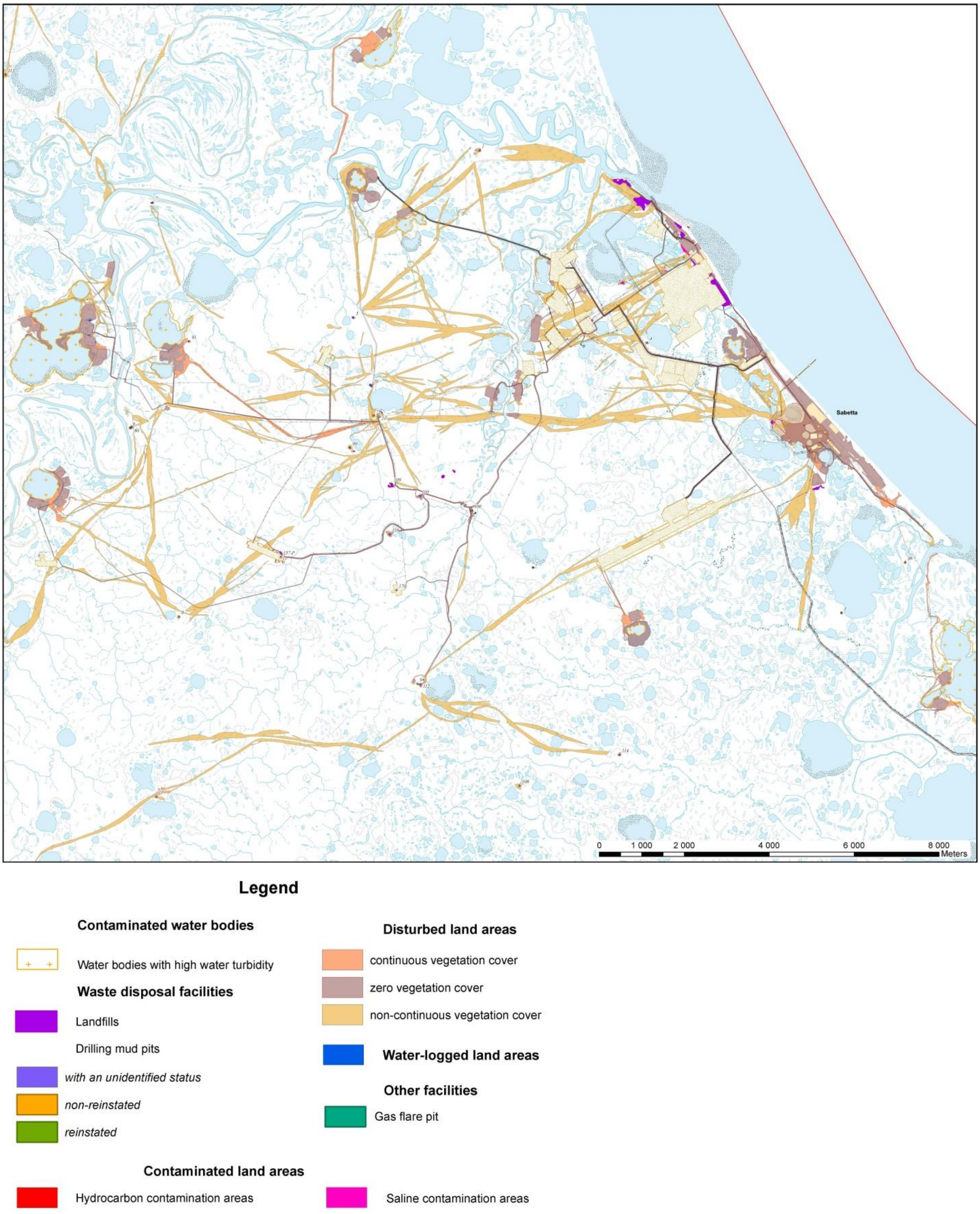


Figure 7.4.1 Location of Historically Contaminated and Disturbed Areas around the Central Project Facilities

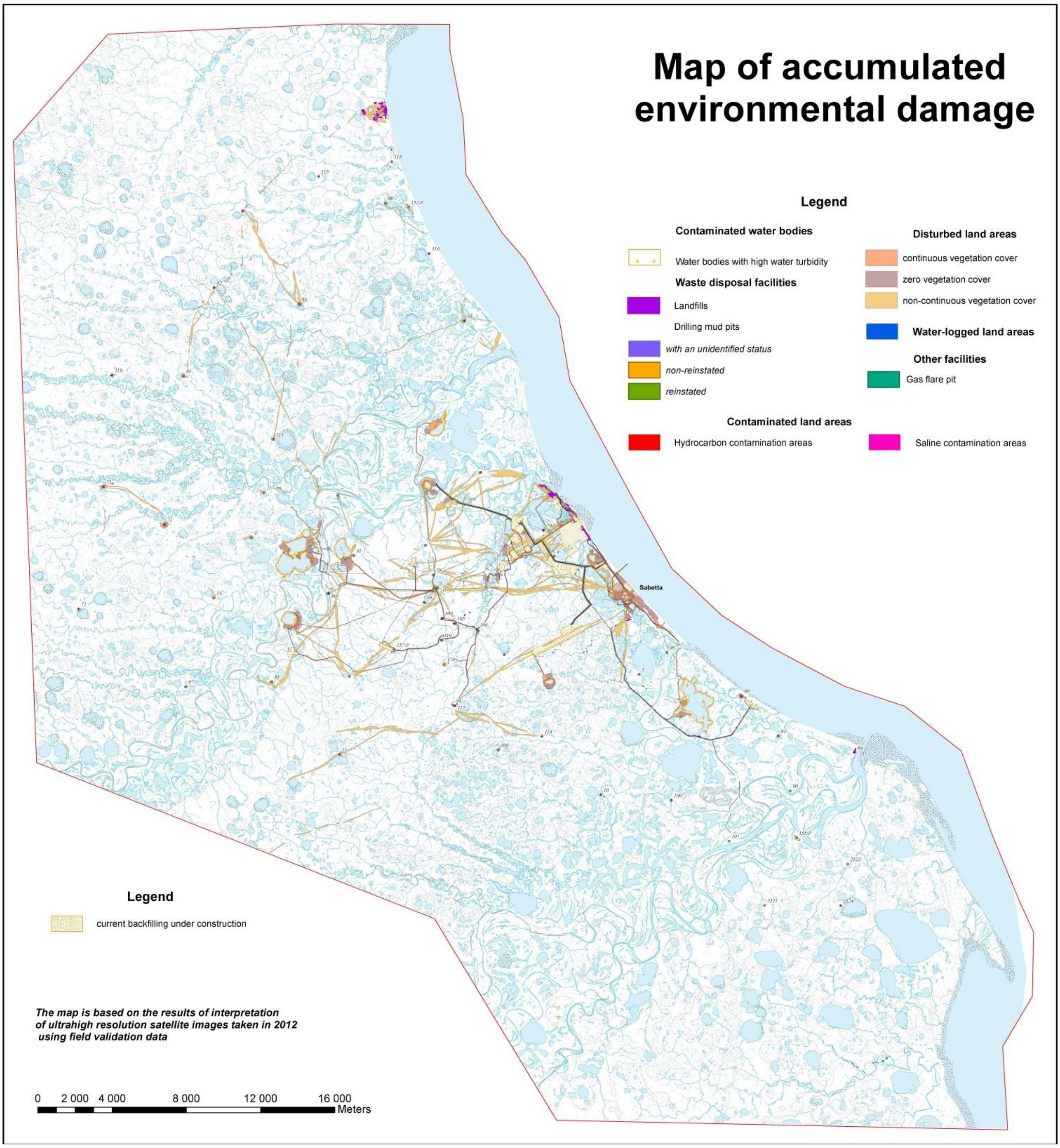


Figure 7.4.2 Location of Historically Contaminated and Disturbed Areas in the License Area

7.4.2 LANDSCAPE AND TOPOGRAPHY

The Project Licence Area is part of the Yamal landscape province. The area is located at the southern boundary of the arctic tundra (commonly known as the southern (right) side of the Venuymuyeyakha River valley). The South Tambey Gas Condensate field is home to 15 natural landmarks and 50 to 60 types of facies[8].

The presence of permafrost, the thawing of permafrost and the resultant soil saturation (see Section 7.3) exerts a significant influence on the formation of the landscape. In the central portions of shallow undulating surfaces, permafrost only thaws to a depth of 20-60cm in poorly drained areas (central areas of undulating interfluvial surfaces). This also leads to saturated ground where moss-lichen tundras are gradually replaced by polygonal tundras, with moss-lichen associations remaining only on the ridges of polygons, hummocky sedge-grass wetlands (waterlogged meadows), sphagnum- cotton grass- sedge and grass-sedge bogs.

The sandy soils in the Project Licence Area are covered by typical hummocky moss-lichen tundras and a significant volume of dwarf shrubs (mossberry, cowberry and blueberry) and a thin growth of dwarf birch, with abundance of cloudberry and miscellaneous herbs.

Perched groundwater is only present on a temporary basis during the warm season.

7.4.2.1 LOW ALLUVIAL MARINE TERRACE

Low alluvial marine terrace deposits are present in the Project Licence Area, in an area 1-5 km wide. These terrace deposits are present 7-10m above sea level. This is a flat undulating waterlogged plain composed of sand with occasional layers of loams and vegetable detritus.

A sand bar is present along the coast of the Gulf of Ob, approximately 6-10m above sea level. The sand bar slopes gently towards the shore and steeply out to sea. The surface of the sand bar ranges in width from 100 to 900m. The hummocky windblown surface is covered by sparse hummocky grass (meadow grass, reed grass) grasslands and occasional unique features with dwarf birch moss-lichen tundras. The sand bar, particularly its seaward slope, is used as a permanent road.

Project associated facilities situated here include: storage facilities, the Sabetta accommodation camp, the proposed LNG and port sites, several wells, and disposal sites for legacy scrap metal and domestic and technical waste. The bar’s natural systems have been essentially undermined by the historical and current economic activity. The areas around the road, storage facilities and industrial sites are characterised by aeolian processes and have an irregular hummocky microrelief (with mounds and depressions); In some places, wind dispersed sands bury the existing (or remaining) vegetation.

The area between the littoral bar and the main surface of the terrace is a trough-like waterlogged depression with the width varying from 0.5 to 2km (Figure 7.4.3). It is almost entirely occupied by sphagnum-sedge, cotton grass-sedge and grass bogs with a depth of 2 to 2.5m. Only marginal

[8] An elementary morphological unit of a geographic landscape.

elevated areas of the depression are covered with waterlogged polygonal tundras and grass-sedge meadows. Several well sites are located on the terrace, but these have no significant effect on the local landscape features.

An area that has been disturbed is a 1.5km wide strip along the motor road running on the right edge of the Salyamlekabtambadayakha valley from the LNG site to the well clusters (see Figure 7.5.1). This area is characterised by local underflooding of stream valleys. The valley sides show evidence of man-induced solifluction (or soil creep). Moss-lichen systems are also being locally replaced by grass and sedge communities. An Abandoned sandpits, which are located 2km west of the LNG site, exhibit features with chaotic (irregular) topography and sparsely mixed herb and grass meadows.

Figure 7.4.3: The surface of low alluvial marine terrace

7.4.2.2 SECOND ALLUVIAL MARINE TERRACE

The second alluvial marine terrace is also composed of sands and lies at an elevation between 10 and 25 masl. The terrace occupies the western part of the Licence Area, rising in an amphitheatre above the lower terrace (Figure 7.4.4). The area is almost untouched by human activity with near pristine natural systems. The terrace surface has a gentle westward slope, but the interfluvial inclinations are so small that the entire surface seems to rest on one level. The characteristic feature of the terrace is a massive ravine-type marginal dissection. Numerous young growing ravines, poorly sodded and undrained gullies and hollows occur on both sides of the terrace (facing the Sabettayakha and the Venuymuyeyakha river valleys). The ravine network is dense and the width of the interfluvial area is not more than 500 to 600m. Ravines are up to 7-8m deep and have steep stepped sidewalls covered by moss-lichen and undershrub polygonal tundras. Thalwegs (bottoms) are covered with continuous sphagnum growth. The biggest ravines have permanent and temporary watercourses, mature floodplains covered by cotton grass- herb meadows and dwarf willow growth. Flat undulating interfluvial surfaces are dominated by sedge-grassland communities. The number of bogs and lake basins located on the second alluvial marine terrace is 10 times less than on the lower terrace.

Figure 7.4.4: The second alluvial marine terrace and valley of small river.

7.4.2.3 FLOODPLAINS

The floodplains of the larger rivers in the field area are stepped, rising from the waterline to the terrace edges, and are characterised by distinct pre-channel and backland (rear) areas. Different parts of the valleys may have 2 to 4 steps. The low pre-channel floodplain is raised to 1-1.5m above the waterline, while the higher floodplains rise to 2.5m. The floodplain is characterised by meandering spurs and by ridged surfaces with an amplitude of up to 0.5m. However, many of the lower ridges can be identified only by the configuration of plant communities. The ridges of higher floodplains are covered by grasslands with dwarf willow, while the ridges of the low floodplains are occupied by rush (horsetail), grass and reedgrass-sedge meadows. Moss-lichen communities with cloudberry and motley grass occur on higher levels. Inter-ridge depressions are occupied by cotton grass-sedge and sphagnum-sedge bogs. The broad rear parts of floodplains have flat, occasionally polygonal surfaces. They are covered by sedge-grass meadows on a continuous carpet of sphagnum. Lake basins with bog complexes are much more common than on the terraces.

7.4.3 SOILS

According to the latest zoning of 2006, the Licence Area is classified as a special northern soil district. There are a number of factors that influence soil formation, including climate, vegetation, the mineralogy of the parent material and the topography.

Climate - Soil formation in the Licence Area occurs during a very short and relatively cold vegetation period. Low temperatures facilitate the prevalence of physical weathering over chemical weathering, and reduce the rate of decomposition of organic residues.

Vegetation - The vegetation cover is discontinous. The slow mineralisation of organic litter (dead soil cover), scarcity of bacterial flora and unfavourable soil temperatures result in the accumulation of considerable reserves of dead plant residues. The biological cycle is slow to the point of stagnation because of low productivity and the low ash content of tundra plants. The organic litter (dead plants) composition is acid.

Mineralogy of parent material – The geological deposits that serve as the parent material for soil formation consist of sand and sandy loam deposits, with a quartz content of 80 to 99%. The content of heavy metals is 1 to 5% maximum. The low content of minerals susceptible to weathering and general fragmentation results in the soil having poor geochemical properties and few mineral nutrients.

Topography – The topography of the Licence Area is characterised by a flat, unevenly broken depositional lowland plain allowing invasion by arctic air masses. The area is characterised by widespread polygonal cryogenic landforms associated with polygonal lode ice and, respectively, abundance of polygonal tundras with relatively rare occurrence of spotty tundras (see section 7.4.1 above).

As a consequence of the above factors, all types of tundra soils in the Licence Area are morphologically indistinct, thin and hydromorphic. They are also characterised by acid pore waters and are poorly humified. Peat formation, gleying and cryoturbation are common.

The gley tundra soils of the northern Yamal are characterised by high concentrations of manganese, phosphorus, and barium. The concentrations of titanium, nickel, cobalt, copper and lead are relatively high, due to the naturally high content of these elements in the soil-forming material.

7.4.3.1 DISTRIBUTION OF MAIN SOIL TYPES

According to the USSR soil classification (1977), the following soil types occur in the territory of the northern Yamal (see Table 7.4.1):

- tundra humus-gley cryogenic,
- tundra humus-gley cryogenic humic-illuvial,
- tundra peat-gley cryogenic,
- tundra peat-gley podzolised,
- peat-bog cryogenic,
- peat-bog degraded, and

- floodplain cryogenic.

The characteristics of each of the above soil types are summarised in Table 7.4.1.

Table 7.4.1: Summary of soil type characteristics (According to the USSR soil classification 1977)

Occurrence	Characteristics	Plant association	Soil-forming material
Tundra humus-gley cryogenic			
Hill tops and slopes, raised and (though rarely) sunken microrelief forms.	One of the most typical and widespread soil types of the well-drained surfaces in the Yamal-Gydan region. Structural profile: peaty underlayer 1-2 cm, humic layer 2-5 cm, gley horizon.	Undershrub-moss and sedge-moss-lichen.	Loam and sandy loam – sand deposits.
Tundra humus-gley cryogenic humic-illuvial			
Raised landforms.	Common across the entire region. Differ from humus-gley by humic-illuvial-humic horizon and less distinct genetic horizons.	Undershrub-moss.	Sand- sandy loam-loam deposits.
Tundra peat-gley cryogenic			
Micro-depressions, hill tops and slopes.	Formed in highly moistened environment. Form complexes with humus-gley soils in well-drained areas and with peat-bog soils in poorly drained areas. The main feature of the structural profile is a peaty horizon, with a thickness of 10 to 15 cm and with a traceable podzolised light underlayer in peaty gley podzolised soils.	Undershrub-moss or sedge-moss.	Sandy loam – loam deposits.
Peat-bog cryogenic			
Flat waterlogged (undrained) interfluvial areas, bottoms of large lake basins and broad floodplain terraces.	Formed in over-moistened environments. The structural soil profile is characterised by a peat horizon with a thickness of 10 to 40 cm. The peat is of a varied composition with different degrees of decomposition. Underlain by genetically undifferentiated gley material of varied mechanical composition.	Cotton grass-sedge and moss, with prevalence of sphagnum.	Vegetation
Floodplain cryogenic			
Well-drained prechannel areas of river floodplains.	These soils are characterised by a thin humic horizon, unevenly replaced by a gleyed laminated alluvial horizon with buried organogenic interlayers.	Dwarf willow-moss, grass-sedge-cotton grass.	Commonly alluvial silt and sand deposits.

According to soil classification 2004[9] following soil types were found in the area of South-Tambey Gas Condensate Field:

- podbours,
- gleyic podbours,
- cryozem (cryogenic soil),
- raw-organic cryozem (cryogenic soil),
- gley soil,
- peat-gley soil,
- alluvial layered soil,
- alluvial humous-gley soil,
- alluvial peat-gley soil,
- alluvial grey humous soil,
- peat oligotrophic soil,
- peat oligotrophic gley soil,
- peat eutrophic gley soil,
- psammozem.

Anthropogenically transformed soils occur in the area of the Sabetta accommodation camp and other existing infrastructure areas (legacy well pads, port, Upper and Lower fuels and lube oils store etc.).

7.4.3.2 SOIL CONTAMINATION STATUS

As described in Section 7.4.1, areas of historically disturbed and contaminated areas have been identified within the License Area (see also Figures 7.4.1 and 7.4.2). In addition, engineering/environmental studies undertaken in 2010-2012 were conducted on behalf of Yamal LNG within the Project License Area, as required by Russian legislation. The scope covered both new facilities (i.e. well clusters, airport and the landfill) and existing facilities (experimental production well clusters, base camp and the industrial zone).

Soil samples were taken from organogenic, organic-mineral and mineral horizons. At some locations aeration zone soil samples were taken from a depth of about 50cm.

Soil Assessment Criteria

In this report, the results of analyses are compared with the Dutch Intervention Values (DIV) as an international benchmark and corresponding Russian quality standards.

The Dutch *Soil Remediation Circular 2009* outlines the criteria for soil contamination assessment and sets DIV that determine whether clean-up measures are required. The DIV have been developed specifically for Dutch conditions and are not legally binding outside the Netherlands. Nonetheless, the DIV can be used for benchmarking purposes when assessing land remediation for the Project.

[9] “Russian soils classification and diagnosis”, 2004.

The Russian assessment approach stipulates two types of standards:

- the maximum permissible concentrations (MPC); and/or
- the temporary permissible concentrations (TPC).

To assess soil quality the following MPC and TPC have been used - Hygienic Standards GN 2.1.7.2041-06 for MPC and GN 2.1.7.2511-09 for TPC.

An MPC for hydrocarbons in soils is not established in Russia. However, if hydrocarbon concentrations exceed 1000 mg/kg (hereinafter referred to as Permissible Contamination Level or PCL), the environmental authorities can impose a fine for soil contamination. The highest fine for soil contamination is issued if the concentration of hydrocarbons exceeds 5,000 mg/kg.

Analytical results are discussed in the section below. It should be noted that only concentrations detected above the corresponding Russian standards and/or the DIV are discussed.

Soil Study Results

The soils were analyzed for the following potential contaminants:

- Heavy metals (cadmium, chromium, copper, manganese, nickel, lead, zinc, mercury) and arsenic;
- Water-soluble chlorides and sulfates;
- Total petroleum hydrocarbons (TPH);
- Phenols; and
- Benz(a)pyrene.

The key findings of the studies are provided below and discussed by area.

Background soil conditions

According to the report "*Environmental background conditions assessment*" (ZAO "Ecoproect", 2010), the following average concentrations of heavy metals and arsenic were identified in the Licensed Area.

Heavy metals and arsenic

Table 7.4.2: Analytical results for background concentration of heavy metals and arsenic in soils of the Licensed Area, mg/kg

Parameter	**As**	**Hg**	**Pb**	**Cd**	**Ni**	**Cu**	**Zn**
Minimum value	<0.2	<0.005	0.67	0.042	17.18	1.17	2.9
Maximum value	0.3	0.035	4.89	0.297	37.60	14.46	29.5
Average concentration	0.14	0.01	2.14	0.21	24.14	4.92	10.58
MAC	2.0	2.1	32.0	-	-	-	-

TPC for sandy and sandy-loam soils	2	-	32	0.5	20	33	55
TPC for acidic clay-loamy soils with pH <5.5	5	-	65	1.0	40	66	110

Background concentrations in soil of arsenic and all heavy metals (mercury, lead, cadmium, copper and zinc) except for nickel are below the MAC/TPC. Background concentrations of nickel exceed the TPC both in sandy and sandy-loam soils. It should be noted that typical concentrations of nickel for this area are in the range of 15-25 mg/kg due to the high content of this heavy metal in soil forming material.

Total petroleum products, phenols and benzo(a)pyrene

Table 7.4.3 Analytical results for background concentrations of total petroleum products, phenols and benzo(a)pyrene, mg/kg

Parameter	**TPH**	**Phenols**	**benzo(a)pyrene**
Minimum value	11.5	<0.5	<0.0012
Maximum value	1279.4	<0.5	<0.0012
Average value	370.01	<0.5	<0.0012
Average value in sandy soils	458.58	<0.5	<0.0012
Average value in clay and organogenic soils	285.4	<0.5	<0.0012

Total petroleum product concentrations of more than 1000 mg/kg are identified in soils of different types, both with extensive and negligible organogenic horizons. All soil samples have high content of organic matter (average content is 9.31%). Taking into account that all soils are natural, the apparent high content of total petroleum products may be associated with the analytical method used for determination of organic matter (infrared analysis), where a quantity of peat (bitumens) may be determined as total petroleum products.

The levels of phenols and benzo(a)pyrene in all samples are less than detection threshold of the analytical instrumentation (<0.5 and <0.0012 mg/kg respectively).

Water-soluble chlorides and sulphates and total iron

Table 7.4.4 Analytical results for water-soluble chlorides, sulphates and total iron

Parameter	**Water-soluble chlorides, mg/kg**	**Water-soluble sulfates, mg/kg**	**Total iron, g/kg**
Minimum value	7.9	<5	1.38
Maximum value	16.9	22.7	12.82
Average value	10.9	7.9	4.9

There are no norms for chlorides, sulphates or iron. Data ranges for water-soluble chlorides are as follows: from 7.9 to 16.9 mg/kg, average concentration is 10.9 mg/kg. Concentrations of water-soluble sulphates vary from <5 up to 22.7 mg/kg.

Average concentration of iron were identified in samples with the highest concentrations of total petroleum products and organic matter, which could be associated with accumulation of iron by organic matter.

Soil acidity and content of organic matter

Table 7.4.5 Analytical results of pH and organic matter content

Parameter	**pH**	**Organic matter, %**
Minimum value	3.99	3.28
Maximum value	4.61	12.43
Average value	4.26	9.31

Data ranges for pH are negligible – from 3.99 up to 4.61. Therefore all soils are considered to be acidic.

The average content of organic matter is 9.31% (ranging from 3.28 up to 12.43%).***Sites Near Sabetta***

The following wells and facilities located near the Sabetta Camp area that have been subject to historical anthropogenic influence were targeted for sampling in the study:

- 'Dump';
- Terminal;
- Bezymyannoye bog (near the treated domestic wastewater settlement reservoir);
- Metal junkyard;
- Fuels and lube oils store;
- Quarry;
- Upper fuels and lube oils store;
- Glubokoye Lake (base camp's water intake);
- Well pad No. 106;
- Well pad No. 7;
- Well pad No. 2322;
- Well pad No. 10; and
- Well pad No. 85.

The exploratory wells listed above are, at present, abandoned with the exception of well No. 106 which will be used in future to supply gas to the base camp.

The results of the soil sample analysis from the sites above that exceed Russian MPC/TPC criteria or the Dutch Intervention Values are summarized in Table 7.4.6.

Table 7.4.6: Analytical Results for soils at sites near Sabetta village

Parameter	Concentration(mg/kg)/times above average background concentration /times above Russian norms/times above the DIV	Russian norms, mg/kg	The DIV mg/kg
«Dump»			
Nickel	36.88/1.5/ 1.8 x TPC/ BES	20	80
Terminal			
Nickel	24.76/1.0/ 1.2 x TPC/ BES	20	80
Bezymyannoye Bog behind settling pond			
Nickel	26.64/1.1/ 1.3 x TPC/ BES	20	80
Upper fuels and lube oils store,			
Nickel	27.82/1.2/ 1.4 x TPC/ BES	20	80
Glubokoye Lake, Water Intake			
Nickel	20.52/0.9/ 1 x TPC/ BES	20	80
Well pad No. 2322			
Nickel	28.76/1.2/ 1.4 x TPC/ BES	20	80
Well pad No. 10			
Nickel TPH	36.84/1.5/ 1.8 x TPC/ BES 1,100.3/3.0/ 1.1 x PCL/ BES	20 1,000	80 5,000
Well pad No. 85,			
Nickel	28.2/1.2/1.4 x TPC/ BES	20	80
BES – Below established standard			

The results indicate that nickel concentrations slightly exceed the TPC. TPH concentrations exceed the PCL at one well pad, No. 10 (1,100 mg/kg). The next highest TPH concentrations are detected at the Terminal (968.6 mg/kg), the upper fuels and lube oils store (921.1 mg/kg) and well pad No. 106 (881.4 mg/kg).

Priority Construction Sites

Soil quality data at priority construction sites is provided in the report, *'The State of the Environment near Priority Facilities of the South-Tambey Gas Condensate Field' (2010)*. The following priority construction sites were included in the study and results are provided in Table 7.4.7:

- Well pads Nos. 21, 106, 152, 155, 157;
- Terminal;
- Glubokoye Lake;
- Bezymyannoye bog, behind the sediment basin,
- Quarry and
- Site "Dump"

Table 7.4.7: Soil Analytical Results for Priority Construction Sites

Parameter	Concentration (mg/kg) /times above average background concentration /times above Russian norms/times above DIV	Russian norms, mg/kg	DIV mg/kg
Well pad No. 21			
Arsenic	10.01/71.5//5.1 x MPC/ BES	2	2
Lead	56.94 /26.6/ 1.78 x MPC/ BES 57.79 /27/ 1.81 x MPC/ BES	32	130
TPH	1810/4.9/1.8 x PCL/ BES	1,000	5,000
Well pad No. 106			
Nickel	20.06/0.8/1 TPC/ BES	20	80
Well pad No. 152			
Nickel	22.64/0.9/1.1 TPC/ BES	20	80
Well pad No. 155			
TPH	1279.4/3.5/1.3 PCL/ BES	1,000	5,000
Well pad No. 157			
Nickel	22.38/0.9/1.1 TPC/ BES	20	80
Glubokoye Lake			
Nickel	20.52/0.9/1TPC/ BES	20	80
'Dump'			
Nickel	36.88/1.5/1.8 MPC/ BES	20	80
BES – Below established standard			

Table 7.4.7 shows that the soils from Well Pad No. 21 have arsenic concentrations 5x above the MPC (and almost 72 times above average background concentration) and lead (27 times above average background concentration) and TPH concentrations are almost 2x the MPC. Soils at other sites generally have slightly elevated concentrations of nickel. Concentrations of nickel in soil sampled from the 'Dump' site are 1.8 times the MPC, although the maximum value of nickel in background soils is 37.6mg/kg. Therefore high concentration of nickel may be associated with background soil geochemistry.

LNG Plant Area and Solid Waste Landfill

Soil quality data for the LNG Plant and well clusters is provided in the 2011 and 2012 Engineering - environmental- study reports undertaken on behalf of Yamal LNG by LLC FRECOM.

The following areas were investigated:

- LNG Plant;
- Water intake;
- Operating personnel's base camp;
- Water treatment plant;
- Offices;
- Fire station and gas rescue plant;
- Landfill;
- Drilling slurry treatment plant, production effluent injection site, wastewater treatment plant, firewater supply pumping station, PS35/10kV utility zone substation;
- Methanol production unit; and
- Contractor operations base.

Table 7.4.8 provides a summary of the soil analytical results.

Table 7.4.8: Soil Analytical Results for the LNG Plant Area and Other Sites

Parameter	**Concentration (mg/kg) /times above average background concentration / times above Russian norms/times above the DIV**	**Russian norms, mg/kg**	**DIV, mg/kg**
LNG Plant			
Cadmium TPH	0.97 /4.6/1.94 x TPC/ BES 1980 /5.4/1.98 x PCL/ BES	0.5 1,000	13 5,000
Water Intake			
Cadmium	0.6 /2.9/1.2 x TPC/ BES	0.5	13
Methanol Production Unit			
TPH	996/2.7/1 x PCL/ BES	1,000	5,000
Contractor Operations Base			
TPH	1381 /3.7/1.4 x PCL/ BES 1486 /4.0/1.5 x PCL/ BES	1,000	5,000
BES – Below established standard			

All soils sampled in the study areas had an acidic reaction.

Two of the ten sites investigated have elevated cadmium concentrations in soil (up to 2x APC at the LNG Plant and Water Intake area). The highest TPH concentrations are detected in soil samples from the most developed part of the LNG Plant area and at the contractor operations bases (concentrations are 1.4 – 2 x PCL). Soil sampled from the Methanol Production Unit also has hydrocarbon concentrations bordering the PCL.

Well Clusters

Soil was sampled and analysed from well clusters (No. 1, 2, 4, 6, 11, 26, 29, 35, 40, 41 and 42).

The results of analyses are summarised in Table 7.4.9.

Table 7.4.9: Soil Analytical Results for Well Clusters

Parameter	Concentration/times above average background concentration / times above Russian norms/times above the Dutch List I.V., (mg/kg/times above/times above)	Russian norms, mg/kg	DIV mg/kg
Cluster No.2			
TPH	2102 /5.7/2.1 x PCL/ BES	1,000	5,000
Cluster No.4			
TPH	1373 /3.7/1.4 x PCL/ BES	1,000	5,000
Cluster No.6			
TPH	956 /2.6/0.95 x PCL/ BES	1000	5,000
Cluster No.26			
Cadmium TPH	1.1 /5.2/2.2 x TPC/BES 2835 /7.7/2.8x PCL/BES	0.5 1,000	13 5,000
Cluster No.42			
Cadmium	0.56/2.7/1.1 APC/ BES	0.5	13
BES – Below established standard			

The soil from well clusters (No. 1, 2, 4, 6, 11, 26, 29, 35, 40, 41 and 42) contain elevated concentrations of cadmium (up to 2.2x TPC). The highest hydrocarbon concentrations are detected in well clusters Nos. 2, 4 and 26, where the PCL is exceeded (1.4x to 2.8x).

Cluster Pads, Service Contractor Pads (SCP), AES 2500 and Related Linear Facilities.

Cluster pads No. 7, 25, 30, 39, 43, 44, 45, 46 and 47 were investigated as well as service contractor pads, AES 2500 and related linear facilities.

The results of analyses are summarised in Table 7.4.10.

Table 7.4.10: Soil Analytical Results for Cluster Pads, Service Contractor Pads, AES 2500 and Related Linear Facilities			
Parameter	**Concentration (mg/kg) /times above average background concentration / times above Russian norms/times above DIV**	**Russian norms, mg/kg**	**DIV mg/kg**
Cluster No.30			
Zinc Nickel TPH	108.23 /10.2/1 x TPC/ BES 87.9/ 3.6/ 2.2 x TPC/ BES 2771 /7.5/ 2.8x TPC/BES	110 40 1000	720 80
Cluster No.46			
Nickel Zinc TPH	60.95 /2.5/1.5 x TPC/BSS 109.3 /10.3/1 x TPC/ BES 1559/4.2/1.6 x PCL/ BES	40 110 1,000	80 720 5,000
BES – below set standard			

Soils analysed from cluster No. 30 and 46 identified elevated nickel concentrations (2x and 1.5x TPC) and with zinc concentrations borderline TPC.

The highest TPH concentrations are identified in organogenic soil horizons at cluster No. 30, the PCL exceeded by 2.8x and at cluster No. 46, 1.6x PCL.

Soil analysed from cluster No. 39 has elevated concentrations of sulfates up to 53 mg/kg. Although Russian norms for sulfates in soil are not established, the registered concentrations at pad No. 39 are approximately an order of magnitude higher than at other pads.

Airport

Background soil concentrations for the proposed Airport location are provided in the 2011 feasibility study undertaken by LLC FRECOM.

The soils analytical results are summarised in Table 7.4.11**.**

Table 7.4.11: Soil Analytical Results for the Airport			
Parameter	**Concentration (mg/kg) /times above average background concentration / times above Russian norms/times above DIV**	**Russian norms, mg/kg**	**DIV mg/kg**
Cadmium TPH	0.55 /2.6/ 1.1 x TPC/ BES 1050-2685/ 2.8-7.2/1.1-2.7 x PLC/BES	0.5 1,000	13 5,000
BES – below set standard			

The airport soils are shown to contain slightly elevated cadmium concentrations above the TPC. TPH concentrations are 1.1x and 2.7x exceeding the PLC.

Seaport

Background soil (and bottom sediment) concentrations for coastal facilities are provided in the 2011 Engineering-environmental study undertaken by OJSC LENMORNIIPROEKT[10].

Sediment results are discussed in the Hydrology Section 7.5.

The soil analytical results are summarised in Table 7.4.12.

Table 7.4.12: Soil Analytical Results for the Seaport

Substance	**Concentration/times above average background concentration / times above Russian norms/times above the Dutch List I.V.,**	**Russian norms, mg/kg**	**The Dutch List I.V., mg/kg (to be provided by Ailish)**
Cadmium	0.83 / 4.0/1.7x TPC/ BES	0.5	13
TPH	(1080-1166)/2.9-3.2/ 1.1-1.2x PLC / BES	1,000	5,000
BES – Below established standard			

One soil sample analysed from the coastal facilities area has a cadmium concentration of 1.7x exceeding the TPC and TPH concentrations slightly above the PCL.

Base camp

Background soil contaminant concentrations are taken from geotechnical investigation reports prepared by URALSTROIPROEKT in 2010.

The following sites were inspected:

- Water intake area;
- Sabetta camp expansion area
- Utility lines/routes: Sabetta settlement – water intake area;
- Sabetta camp;
- High voltage line; and
- Upper fuels and lube oils store.

[10] Geotechnical investigations. Coastal facilities. Engineering-environmental investigations. Technical report. Book I. Explanatory note. 2030-44478-00-ИД".СУБ-2.1. Volume 3.   Prepared by OAO "LENMORNIIPROECT", OAO "INSTITUT YUZHNIIPGIPROGAS (OOO'FRECOM"), 2011.

Soils samples from the planned water intake area did not show any exceedances of permissible concentrations of heavy metals,TPH, phenols and benzopyrene.

Soil samples from the Sabetta camp expansion area and the high voltage line site showed concentrations of Arsenic at 1.6 times (15.76 mg/kg) above MPC (which is 112 times the average background concentration) and slightly elevated background concentrations of lead and cadmium.

Soil samples from the Sabetta camp are reported to have TPH levels close to the PCL (800 mg/kg).

(It should be noted that concentrations of arsenic, cadmium and nickel were not provided by the reports.)

Conclusions

The studies indicate the following:

1. Cadmium is generally present at slightly elevated concentrations. The maximum concentration, detected at one location is 2.2 times the TPC. Nickel concentrations are also found to be slightly elevated with a maximum concentration 2.2 times the TPC at one location.

2. Zinc concentrations are elevated in two samples analysed with a maximum concentration of 1 times the TPC. Arsenic concentrations are elevated in one sample with 5.1 times the APC. Lead is also elevated in one sample with 1.8 times the MPC.

3. Several samples have hydrocarbon concentrations exceeding the PCL (the maximum 2.8 times the PCL). The studies contain no reference to observed hydrocarbon spills on the ground.

4. None of the analysed soil samples have elevated concentrations of benzo(a)pyrene or phenols.

5. None of the analysed soil samples exceed the DIV.

When interpreting the conclusions from the investigation findings, it should be taken into account that a map showing the location of the water sampling points has not been made available in the reports.

It may be concluded from the above results that the concentrations of the studied substances are below the Dutch List intervention values (2009) (despite the fact that the Dutch List intervention values are not adopted in the RF as standards, they serve as adequate guidelines for interpretation of the available soil monitoring data).

The soil quality standards of the RF (MPC and APC values) have been developed with due consideration of indirect impacts on human health. The difference between the MPC (Maximum Permissible Concentrations) and the APC (Approximate Permissible Concentrations) values is in the procedure used for calculation of these values (they are calculated based on long-term and short-term research results, respectively) and the periods of their validity (MPC values are permanent standards and APC values are valid during periods from 3 to 5 years).

As far as the APC norms are concerned it should be pointed out that the scale of non-compliance with these norms is relatively small and uniform. As has been already mentioned earlier (Section 7.4.2), the natural concentrations of metals (in particular, nickel) in soils within the License area are relatively high due to the high content of these elements in the soil-forming material. This is not typical of soils contaminated as a result of anthropogenic factors.

It should be also pointed out that the presence of peat in the soils can cause natural formation of hydrocarbons, which can be determined by means of analysis for total hydrocarbon content.

The results of soil investigations at the No.21 well pad and in the Sabetta camp expansion area demonstrate some isolated 'hot points' of heavy metals concentrations.

The concentrations of contaminants in soils at those points exceed by many times the respective concentrations in soils in the adjacent areas (see below), and it cannot be ruled out that imported soils had been used as fill soil:

- Well pad No. 21 (arsenic and lead concentrations exceed the respective MPC values by 5 and 2 times, respectively, and correspond roughly to the exceedance of hydrocarbons concentration (by 2 times). The arsenic and lead concentrations exceeds the respective baseline concentrations by a factor of 72 and 27, respectively.

- In the Sabetta camp expansion area (the area of the high-voltage power transmission line) the arsenic concentration exceeds the MPC value by a factor of 1.6 and the baseline concentration by a factor of 115.

Approved trigger levels to start remediation of contaminated soils apply to residential and agricultural areas, and are presented in the below tables 7.8.13 and 7.8.1.4.

Table 7.8.13: Levels of soil contamination with chemicals according to Federal Healthcare Standard on soil quality SanPiN 2.1.7.1287-03

Levels of soil contamination	Contents of pollutants in soil						'Zc' Index Value
	Hazard class I		Hazard class II		Hazard class III		
	Organic compounds	Inorganic compounds	Organic compounds	Inorganic compounds	Organic compounds	Inorganic compounds	
Low	From the background level to MPC	From the background level to MPC	From the background level to MPC	From the background level to MPC	From the background level to MPC	From the background level to MPC	–
Permissible	From 1 to 2 MPC	From double background level to MPC	From 1 to 2 MPC	From double background level to MPC	From 1 to 2 MPC	From double background level to MPC	<16
Medium hazardous	Not approved				From 2 to 5 MPC	From MPC to Kmax	16 to 32
Hazardous	From 2 to 5 MPC	From MPC to Kmax	From 2 to 5 MPC	From MPC to Kmax	>5 MPC	> Kmax	32 to 128

Extremely hazardous	>5 MPC	> Kmax	>5 MPC	> Kmax	Not approved	>128
Kmax – maximal value of compound's MPCs with regard to one of the four hazard indices $Zc = Kc_1 + ... + Kc_i + ... + Kc_n - (n-1)$, where Kc is a ratio between observed and background concentrations of contaminants						

Table 7.8.14: Levels of soil contamination with chemicals according to Federal Healthcare Standard on soil quality SanPiN 2.1.7.1287-03	
Levels of soil contamination	Limitations and restrictions on soil use
Low	*No limitations/restrictions*
Permissible	No limitations/restrictions with the exception of sites with increased health or environmental risk
Medium hazardous	The soil can be used as filling material and must be covered with at least 0.2 m thick non-contaminated soil.
Hazardous	The soil can be used as filling material and must be covered with at least 0.5 m thick non-contaminated soil.

The Zc index value of all studied soil samples is below 16 with an exception of the following areas:

- The Sabetta camp expansion area (Zc = 113).
- Well pad No. 21 (Zc =101).
- Well pads Nos. 30 and 46 (Zc = 21).

It follows that according to SanPiN Norm 2.1.7.1287-03 the categories (levels) of soil contamination may be classified as follows:

- The Sabetta camp expansion area (High-voltage power transmission line) – 'Hazardous'.
- Well pad No. 21 – 'Hazardous'
- Well pads Nos. 30 and 46 – 'Moderately Hazardous'.

According to SanPiN 2.1.7.1287-03 any soils having the contamination category 'Hazardous' may be used as fill material and should be covered with a layer of uncontaminated soil at least 0.5 m thick, and any soils having the contamination category 'Moderately Hazardous' may be used as fill material and should be covered with a layer of uncontaminated soil at least 0.2 m thick.

7.4.4 LEGACY WASTES AND EXPLORATION WELLS

As described in Section 7.4.1, areas of historically disturbed and contaminated areas have been identified within the License Area (see also Figure 7.4.1). Survey of the legacy impacts within the License Area was conducted by the Federal state unitary enterprise "Aerogeology" in 2012. The survey was based on interpretation of high resolution remote sensing images and ground-trothing data collection.

Following types of disturbed areas were revealed within the Project License Area:

- Unauthorized waste dumps;
- Mud pits;
- Land plots contaminated with oil products and saline wastewater;
- Mechanically disturbed land plots.

In total 64 unauthorized waste storage areas have been identified within the Project License Area with a total area 45.02 ha. Waste material primarily composed of scrap metal, drilling wastes and solid domestic wastes is stored on the ground without any waterproof protection.

The majority of the waste storage areas are concentrated near Gulf of Ob shoreline in the vicinity of the former 'Lower' Fuel Depot (8 plots with a total area of 21.38ha) and are planned for removal from the Yamal peninsula by Yamal LNG for further utilization and recycling.

Other legacy waste areas were identified near to:

- Tambey Factoria (18 plots with a total area of 17.1 ha)
- Sabetta accommodation camp (4 plots with a total area of 1.3835 ha)
- Prospecting well pads (31 plots with total area 1.1474 ha).

In total, 55 prospecting and exploratory wells were drilled within the Project License Area. On the basis of the survey, 34 drill pits were identified; 22 of the pits were not subjected to remediation after drilling completion. The total area of the identified pits is 4.637 ha.

In total 6 minor areas were identified with contamination from oil products, with a total of area 0.23 ha. The plots were found near the following facilities:

- Two plots near the 'Lower' Fuel Depot (total area 0.0643 ha)
- Two plots near the 'Upper' Fuel Depot (total area 0.147 ha)
- One plot near well 119 (0.003 ha)
- One land plot near well 21 (0.017 ha).

In addition, a further nine land plots were identified with soil contamination by saline wastewater, with a total area 1.83ha. Saline contaminated land plots are related to spillages of produced water, drilling mud and other technological liquids, in particular, from mud pits. These land plots are located near well 157, to the north of well 21, near well 105, and to the west of the 'Lower' Fuel Depot.

The total area of mechanically disturbed land plots was found to be 2792.5 ha, which amounts to only approximately 0.1% of the mining license area. The majority of these land plots are characterized by a disturbed vegetation cover, with approximately 33% of the total areas (932.7ha) showing a full or partial loss of vegetation cover. Following analysis of multi-temporal images, it was concluded that major disturbance occurred during initial development of the area, including during drilling of prospecting wells.

Generally, the environmental impacts described above are connected mainly with the initial development period of the area, including materials supply to the site, constriction of the base camp and infrastructure, prospecting drilling and operations for pilot condensate production.

7.5 HYDROLOGY AND WATER QUALITY

7.5.1 HYDROGRAPHY OF THE YAMAL DISTRICT

The topography of the Yamal Peninsula comprises a flat terraced accumulation plain opening to the north. The surface of the peninsula is only slightly above sea level, is washed by the Kara Sea and is deeply cut by the Gulf of Ob and Taz Estuary. The area is characterized by high water saturation. It is typical for the rivers in the area to be plain-type, shallow and belong to the catchment of the Kara Sea. Permanent hydrological monitoring stations are located in the south of the Yamal Peninsula.

The Project License Area lies within polygonal and arctic mineral sedge bogs. A number of different types of wetland are present:

- Peat-hummock tundra.
- Bogged moss tundra.
- Lowland sedge bogs.
- Sedge-hummock bogs.

Only limited studies of the hydrology of the South-Tambey Gas Condensate field area have previously been undertaken.

The hydrographic network belongs to the Kara Sea catchment and surface watercourses mainly comprise small and mid-size rivers. There are also many lakes, most of which are located in river floodplains, in estuaries and near-estuarine areas. Lakes occupy up to 38% of the area of the river basins in the Yamal Peninsula.

7.5.1.1 SURFACE WATERCOURSES

Within the South Tambey Gas Condensate Field (STGCF), the river network has a density of 0.80-0.98 km/km². The largest rivers (with a catchment area over 1000 km²) are the Sabettayakha and Venuymuyeyakha, which are both considered mid-size rivers[11]. The remaining rivers are 'small-size'. Table 7.5.1 provides a listing of the largest rivers within the STGCF.

Table 7.5.1: Summary of the Largest Rivers within the STGCF

Name*	Tributary of	Length (km)
Venuymuyeyakha (Venuieuo, Venui-Euo, Venui-Yakha)	Gulf of Ob	208
Sabettayakha (Sabetta-Yaha)	Gulf of Ob	165
Ngarkanedarmayakha (Ngarka-Nedarma-Yaha)	Nedarmayaha	37
Yaratose (Yarato-Se-Yaha)	Nedarmayaha	34

[11] Definition based on GOST 19179-73 Hydrology of land, terms and definitions.

Table 7.5.1: Summary of the Largest Rivers within the STGCF

Name*	Tributary of	Length (km)
Nyaruiyakha (Nyarui-Yaha)	Gulf of Ob	33
Yaptanedarmayakha (Yapta-Nedarma-Yaha)	Nedarmayaha	31
Nedarmayaha (Nedarma)	Gulf of Ob	30
Yunkoyakha (protoka №4426)	Sabettayaha	30
Salyamlekabtambadayakha (Salem-Lekaptambada)	Sabettayaha	26
Myacyahad'yakha (Machaha-Yaha)	Nedarmayaha	24
Yaramakodayakha (Yaramkoda-Yaha)	Nedarmayaha	23
Nyaharvangotoyakha (Nyahar-Vanguta-Yaha)	Gulf of Ob	21
Hal'meryakha (Hal'mer-Yaha, Khalmeryakha)	Nyaharvangotoyaha	17
Nganorahayakha (Nganoraha-Yaha)	Myacyahad'yaha	14

* other commonly used names are given in brackets

All the rivers are plain rivers. It is characteristic of mid-size and small-size rivers to have highly meandering beds. They have wide bar floodplains with back sides heavily affected by cryogenic processes and are abundant in thermokarst lakes. Most rivers have sandy beds. The smallest rivers and rivulets often have a narrow beaded floodplain with peat riffles.

The lower sections of rivers that discharge to the Gulf of Ob are subjected to tidal surges and in some instances the tidal influence extends a considerable distance inland. This has a bearing on morphology and bank erosion processes in these rivers.

The main rivers in close proximity to the Project facilities are shown in Figure 7.5.1.

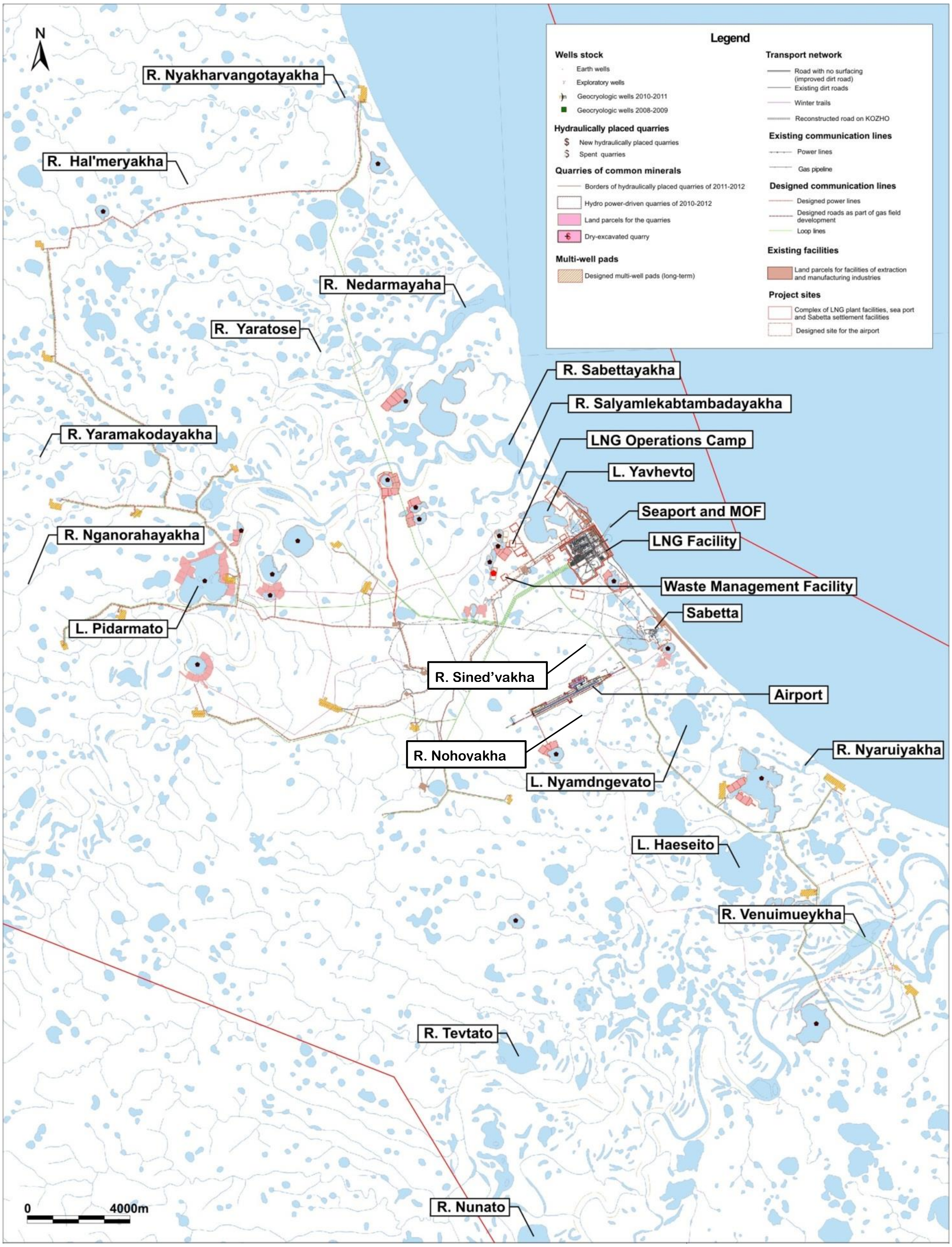


Figure 7.5.1 Main rivers and lakes within the Project License Area

7.5.1.2 LAKES

Lakes within the South Tambey Gas Condensate Field (STGCF) are mainly paludal ('marshy'), floodplain or thermokarst in origin. Most of the lakes have an area of less than 5 km². The lakes are shallow with beds comprising sand and silt. The lake banks are low and grass-covered. The largest lakes include Haeseito (3.6 km²), Eserotato (6.4 km²), Pidarmato (2.4 km²), Yavhevto (1.6 km²), Tevtato (1.7 km²), Paruito (1.4 km²), Nyamdngevato (1.7 km²), Pakalmyto (1.3 km²) and Nunato (1.3 km²). The main lakes in the near vicinity of the Project facilities are shown in Figure 7.5.1.

Oxbow lakes, river sections isolated from the river channels during low water periods (e.g. see Figure 7.5.2), connect with the main channels during high water conditions. Currents are formed during high water conditions, which result in shore erosion and transport sediments.

Figure 7.5.2: Examples of Oxbow Lakes in the License Area

The lake basins are deeply incised into the permafrost strata and have steep yet low banks. The relief of large lakes is complex, but typically consists of a wide terrace of shallow water around the lake shore that dips abruptly to deeper water towards the centre of the lake. The topography of the lake bed is often irregular due to the uneven thawing of wedge ice formations. The depths of large lakes vary between 4 m and 30 m. In contrast, the majority of smaller tundra lakes are shallow with smooth lake-bed topography.

The lakes are fed by precipitation (snowmelt and rain). There is no significant groundwater input due to the permafrost conditions. It should be noted that the lack of significant groundwater input to the lakes does not have any adverse implications for the Sabetta water source (Lake Glubokoye and 2 smaller unnamed lakes), as the water source is replenished by precipitation and snowmelt. The amount of water that is abstracted from the source must not exceed the rate stipulated by the conditions of abstraction licenses issued by the relevant authority. The permitted rate of abstraction is set by the authority to ensure that it does not exceed the rate at which the source is replenished by precipitation and snowmelt.

Sediments in the near-shore shallows typically comprise sands or silty sands, whereas silt predominates in deeper parts of the lakes. Hollows in the topography of lake beds are often filled by sediments that are derived from bank erosion or that have been transported to the lakes by rivers. Sediment might also be derived from the remains of aquatic organisms. These sediments often accumulate to a depth of 2-3 m, which suggests that the lakes are very old.

7.5.1.3 GULF OF OB

The boundary of the proposed sea port is located 1 km south of the Sabettayaha river estuary. Depths within the port boundary and external access routes from the northern parts of the Gulf of Ob vary from 10 m to 22 m. It is characteristic of the coastal waters to have shrinking sand banks. A 15 m isobathic line which delimits an open sea navigation area is situated 7.5 km away to the north. The sea bed in the area of the proposed sea port berthing facilities has gentle slopes. The sediments at depths of 6 m or less mainly comprise fine sands. Sediments at greater depths mainly consist of sandy silt and banks of sand.

7.5.1.4 WATER PROTECTION ZONES

According to the Russian Federation Water Code, each surface water body must have a defined water protection zone. The two largest rivers, the Sabettayakha and Venuymuyeyakha, each have a 200 m water protection zone . The Nohoyaha river, Sined'yakha River and most other rivers have protection zones of 100 m. The Nohoyaha stream and other small streams have a 50 m protection zone. The width of the water protection zone for the Gulf of Ob is 500 m.

The width of the near-water protection strip depends on the slope of the beach. A 30 m strip applies to a beach with a reverse or zero gradient, 40 m for a gradient below three degrees, and 50 m for a gradient of three degrees or higher.

Watercourses and lakes in the Project License Area have been designated a near-water protection strip 50 m wide.

According to Article 65 of Water Code the following activities are prohibited within water protection zones/belts:

- use of wastewater to fertilize soils;
- cemeteries, burial grounds, waste disposal, disposal of chemical, explosive, toxic, poisonous substances, disposal of radioactive waste;
- aerial spraying for pest control;
- vehicular traffic and parking (except traffic on paved roads and parking in special areas);
- plowing;
- disposal of dredge spoil;
- livestock grazing.

Design, construction, reconstruction, commissioning, operation of commercial and other facilities are allowed within water protection zones if they are provided with water protection facilities.

7.5.2 SURFACE WATER BODY HYDROLOGY

7.5.2.1 RIVER HYDROLOGY

The rivers of the Yamal Peninsula have the West-Siberian type of hydrology with flooding in spring and summer and low water in winter and summer/autumn. Rivers are predominantly fed by snow meltwater, which accounts for approximately 70-80% of river flow. Direct runoff of precipitation contributes to only approximately 20%. The contribution of groundwater seepage to rivers is very low due to the presence of a shallow permafrost rock. Due to the predominance of freezing temperatures during the year, river flow (especially in small rivers) is limited to around 2.5 months, with many rivers being completely frozen in the winter months.

On average, the highest precipitation occurs in June and has an average duration of 15-20 days. During periods of high precipitation water levels wise rapidly and recede relatively slowly. The average rise in daily water level during these periods is 30-40 cm and the water recession rate is 5-10 cm per day. High water levels result in extensive flooding, to which wide valleys and weakly incised riverbeds are conducive. At the time of the spring floods, the most extensive bank erosion occurs at bends where water and ice floes become easily congested.

The average duration of the Summer/Autumn low-water period is usually 30-35 days, but no low-water period may occur in years of particularly high rainfall. Winter low-water begins in late October and ends in mid-May with an average duration of around 200 days. As below zero temperatures arrive, the already small amount of groundwater contribution to river flows starts to decrease, river flow drops and by the second half of October most rivers have frozen through entirely.

On average, various ice formations ('zaberegi', 'shuga', 'salo' in the local dialect) can be observed in the rivers after October 10, with solid ice sets appearing on rivers from October 15 for an average duration of 230 days. Winter discharge for large rivers is 8-10% of the annual river discharge. The thickness of the ice depends on the winter severity and other local factors and can reach 150-200 cm in thickness or more (the maximum recorded is around 250 cm). Ice forms on smaller rivers by sections of land-fast ice welding together. In winter, the rivers freeze through giving virtually no discharge.

Ice congestions and 'floe diving' can give rise to intensive riverbed deformations due to the shallow depths and extensive meandering nature of the rivers.

In permafrost areas, ravines and river bank slopes undergo thermal erosion, solifluction (flow of water-saturated soil down a slope) and soil heaving, etc. Such phenomena are also conducive to riverbed and valley slope deformation, especially in sections with a southern aspect.

Sabettayakha River

The Sabettayakha River discharges into the Gulf of Ob (see Figure 7.5.1). The river is 165 km in length with a catchment area of 1680 km^2. The lowest width reach is 150-250 m and in the estuary it can be as wide as 600-700 m. The river is between 1.5 m-2.5 m deep in its non-tidal reaches, and up to 3.5 m deep in the estuary. The flow velocity drops to 0.1-0.2 m/s in the estuary. The river floodplain is up to 2-3 km wide and in some places heavily waterlogged. It includes numerous lakes and smaller rivers and streams. The Salyamlekabtambadayaha River flows into the Sabettayaha River around 1 km upstream from the mouth of the estuary.

During spring floods, when water levels are at their highest, the waters of the Sabetta-Yaha River merge at the lowest section of the estuary with those of the more northern Nedarma-Yaha river, as they share one floodplain.

During strong easterly winds, the estuary of the Sabettayaha River may experience back flow surges reaching up to 5 km upstream.

Depending on the severity of winter, the river periodically freezes through its upper and middle reaches. At its lower reaches, 10-11 km upstream from the estuary, the river does not freeze through due to the influence of the Gulf of Ob.

Sined'yakha River

The Sined'yakha River is located to the south of the proposed Project sea port and near the airport facilities (see Figure 7.5.1). The river is 11.5 km in length with a catchment area of around 22 km^2. Near the airport site the riverbed is beaded, meandering in lower reaches with a width of around 20 m. In the estuary the river is up to 50 m wide. The river banks are up to 1 m in height. The river's floodplain is up to 10 m wide in periods of high water.

Nohoyakha River

The Nohoyakha River also flows south of the proposed airport (see Figure 7.5.1), which will be situated on its left-hand bank. The Nohoyaha is a left tributary of the Nyaruiyaha River and discharges into it around 700 m from the Gulf of Ob. The Nohoyakha river catchment area is 16 km^2. The river is 12 km in length, around 2-2.5 m in depth and varies in width from 2 to 20 m in the vicinity of the proposed airport. The river predominantly meanders, and occasionally features lake-like expansions. The river bed comprises sand and its banks are low and waterlogged. The river flow is notably weak in the low-water period.

7.5.2.2 LAKE HYDROLOGY

Lakes are predominantly fed by snow meltwater. The contribution of groundwater is largely non-existent due to permafrost conditions. Meltwater discharge to almost all exorheic (free draining) and endorheic (closed without an outlet) lakes comes from small catchment areas. An exception is flow-through lakes as they receive meltwater from the basins of the rivers discharging into them.

Figure 7.5.3: Photograph of a lake within the Project License Area

The water level pattern during the year is relatively consistent without an abrupt rise or fall (exceptions are exorheic lakes, where the level depends on its associated river). Annual water level fluctuations vary within a narrow range. In closed lakes the range does not exceed 10 cm and in free draining lakes 50 cm. The water level in lakes has a clear spring maximum, decreasing in June around the time of ice recession.

Overflowing floodplain lakes can result in the land separating the lakes and rivers becoming washed away. When this occurs, the lake will empty into the river with a flow velocity at the connecting passage reaching 3-5 m/s. This results in empty lake basins ('hasyrei' in the local language or ‘alas’).

7.5.2.3 BOG HYDROLOGY

Water levels in arctic bogs are influenced by climatic factors including precipitation, surface layer heat, seasonal thawing and evaporation processes.

The highest levels of bog waters are observed directly after snow cover recession and are 10-20 cm to 25-30 cm above average. Annually, the rise of bog water levels begins around late August. Bog land is also depicted in Figures 7.5.2 and 7.5.3.

Shrub tundra, areas with a permanent cover of cotton-grass-moss, thaws to depths from 0.3 m to 0.8 m. Grass-shrub covered areas thaw up to 1.0 m depth. Key factors that determine thaw depth include solar radiation, topography, humidity and the type of top soil and vegetation.

Due to the flat nature of bogs, water drainage is a very slow and lengthy process. Annual amplitudes of water level fluctuations are around 15-20 cm. In October-November bogs freeze through entirely and the lower border of the frozen layer comes into contact with the underlying permafrost.

The water regime of bogs found in the river floodplains is closely connected with the water regime of the rivers themselves and the lakes located in their floodplains. The direction of bog outflow is determined by floodplain relief. The bog water main outflow occurs during the spring flood, with the highest rate of outflow occurring after rainfall events.

7.5.2.4 GULF OF OB HYDROLOGY

The length of the Gulf of Ob from the Ob estuary to the Kara Sea outlet is 760 km. The total area of the Gulf is 40,800 km^2, with a width of 35 to 80 km and a depth of 10 to12 m, deepening to 20-22 m in the northern section. The water level in the Ob-Taz estuarine area is influenced by the tide, surge processes, riverbed morphology and ice processes. A 0.5 m high tide in the Kara Sea rises to 2-3 times this height as it enters the narrows of the Gulf and then gradually drops in height reaching almost zero fluctuation in the middle of the Ob estuary.

Surges in the Gulf of Ob occur due to northerly, westerly and north-westerly winds. South-westerly winds may result in a small rise in water level. Negative surges are caused by easterly, southerly and south-easterly winds. Irregular water level fluctuations reach their maximum at the southern border of the estuarine coast (Cape of Yam-Sale).

Water levels in the Gulf of Ob are also influenced during periods of severe flooding from the rivers discharging into it. Information on the average, maximum and minimum water levels is supplied by the Tambey marine hydro meteorological station:

- Long-term average water level - minus 29 cm Baltic Height System (BHS).
- Maximum estimated annual level, every 100 years - 128 cm BHS.
- Maximum estimated annual level, every 50 years - 118 cm BHS.
- Minimum estimated annual level, every 20 years - minus 147 cm BHS.

Permanent, tidal and wind-driven currents occur in the Gulf of Ob. Permanent currents are predominantly influenced by discharge from the Ob River and flow to the north with a velocity of 0.05-0.1 m/s. Tidal currents can have a velocity as high as 0.6-0.7 m/s in the north-western parts of the Gulf of Ob. Wind-driven currents are caused by northerly and southerly winds.

On the surface, the velocity of combined currents reaches 1.4 m/s. At depth (20 m in the northern section), the maximum current velocity was 0.48 m/s. The most dominant current is observed on the surface and flows north-south.

The highest waves develop from steady northerly and southerly winds. During the whole navigation period (when the ice has receded), waves of 1 m in height or lower occur 50-60% of the time. With a wind velocity of 10-15 m/s, average wave heights are between 1.0 to 1.5 m. The number of storm days in the Gulf of Ob is 50-60 a year and storms occur more frequently in the winter months. Waves up to 4-5 m in height can also occur.

The natural navigation period in the Gulf lasts only 70 to 90 days. It is prolonged only with the help of ice-breakers. According to the Tambey Weather Station, the ice period in the Gulf of Ob lasts from 275 to 290 days, although a maximum ice period of 322 days was recorded near the settlement of Tambey. The Gulf is ice-free between July and October. Ice reaches its maximum development in April/May with an average thickness of stationary ice of 150 cm and a maximum thickness of 240 cm.

In the western parts of the Gulf, where shallows are abundant, ice hummocks are formed at a larger rate than in the central parts of the Gulf. Drift-ice that runs aground (‘stamukhas’ in local dialect) is held by landfast ice at depths less than 10-15 m. Over 30% of the Gulf bed is gouged as stamukhas plough along the Gulf. The largest numbers of gouges along the navigational approach channel occur at water depths of 10-15 m, with some gouges cut to a depth of up to 1.3 m. The flora and fauna in the northern part of the Gulf of Ob is subjected continuously to impacts of stamukha and is capable to recover after such impacts. However, the recovery processes at higher latitudes is slower and due to this reason the biodiversity in the subject area is significantly lower than in the middle and southern parts of the Gulf of Ob.

It is characteristic of ice conditions in the northern parts of the Gulf of Ob to have an area of unfrozen sea within the ice pack. The Gulf’s borders change position both during the year and year to year, depending on the severity of the winter.

The water temperature in the Gulf of Ob is consistent with the air temperature in that it falls towards the north. At the Gulf bed in the north, water temperature can be below 0°C, even in summer. In the winter, fresh water temperatures remain around 0°C and in the far north fall below zero.

In the northern part of the Gulf of Ob, the division borderline (halocline, caused by a strong, vertical salinity gradient within a body of water) is slanted towards the Gulf in near-bed layers and can shift significantly. The largest influence on shifting of this zone is due to fluctuations in annual river discharge. In summer, sea water with a salinity of around 30‰ reaches as far as 10 km in to the Gulf. In the autumn the distance reached is 210 km and in winter up to 340 km. In winter, in the northern parts of the Gulf, salinity is distributed vertically, the presence of a flaw polynia (open area of water) being a major factor. Salinity at the water surface is 8.0-9.0‰, while at the sea bed it can be as high as 18.0-19.0‰. Intensive surge and tidal processes are conducive to mixing. For this reason, homogenous vertical salinity is observed in winter. In July, the water surface salinity is 1-2‰ and in September 5‰. In summer, at a depth of 8 m the salinity is 6-9‰.

The coastline near the proposed airport comprises a full profile beach. It has underwater and above water ridges, 20-50 m wide and 1-2 km long. The beach comprises medium-to-coarse grained sand and periodically experiences wave, tidal and surge impacts.

7.5.3 SURFACE WATER HYDROCHEMISTRY SUMMARY

7.5.3.1 LAKES AND RIVERS

As described in Section 7.4.1, historical contamination has been identified in certain surface waters within the License Area (see also Figures 7.4.1 and 7.4.2).

The chemical composition of surface waters in the Project License Area is determined by the type of soil and the quantity of moisture in river basins. In the Yamal Peninsula, peat-bog soils predominate. A high degree of looseness, characteristic of loamy tundra soils, results in high turbidity. Elevated levels of silicone colloid compounds arise from washout and runoff of suspended solids, especially during the spring floods.

Rivers begin to carry suspended solids after the ice breaks away from the river bed. The highest turbidity in rivers (3,000-5,000 g/m³) in the northern parts of the Yamal Peninsula occurs during the flood recession due to a sharp increase in river bed erosion and the onset of soil thawing. The lowest turbidity (300-400 g/m³) occurs at the end of summer. The seasonal changes in turbidity levels influence the timing of migratory fish runs and spawning, with spawning typically timed to coincide with low turbidity within spawning grounds.

It is characteristic of tundra soils for highly soluble salts (e.g. chlorides and sulphates) to leach out with rainwater, which results in low mineralization of surface waters at all stages of the hydrological cycle.

Waterlogged catchment areas contain waters with low or reduced mineralization, high levels of organic compounds and have high oxidability and water colour indices. It is characteristic of water in bogs and waterlogged areas to have elevated background levels of some microelements (e.g. iron, copper, manganese).

It is also characteristic for tundra areas to have a brief period of open water surfaces, which results in the reduction of dissolved oxygen levels to 2-3 mg/l at the end of low water period (25-30% of saturation level).

Background hydrochemistry data in the area of the South Tambey Gas Condensate field and within the proposed LNG Plant impact zone is sourced from a feasibility study conducted by OOO FRECOM in 2011.

The pH of surface waters in the study area ranges from neutral (pH 7) to slightly alkaline (maximum pH 8.33 in a lake).

Surface waters in the study area also have a low colour index relative to region-wide values, which indicates a low level of dissolved organic compounds. The lowest colour index was found in a lake located west of well 112 (10°PtCo).

The ionic composition of surface waters is quite homogenous. Natural (undisturbed) surface water bodies of water are classified as a hydrocarbonate class, magnesium group or calcium group. The total levels of calcium and magnesium salts, which determine water hardness, are insignificant. Sulphate and chloride concentrations identified in samples are present in quantities that are well below the Russian Maximum Allowed Concentration (MAC). It is characteristic of surface waters in the study area to have insignificant levels of nitrogen compounds and high levels of phosphates. All screened bodies of water showed low levels of nitrogen mineral compounds. Orthophosphate levels in river waters are recorded above MAC for fishery water bodies (0.05 mg/l) and in lakes orthophosphate levels were 0.9 of the MAC. The highest levels of orthophosphates are reported in the Salyamlekabtambadayakha River. Nitrites and nitrates in all studied surface water bodies are considerably below the MAC (0.08 mg/l for nitrites and 40 mg/l for nitrates). Surfactant levels exceed fishery MAC by 1.2-2.65 times in the Salyamlekabtambadayakha River and the lake to the west of Sabetta.

Hydrocarbon concentrations are below the laboratory detection limit, with the exception of the lake west of Sabetta. The lake (YT05LW monitoring station) had visual signs of hydrocarbon contamination and hydrocarbons were detected by laboratory analysis. It is noted that hydrocarbons identified in surface water bodies in Yamal can have biogenic origins from the decay of plant remains (humids and lipids) in bog or lacustrine facies.

Phenol concentrations in all samples are below the laboratory detection limit (0.0005 mg/l) and therefore below the MAC for fishery water bodies and sanitation-hygiene. Benzo(a)pyrene (a polycyclic aromatic hydrocarbon or PAH) concentrations are also below the laboratory detection limit of 0.0005 µg/l.

The Salyamlekabtambadayakha River and an unnamed lake near Sabetta have elevated concentrations of copper, manganese and iron above the MAC (see Table 7.5.2).

Table 7.5.2: Heavy Metal Levels in Salyamlekabtambadayakha River and a Lake near Sabetta (mg/l)

Monitoring Station	Fe_{tot}	Mn	Cu	Zn	Pb	Cd	Hg	Ni
YT01RW	0.10	0.0333	0.0032	<0.0020	<0.00025	0.00005	<0.000010	0.0073
YT05LW	0.32	0.0232	0.0034	0.003	0.00028	<0.00002	<0.000010	0.0242
YT08RW	0.11	0.0178	0.0064	<0.0020	<0.00025	0.00002	<0.000010	0.0091
YT11LW	0.09	0.0055	0.0056	<0.0020	<0.00025	0.00002	<0.000010	0.0018
***MAC**$_{fishery}$*	***0.1***	***0.01***	***0.005***	***0.05***	***0.01***	***0.01***	***0.00001***	***0.01***
***MAC**$_{household}$*	***0.3***	***0.1***	***1.0***	***1.0***	***0.01***	***0.001***	***0.0005***	***0.02***

The water quality in the unnamed lake near Sabetta meets microbiological and parasitological requirements (SanPiN 2.1.5.980-00) imposed for both drinking waters (Category 1) and recreational waters (Category 2).

A water quality assessment using the integrated water quality index classifies the studied water bodies as 'moderately contaminated' (Quality Class III). High levels of surfactants (and potentially orthophosphates) in surface water bodies are considered to be related to human activities. Water quality (e.g. in relation to the levels of hydrocarbons and heavy metals) is largely determined by specific geochemical background conditions, with human impacts contributing to a much lesser degree. Therefore the 'elevated' levels of some substances are considered to represent the natural hydrochemistry of the water bodies.

7.5.3.2 GULF OF OB

The dissolved oxygen levels in the Gulf water along the coastline indicate a good oxygen supply.

Near-shore waters in the Gulf have elevated concentrations of phenols above the MAC for fishery water bodies (4.9 times above the MAC), but do not exceed the MAC for household and recreational water bodies. In addition zinc, copper and chromium concentrations have been detected in near-shore waters (water intake area) although they do not exceed the MAC.

It is characteristic of the water in the Gulf to be low in hardness and to have a neutral to slightly alkaline pH. As the Gulf is located in a permafrost zone it is also characterized by low mineralization. Recorded dissolved oxygen levels in the area of the proposed sea port berthing facilities decline in the water's surface layer from south-west to north-east. On average, the near-bed water layer has higher oxygen and saturation levels in comparison to levels recorded at greater depths. BOD_5 values (an indicator of the presence of easily oxidizing organic matter) are recorded as 1.09-3.24 mg O_2/l in the water's surface layer and 0.71-1.99 mg O_2/l in the near-bed layer. This is characteristic of Arctic sea coastal areas with marine ecosystems of high productivity.

The highest levels of silicates are recorded in the coastal area and are shown to decline towards the north-east. Silicate levels are otherwise distributed evenly along the water column. The COD levels vary from 0.54 mg O2/dm^3 to 8.23 mg O_2/dm^3 in the water's surface layer and from 1.48 mg O2/dm^3 to 7.46 mg O2/dm^3 in the near-bed layer.

Levels of ammonia (0.001-0.014 mg/dm^3) and nitrite nitrogen (0.002-0.014 mg/dm^3) are low and generally distributed evenly through the water column. Levels of nitrate nitrogen fluctuate from 0.013 to 0.106 mg/dm^3 in the water's surface layer to 0.048 to 0.113 mg/dm^3 in the near-bed layer. Organic compounds account for over 90% of total nitrogen content, which correlates well with biological processes ongoing in the region in summer.

Phosphates in the Gulf are distributed unevenly across the water column. On average, organic phosphorus accounts for around 40% of the total. Phosphate phosphorus levels vary from 0.036 to 0.134 mg/dm^3 in the water's surface layer and from 0.039 to 0.134 mg/dm^3 near the Gulf-bed.

Total dissolved solids across the water column correspond with the levels of inorganic salts, with maximum levels recorded at coastal monitoring stations. The highest levels of practically all soluble salts are recorded at monitoring stations near the shoreline, while the lowest levels are recorded at the near-bed water layer by deepwater monitoring stations.

Some MAC exceedances have been recorded in the surface water layer for hydrocarbons (1.3 - 1.6 times the MAC). One sample from the near-bed water layer exceeds the MAC for hydrocarbons (1.1 times).

According to the study findings, the surface water layer is a Class 2 (clean water) with the exception of monitoring point # 20 which falls under Class 3 (moderately contaminated), while the near-bed water layer is a Class 2 (clean water).

Bacteriological and parasitological parameters of all water samples obtained in the study meet the requirements of SanPiN 2.1.5.2582-10.

7.5.4 BOTTOM SEDIMENTS

7.5.4.1 ASSESSMENT CRITERIA

At present, assessment criteria for bottom sediments are not available in Russia. Standard assessment criteria for sediments have been retracted from use in the Netherlands since the assessment of sediments was changed to correspond with guidance in the EU Groundwater Framework Directive. For this reason, the results from sediment studies undertaken in the Project area have not been compared against any standards (as none are applicable).

7.5.4.2 MARINE SEDIMENTS

The Gulf of Ob bottom sediments were studied by OJSC Lenmorniiproekt in 2011[12]. The findings are presented in full in the 'Technical Report on the Gulf of Ob Feasibility Study'.

In summary, a total of 281 bottom sediment samples were obtained in the study. Each sample was analyzed for heavy metals (As, Cd, Cu, Cr, Hg, Mn, Ni, Pb, Zn), total petroleum hydrocarbons (TPH), polychlorinated biphenyls (PCB 28, PCB 52, PCB 101, PCB 138, PCB 153, PCB 180), pesticides (DDT, DDE, lindin g-HCH, lindin a-HCH) and benz(a)pyrene (a key indicator polycyclic aromatic hydrocarbon or PAH).

The analytical findings show that PCB, pesticide, and benz(a)pyrene levels in all samples were below the laboratory method detection limit (LMDL, i.e. 0.0001 mg/kg for PCB, 0.01 mg/kg for pesticides and 0.004 mg/kg for benz(a)pyrene).

TPH concentrations in bottom sediments are between the detection limit (5 mg/kg) and slightly over 100 mg/kg in two samples.

Heavy metals concentrations are low, as shown below:

- As – 0.1 – 2.6 mg/kg;
- Cd – all <LMDL 0.05 mg/kg;
- Cu – 1 - 20 mg/kg;
- Ni – 1 – 36 mg/kg;
- Pb – 1 - 280 mg/kg; and
- Zn – 2 - 74 mg/kg.

7.5.4.3 RIVER AND LAKE BOTTOM SEDIMENTS

An assessment of bottom sediments was also conducted c. 2011 for surface water courses in the area of the proposed airport and sea port. Sediment samples were obtained from the following locations:

- Sined'yakha river (Ref: A-21D/11);
- Bezymyannoye lake (Ref: A-12D/11);
- Salyamlekabtambadayakha river (L-17-1D/11);
- Nohoyakha river (L-17-2D/11);
- Gulf of Ob (A-02D/11); and the
- Nohoyakha river (A-22D/11).

Table 7.5.3 provides a summary of the results for inorganic parameters.

[12] Environmental-engineering survey contractor LLC Eco-Express-Service

Table 7.5.3: Inorganic Parameters in Bottom Sediments (mg/kg)							
Sample code	**Zn**	**Pb**	**Cu**	**Cr**	**Ni**	**Mn**	**Cd**
A-02D/11	7,3	7,5	2,7	10,8	5,7	126,0	<0,10
A-21D/11	19,0	6,6	8,5	28,4	18,3	150,2	<0,10
A-22D/11	8,5	6,7	3,9	15,0	5,2	96,0	<0,10
A-12D/11	7,2	6,1	2,75	10,8	2,55	112,5	<0,10
L-17-1D/11	8,5	5,8	2,5	11,3	2,83	145,5	<0,10
L-17-2D/11	7,4	4,8	3,10	13,7	4,5	102,98	<0,10

The results show that the highest concentrations of zinc, copper, nickel and chromium are detected in the Sined'yaha river bottom sediment samples. With that exception considered, the concentrations of heavy metals in bottom sediments are generally low.

Table 7.5.4 summarises the organic parameter analytical results.

Table 7.5.4: Organic Parameter Concentrations in Bottom Sediments (mg/kg)			
Sample code	**TPH**	**Benz(a)pyrene**	**Phenols**
A-02D/11	<50	<0,0002	0,003
A-21D/11	690	<0,0002	0,008
A-22D/11	<50	<0,0002	0,0035
A-12D/11	225	<0,0002	0,0030
L-17(S)D1/11	89	<0,0002	0,0060
L-17(S)D2/11	169	<0,0002	0,0030

The table shows that although a range of TPH concentrations have been detected, the results are generally low. The maximum hydrocarbon concentration of 690 mg/kg was detected in a bottom sediment sample obtained from the Sined'yaha river.

Bottom sediments were also obtained from other surface water courses within the South Tambey Gas Condensate Field (STGCF) as follows:

- A nameless lake near Sabetta (station YT05LWS).
- The Salyamlekabtambada-Yaha river (YT01RWS and YT08RWS near well 106).
- A nameless lake near well No. 112 (YT11LWS).

The results for inorganic parameter concentrations are shown in Table 7.5.5.

Table 7.5.5: Inorganic Parameters in Surface Water Sediments (mg/kg)							
Station	**PP**	**Zn**	**Pb**	**Cd**	**Cu**	**Ni**	**Hg**
YT01RWS	9.4	5.3	0.34	<0.01	1.03	3.46	0.007
YT05LWS	8.2	4.9	0.30	<0.01	0.83	2.27	0.006
YT08RWS	<5	13.0	1.56	<0.01	2.23	9.50	<0.005
YT11LWS	8.2	5.2	0.26	<0.01	1.00	2.65	0.005

The table shows that the concentrations of inorganic parameters in these surface water bottom sediments are generally low.

The feasibility study for the LNG plant conducted by OOO FREKOM in 2011 confirms that concentrations of inorganic parameters in bottom sediments within watercourses and water reservoirs in the South Tambey Gas Condensate field are generally low.

7.5.5 SHALLOW GROUNDWATER

The permanently frozen ground, below the shallow zone of thawing, will prevent any connection between groundwater in the shallow thaw zone and the deeper aquifer (discussed in detail in Section 7.3.5). However, groundwater in the shallow thaw zone has the potential to connect and discharge to surface waters. Therefore, it is relevant in this instance to consider shallow groundwater in the thaw zone as part of the hydrological system.

The Project area belongs to the Prikarski groundwater catchment. Shallow groundwater in the area is supra-permafrost talik and divided into two categories:

i) Thawed layer groundwater is fed by rainwater and melting underground ice. These are common within the South Tambey gas condensate field at depths of between 0.1 m and 0.33 m. Discharge occurs in depressions and often results in land flooding. The groundwater freezes simultaneously with the thawed layer.

ii) Open taliks groundwater located beneath lake beds and river beds. The thickness of open taliks groundwater beneath shallow lakes is rarely greater than 2 m to 3 m. Beneath river beds this groundwater is under low and permanent pressure and often belongs to a valley (thalweg) extending across an area 30 m to 50 m wide.

There can also be continuous permafrost patches along the Gulf of Ob coastal area and beneath larger lakes usually comprising fresh and unconfined groundwater.

Within the deeper ground there can be unfrozen layers (cryopegs) with intra-permafrost groundwater (negative temperature and high salinity). However, they are normally found below the proposed Project installations' impact depth (i.e. >10 m).

7.5.5.1 ASSESSMENT CRITERIA

In this report, the results of analyses are compared with the corresponding Russian quality standards and Dutch Intervention Values (DIV), where Russian standards are absent.

Russian Maximum Permissible Concentrations (MPCs) for potable, domestic and recreational water supply purposes were used as the standards for screening groundwater concentrations (Hygienic Regulations GN 2.1.5.1315-03 and GN 2.1.5.2280-07).

The DIV for groundwater (*Soil Remediation Circular 2009, modified April 2012*) are used in the assessment of contamination and can be used as a benchmark for groundwater remediation. This report uses the DIV as a benchmark that, when exceeded in the Netherlands, indicates potential remediation measures are required. It should be noted that the DIV are not legally binding outside the Netherlands.

7.5.5.2 GROUNDWATER STUDY DATA

An environmental-engineering survey for groundwater was conducted in 2011 by LLC FRECOM at the South Tambey Gas Condensate Field (STGCF) infrastructure, LNG plant and other Project related sites[13].

In the feasibility study, groundwater samples were obtained from the first stage cluster pads Nos. 7, 44 and 46 and the second stage well pads - Nos. 22 and 41. In total, twenty well pads are scheduled to be installed.

The groundwater samples obtained in the study were analyzed for pH, mineral content, dry residues, electrical conductivity as well as organic and inorganic parameters, including:

- total petroleum hydrocarbons (TPH);
- phenols;
- surfactants;
- benz(a)pyrene; and
- metals (copper, lead, zinc, nickel, cadmium).

The groundwater is non-saline and contains hydrocarbonates, chloride-carbonates and calcium-sodium. The mineral content ranges between 0.57 and 0.70 g/dm^3 and the range of total hardness is between 2.4 and 4.4 mg-equ/l.

The groundwater in the vicinity of the LNG Plant was also analysed at three locations. Results indicate the groundwater is low in mineral content and weakly acidic (low pH).

Table 7.5.6 shows a summary of heavy metals analyses in groundwater at several locations.

Table 7.5.6: Summary of Heavy Metal Concentrations in Groundwater

Location	Zn	Cu	Pb	Ni	Cd
Well cluster #22	0,013	<0,0006	0,0014	<0,0002	0,00004
Well cluster #41	0,008	<0,0006	<0,0002	<0,0002	0,00003

[13] Project Documentation "South-Tambey GCF Gas Condensate Production, Preparation, and Liquation, LNG and Gas Condensate Shipment Complex Construction, Chapter 8 "List of Environmental Protection Measures, including EIA", volume 1. LLC Frecom, 2012.

Table 7.5.6: Summary of Heavy Metal Concentrations in Groundwater					
Location	**Zn**	**Cu**	**Pb**	**Ni**	**Cd**
Well cluster #7	0,013	0,0015	<0,0002	<0,0002	0,00004
Well cluster #44	0,016	<0,0006	0,0004	<0,0002	0,00002
Well cluster #46	0,0044	<0,0006	0,0003	<0,0002	0,00005
Sea port (coastal facilities)	0,0045	0,0016	0,0013	<0.0002	0.00004
	0.0065	<0.0006	0.0004	<0.0002	0.00002
	0.012	0.0038	0.0005	<0.0002	<0.00001
Airport	0,0084	0,0015	0,0006	<0,0002	<0,00001
LNG plant	0,0065	<0,0006	0,0004	<0,0002	0,00002
	0,0074	0,0014	<0,0002	<0,0002	0,00006
	0,0074	<0,0006	<0,0002	<0,0002	<0,00001
MPC*household*	***1,0***	***1,0***	***0,01***	***0,02***	***0,001***
DIV	***0.8***	***0.075***	***0.075***	***0.075***	***0.006***

Analytical results show that metal concentrations in groundwater are either <LMDL or well below the applicable MPC and DIV.

Table 7.5.7 shows a summary of organic parameter concentrations in groundwater at several locations.

Table 7.5.7: Summary of Organic Parameter Concentrations in Groundwater				
Facility	**Phenols**	**Anionic surfactants**	**TPH**	**Benzo(a)pyrene**
Well cluster #22	<0,001	<0,025	0,008	<0,002
Well cluster #41	<0,001	<0,025	0,023	<0,002
Well cluster #7	<0,001	<0,025	0,011	<0,002
Well cluster #44	<0,001	<0,025	0,009	<0,002
Well cluster #46	<0,001	<0,025	0,007	<0,002
Sea port (coastal facilities)	0.026	0,044	0.017	<0.002
	0,0018	<0.025	0.36	<0.002
	0,0071	0.048	0.078	<0.002
Airport	0,000730	<0,025	0,008	<0,000002

Table 7.5.7: Summary of Organic Parameter Concentrations in Groundwater

Facility	Phenols	Anionic surfactants	TPH	Benzo(a)pyrene
LNG plant area	0,0018	<0,025	0,36	<0,002
	0,0057	<0,025	0,064	<0,002
	0,0026	<0,025	0,006	<0,002
MPC*household*	***N/A***	***N/A***	***0,3***	***0,000001***
DIV	***2***	***N/A***	***0.6***	***N/A***

N/A – Not available

Although concentrations of TPH in groundwater are generally low, samples obtained at the LNG Plant and seaport coastal facilities have concentrations exceeding the applicable MPC. It should be mentioned that the LMDL for benzo(a)pyrene analysis is <0.002 mg/l and is higher than the MPC (0.000001 mg/l). According to available groundwater data, none of the parameters analysed exceed the DIV.

7.6 BIODIVERSITY

7.6.1 ECOSYSTEM SERVICES

7.6.1.1 INTRODUCTION

Ecosystem services (ES) are the goods and services provided by ecosystems upon which human wealth and individual well-being depend. The environment provides mankind with the food, water and air that are essential for life and with the minerals and raw materials for industry and consumption. Less obviously, it provides the processes that purify air and water, and which sequester or break down wastes. It is also in the environment where recreation, health and solace are found and in which human culture finds its roots and sense of place. Scientists refer to these services that the environment provides as 'ecosystem services', recognising that it is the interaction between the living and physical environments that deliver these necessities[14,15]. For the ES approach used herein, ES are depicted within four service subset categories: Provisioning; Regulating; Cultural; and Supporting. Supporting services (e.g. soil formation, primary production and genetic exchange) are those that underpin the other three categories of services. Therefore supporting services are not assessed separately within this section.

The overall aim of the ecosystem service concept is to bring a holistic approach to environmental decision-making by valuing the environment in terms of the benefits people obtain from ecosystems. It is practical and pragmatic, focussing on goals that provide greatest environmental benefit at least cost to society and the natural environment with the aim of avoiding taking decisions with unintended secondary consequences that may be costly, increase risk or be detrimental to ecosystems and human wellbeing. The evaluation of the effects, both desirable and undesirable, of approaches to landscape management on the delivery of ecosystem services allow for a broader assessment of the true costs and benefits of actions and policies.

Ecosystem service principles and/or cost-benefit analyses are enshrined in European environmental protection legislation and policies such as the Environmental Liability Directive (2004/35/EC), the Habitats Directive (92/43/EEC), the Water Framework Directive (2000/60/EC) and the REACH Directive (1907/2006). Recent initiatives such as the United Nations Millennium Ecosystem Assessment (2004)[16], UK National Ecosystem Assessment (2011)14 and The Economics of Ecosystems and Biodiversity (TEEB, 2010[17]) have built on concepts and methods developed over more than 20 years in the United States to deal with legacy contamination (US Natural Resource Damage Act). Many of the US approaches have informed more recent European initiatives on environmental liability, habitat banking, biodiversity offsetting, life cycle

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[14] UK National Ecosystem Assessment (UKNEA, 2011). The UK National Ecosystem Assessment: Synthesis of the Key Findings. UNEP-WCMC, Cambridge.
[15] IFC Performance Standards , January 2012.
[16] Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.
[17] TEEB (2010) The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB.

assessment (foot printing), strategic planning, operational risk reduction and now product registration.

The IFC Performance Standards divide Ecosystem services into two priority types:

(i) Those services on which project operations are most likely to have an impact and, therefore, which result in adverse impacts to Affected Communities.

(ii) Those services on which the project is directly dependent for its operations (e.g. water).

In addition, where Affected Communities are likely to be impacted, they should participate in the determination of priority ecosystem services in accordance with the stakeholder engagement process as defined in IFC Performance Standard 1. Table 7.6.1 screens the ecosystem services that are relevant to the Project Area of Influence and categorises them according to either priority 1 or priority 2.

Table 7.6.1: Ecosystem Services

Ecosystem Service	
Provisioning	**Relevance to Study Area**
Crops	Not relevant - no crops grown
Livestock	Priority 1 - grazing by reindeer
Capture fisheries	Priority 1 – fishing in Gulf of Ob and rivers
Aquaculture	Not relevant – no aquaculture
Wild foods	Priority 1 – fungi and berries
Timber and other wood fibre	Not relevant – no timber resources present
Other fibres (e.g., cotton, hemp, silk)	Not relevant – no fibre harvested
Biomass fuel	Not relevant – no biomass harvested
Hunting	Priority 1 – hunting for both food and fur
Freshwater	Priority 1 – freshwater used by grazing reindeer and local people. Priority 2 - freshwater provision to facility.
Genetic resources	Priority 1 – relationship with cultivated species of native plants
Biochemicals, natural medicines, and pharmaceuticals	Priority 1 – collection of medicinal plants. Plants used in tanning.
Regulating	
Air quality regulation	Priority 1 – clean air
Global climate regulation	Priority 1 - stored carbon in permafrost and soils
Regional/local climate regulation	Priority 1 – microclimates
Water regulation	Priority 1 – hydrology and water tables.
Erosion regulation	Priority 1 – vegetation cover reducing erosion due to disturbance

Table 7.6.1: Ecosystem Services

Ecosystem Service	
Water purification and waste treatment	Priority 2 – Disposal of plant waste
Disease regulation	Priority 1 – naturally functioning ecosystems generally self-regulating against disease / pathogens
Pest regulation	Priority 1 – naturally functioning ecosystems generally self-regulating against pests.
Pollination	Priority 1 – pollination important for wild food production
Natural hazard regulation	Priority 1 and 2 – vegetation cover, unimpacted soils and natural drainage important in flood alleviation.
Cultural	
Sacred or spiritual sites	Priority 1 – sacred sites present
Areas used for religious purposes	Priority 1 – area used for religious purposes
Recreational value	Not relevant – area currently not used for recreational purposes
Ecotourism areas	Priority 1 - area currently not used for tourism, but new infrastructure could be used in future for eco-tourism
Aesthetic value	Priority 1 – area appreciated by local people

7.6.1.2 PROVISIONING SERVICES

Livestock

Reindeer breeding is the principal traditional economic activity in the YNAO. Yamalsky District is the world's leader in the number of domesticated reindeer with over 284,157 head[18] in total as of January 2013. Nomadic reindeer breeding and herding in Yamalsky District has been sufficiently resilient to withstand the 1990's economic crisis in Russia.

At present, there are three main forms of reindeer husbandry in Yamalsky District:

- municipal enterprises;
- communes; and
- private/family husbandries.

The description of these forms within the reindeer breeding sector is provided in Chapter 8 "Socio-economic baseline" (Reindeer husbandry in Yamalsky District). It should be noted that the reindeer in the Project Licence Area are essentially domesticated stock, rather than 'wild' animals. Therefore, they have no conservation status with respect to IUCN or RDB YNOA.

[18] As reported by the YNAO Department of Agribusiness

The Project Licence Area is used for grazing of herds owned by the "Yamalskoye" municipal reindeer breeding farm (MOP) which is within the jurisdiction of the Seyakha village administration. The area is primarily used for the seasonal migration of reindeer herds, mainly by the MOP Yamalskoye and by a number of the local indigenous communes and families of reindeer breeders. These indigenous communes and households predominantly live in the tundra and lead nomadic lifestyle, i.e. migrating between the seasonal pastures depending on the time of the year, without resorting to permanent residence.

Further specifics on the reindeer breeding practices and the structure of herder migration routes, as well as on the nomadic and settled population (including indications of numbers using the provisioning services in the Licence Area) and the types of land use (including transhumance patterns) within the Project Licence Area are presented in Chapter 8 "Socio-economic baseline".

Capture Fisheries

Fishing is another important activity that plays a considerable role in the local economy. Fishing enterprises include both municipal and state-owned entities as well as private associations (communes, cooperatives and small private undertakings). Indigenous people constitute the largest workforce in the fishing industry. Currently, fishing practices draw on traditional methods using nets and the migration of indigenous fishermen between the fishing areas accompanied by their families. Officially, the fishing areas in the region are assigned to the enterprises while the indigenous population typically fish without a special permit or allocation of individual fishing grounds. Informal fishing also occurs, although limited information on this is available – this is further discussed in Chapter 8.

Fishing on water bodies in the region is run mainly by the local population (reindeer farmers, trading post workers, and oil industry workers). Fishing is seasonally based as follows:

- Springtime fishing – June and July;
- Summertime – July to September;
- Autumn – September and October;
- Ice fishing – October to December; and
- Wintertime fishing – November to May.

No fishing statistics specific to the Project Licence Area are available. However, within the whole Gulf of Ob basin, catches of all commercial fish species have reportedly been declining over recent years (see Chapter 8 for further details).

Primary fish species characteristic of the South Tambey Gas Condensate field are presented in Table 7.6.2. The dominant species are: Arctic cisco (*Coregonus autumnalis*), Arctic grayling (*Thymallus arcticus*) and Arctic four-horned sculpin (*Triglopsis quadricornis*). Arctic cisco is a semi-anadromous species and hence its population fluctuates. Arctic four-horned sculpin is very common and while caught in large numbers is of little commercial value. Round-nosed whitefish (C. *nasus*) and muksun (*C. muksun*) are not abundant in the region. All the above species are characteristic of the Nyaruiyakha river (see Figure 7.5.2) and its tributaries.

Table 7.6.2: Cyclostomes and bony fishes in the Project License Area

Fish Species	Range Within Yamal	Species Ecology	Commercial Value	Local Population Status[1]
Siberian lamprey - *Lethenteron kessleri*	Populates large rivers in Southern and Middle Yamal. Not found to occur north of the Tambey river	Studied insufficiently. River form. Breeds in summer.	N/a. Used as bait	Low numbered, rare species
Siberian sturgeon – *Acipenser baerii*	Populates large rivers of Yamal	Semi-anadromous form	Most valued commercial fish	Stock has been heavily damaged.
Siberian white salmon – *Stenodus leucichthys*	Populates large rivers and lakes of Yamal	Semi-anadromous or entirely freshwater fish	Very important and valuable commercial fish	Rare
Siberian vendace - *Coregonus sardinella*	Enters large rivers of Yamal	Semi-anadromous, more rarely - lake fish	Very important commercial fish	Middle-size population species
Arctic cisco - ***Coregonus autum nalis***	All Yamal rivers	Semi-anadromous fish	Very high commercial value	Large population
Round-nosed whitefish – ***Coregonus nasus***	Large Yamal rivers, not found further north than the Tambey river basin	Lake-river fish	High commercial value	Population: low
Muksun – ***Coregonus muksun***	Large Yamal rivers, not found further north than the Tambey river basin	Semi-anadromous cisco	Most valued commercial fish	Low numbered species.
Arctic grayling – ***Thymallus arcticus***	Yamal river south of the Tambey river	River fish.	Not a commercial species	Middle size population
Burbot – *Lota lota*	Large rivers of Yamal	Freshwater lake-river fish	Valued commercial fish	Middle size population
Navaga – *E. navaga*	Enters large rivers of Yamal	Sea species. Bottom, littoral, cold water fish	Valued commercial fish	Middle size population
Pope – *Gymnocephalus cernuus*	Large Yamal rivers, not northerner than the Tambey river basin	Schooling lake-river fish	N/a. Amateur fishing species	Low numbered species
Arctic four-horned sculpin – ***M. quadricornis***	Enters all rivers of Yamal	Cold water fish, populates littoral zone	None	Common species

The flagship species in the region is Siberian sturgeon (*Acipenser baerii*) and is hunted by poachers. This fish may occur in coastal waters of the Gulf of Ob in the vicinity of the Project Licence Area. The longest migrations are reported in the Ob and Irtysh rivers. It is a highly valued Red List species, whose population has been significantly reduced and is still decreasing.

Additional information on fish is provided in section 7.6.2 below. Further specifics on fishing within the Project Licence Area and Bay of Ob are presented in Chapter 8 "Socio-economic baseline"

Edible plants

Economically important edible plants are represented by 8 species of berry underbushes and 20 species of mushrooms. Edible plants include cloudberry (*Rubus chamaemorus*), cowberry (*Vaccinium vitis-idaea*) and bog whortleberry (*Vaccinium uliginosum*). In the more southern areas of the peninsula cloudberry can give up to 20-50 t/hectare in a mast year (Igoshina, 2003). The productivity of cowberry and bog whortleberry can be up to 15-25 t/hectare, although areas supporting this level of productivity are limited (less than 3-5% of the area). Productivity further north (including the Project Licence Area) is unlikely to be as high.

More detailed information on the use of edible plants by local people in the Project Licence Area is provided in Chapter 8.

Hunting

The YNAO has traditionally been a hunting ground for arctic fox, hare, squirrel, partridge and waterfowl. However, fur hunting is presently on the wane due to the lack of sales market. Subsistence hunting still represents the traditional activity that is used by region's indigenous communities, primarily as a subsistence food supply. Unlike the more profitable reindeer breeding and fishing activities, indigenous people generally resort to hunting on an occasional basis in order to diversify the family diet.

More detailed information on the extent of hunting by local people in the Project Licence Area is provided in Chapter 8.

Freshwater

Freshwater resources are used by reindeer herders along their migration routes. Freshwater will also be an important resource for the proposed facility. A peak water use requirement of approximately 1,900 m^3/day of water will be required by the Project for drinking and process usage. The current abstraction rate from the existing water intake from the Glubokoye Lake is 240m^3/day and therefore insufficient to meet anticipated future demand. Therefore, desalination will be used to provide additional freshwater from seawater.

Glubokoye Lake has a specific water protection regime. Protection of Glubokoye Lake as a source of freshwater is determined by state sanitary requirements "Sanitary protection zones of water supply sources and drinking water pipelines. SANPIN 2.1.4.1110-02".

Genetic

Many species from families of cereals, sedges, legumes growing in the South Tambey Gas Condensate field area are related to fodder species. The lichens are mainly related to the

Cladonia, Cladina and *Cetraria* genera and represent an important component of domesticated reindeer fodder.

Biochemicals, natural medicines, and pharmaceuticals

The list of medicinal plants in the Licence Area can include up to 10-15 species although not all are officially recognised as medicines. More detailed information on the use of medicinal plants by local people in the Project Licence Area is provided in Chapter 8.

7.6.1.3 REGULATING SERVICES

Air quality regulation

This is the influence ecosystems have on air quality by emitting chemicals to the atmosphere (i.e. serving as a source) or extracting chemicals from the atmosphere (acting as a sink). The lack of tall vegetation and the short growing season reduces the Arctic environment's interaction with air quality. However, changes in vegetation cover and composition could have an impact on its regulating function.

Global climate regulation

Ecosystems influence the global climate by emitting greenhouse gases (GHG) or aerosols to the atmosphere or by absorbing GHG or aerosols from the atmosphere. The short growing season and cold climate affects the Arctic vegetation's ability to capture carbon. However, the cold climate also slows the decomposition of plant material. Large amounts of methane are locked into the permafrost and increased thawing of the frozen ground can release this methane into the atmosphere. More detail on the region's climate is provided in Section 7.2 and on permafrost in Section 7.3.

Regional/local climate regulation

Ecosystems can also influence local or regional climate for example by affecting the rate of evaporation, reflection of sunlight (e.g. by snow), wind speed etc. More detail on the region's climate is provided in Section 7.2.

Water regulation

Ecosystems influence the timing and magnitude of water runoff, flooding and aquifer recharge, particularly in terms of the water storage potential of the ecosystem or landscape. More detail on the hydrogeology within the Licence Area is provided in Sections 7.3 and 7.5.

Erosion regulation

The integrity of ecosystems and in particular that of its plant cover can significantly affect erosion processes by retaining and replenishing soil and sand deposits. Arctic environments are subject to specific erosional processes relating to freeze thaw action. More detail on the region's soils are provided in section 7.4 and erosion processes within Sections 7.3.

Water purification and waste treatment

Ecosystems play an important role in the filtration and decomposition of organic wastes and pollutants in water as well as the assimilation and detoxicifcation of compounds through soil and subsoil processes. The ability of Arctic environments to provide water purification services is significantly affected by the cold climate. More detail on hydro-geological processes is provided in Section 7.5.

Pollination

Many species of insect, birds and mammals provide pollination services, which in turn is important for the production of crops and wild plants. The lack of crops grown in the region limits the importance of this service. However, the use of wild food and medicinal plants could be affected by changes in the levels of pollination, as would the availability of certain plants used by reindeer for fodder.

Natural hazard regulation

The integrity of ecosystems has an influence to reduce the damage caused by natural events such as flooding, storms, and landslides.

7.6.1.4 CULTURAL SERVICES

Sacred or spiritual sites

According to the YNAO Historical and Cultural Heritage Protection Agency, three cultural heritage sites listed in the Regional Historical and Cultural Heritage Registry are located in or near to the Project Licence Area:

- Two sites known to be located within the Project Licence Area are:
  - The Hill of Heads (‘*Neycheda Sanctuary*’) – located in the Sabetta Camp area and comprises a round mound on top of which reindeer antlers and skulls are traditionally placed; and
  - The Seven Little Mounds (‘*Siulortse*’) – consists of the seven small mounds (with the height of 100-120 cm) on top of which rocks as well as reindeer antlers and skulls are placed.
- A third sacred site, ‘Khalvure Seda’, is located outside the Project Licence Area.

Yamal LNG conducted additional studies with the aim of identifying sacred sites that are of cultural and spiritual importance to the local population for the period of May - August 2013[19]. These studies were conducted within the Project License Area and in a 10km wide protection zone around the License Area. The studies identified 11 sacred and specially worshipped sites (including the abovementioned ones), seven of which are categorized as sacred sites and four are cemeteries (see Chapter 8 for details).

[19] “Research of Traditional Nature Use and Ethno-Cultural Environment within the Area of Influence of the South Tambey Gas Condensate Field Development Project. South Tambey License Area”, "Yamal LNG" JSC, Moscow-Sabetta-Petersburg 2013, prepared by FRECOM

None of these sites is expected to be physically impacted by the Project activities either during the construction or the operation phases as they do not overlap with the Project infrastructure, although detailed information on potential non-physical Project impacts on these sites, as well as measures to ensure their protection are further developed and described in Chapters 8 and 10.

During May-August 2013 a separate archeological survey of the South Tambey license area was also carried out[20]. In the process of the archeological survey, 49 sites were investigated, one object of cultural heritage identified and 65 stratigraphic cross-sections plotted.

The identified object of cultural heritage was an ancient settlement - Salyangylnato 1 - located at the axis of the planned corridor for linear facilities to well cluster #25. The planned corridor crosses the settlement site in the direction of NW-SE. Construction work in this area has the potential to damage or even completely destroy this cultural heritage object. In light of this, Yamal LNG has decided that the facilities corridor will be re-routed to bypass the Salyangylnato 1 site.

Intangible Heritage

Spiritual aspects of cultural heritage primarily relate to traditional lifestyles, knowledge and skills, construction and maintenance of nomads' dwellings (*chums* – mobile and portable dwellings with wooden structure covered by reindeer hides), processing products of reindeer breeding, fishing and gathering, folk medicine, rituals and habits of the Indigenous Peoples of the North (IPN).

Further information concerning cultural services is provided in Chapter 8.

Recreational use

The importance of natural landscapes for maintaining mental and physical health is increasingly being recognised. However, the Project Licence Area is not currently used for recreational purposes and there is very limited scope for this to change during the Project lifetime.

Areas of eco- and ethno-tourism

Nature-based eco- and ethno-tourism can provide considerable economic benefits to regional and local economies and provide a diversified employment source. There is currently no established practices of eco- or ethno-tourism to the Project Licence Area and the extreme remoteness, lack of transport, very limited accessibility of the area and permit-based entry restrictions that are in force in the entire YNAO significantly limit the future development of this service. However, the improved infrastructure provided by the Project could potentially enable some limited ecotourism opportunities in the future. The development of ethno-tourism may also be constrained by indigenous peoples' reticence and their endeavour to safeguard their sacred assets and practices.

[20] "Historical and Cultural Survey of Land Provided for the Facilities of the South Tambey Licence Area, the Yamal Region, Yamal-Nenets Autonomous Okrug, Moscow– Sabetta 2013", developed by FRECOM

Aesthetic value

Ecosystems can be important for educational purposes, personal inspiration, as well as informing culture and art. Both local people and the Project workers can derive aesthetic value from the local environment.

7.6.2 PROTECTED AREAS, HABITATS AND SPECIES

7.6.2.1 INTRODUCTION

This section of chapter describes the ecological baseline of the Project Licence Area, including protected areas, habitats and species. The ecological baseline has been determined through a combination of secondary data obtained from existing published sources and field surveys. A limited range of field surveys were completed in September 2011 to inform Russian OVOS for the Project. These investigations included surveys of flora, freshwater phytoplankton, zooplankton and macrobenthos, fish and birds. During 2013, a detailed set of ecological surveys were completed within the Mining Allotment Area according to the schedule set out in Table 7.6.3. The surveys were limited to the boundaries of the Mining Allotment Area because it is the area where Yamal LNG is licensed to operate and where all exploration and development operations will take place. The habitats and species within the Mining Allotment Area are considered representative of the Project Licence Area as a whole.

Table 7.6.3: 2013 Survey schedule

Dates	Field-work stage	Work description
May 22–June 26 2013	**Ornithology** Survey of the spring arrival and nesting of birds Ornithologist team (3 experts)	Targeted ornithological survey of the Project area during the spring arrival and nesting (reproduction) of birds at 4 field locations. Identification of 8 bird count plots. Identification of count routes, line transects, and key points within major habitat types. Stage duration: 36 days.
June 16–July 15 2013	**Hydrobiological surveys** Hydrobiologist team (3 experts)	Hydrobiological status assessment (phytoplankton, zooplankton, and macrobenthos) at 14 sampling locations. Ichtyological research in 11 water bodies. Marine mammals survey in the Gulf of Ob. Stage duration: 30 days.
July 15 – 27 2013	**Mesofauna and surface entomofauna surveys** Soil zoologist team (3 experts)	Research on the structure and composition of the mesofauna and surface entomofauna. Collection of invertebrates on identified survey plots (5 field camps). Stage duration: 13 days.
August 5 – 28 2013	**Botanical surveys, Theriofauna assessment, hydrobiological**	Ornithological survey of the Project Licence Area during the summer moulting and young bird growth season at 4 field camps. Zoological surveys using identified routes and at key points within

Table 7.6.3: 2013 Survey schedule		
Dates	**Field-work stage**	**Work description**
	surveys, investigation of post-nesting movement and moulting of birds Ornithologists (3 experts), botanists (3 experts Zoologists (3 experts) Hydrobiologists (3 experts)	the Project Licence Area at 10 key habitat points. Field geobotanical and floristic surveys on sample plots and routes within 25 survey plots. Hydrobiological status assessment (phytoplankton, zooplankton, and macrobenthos) using 19 sampling points. Ichtyological research in 11 water bodies. Marine mammals survey in the Gulf of Ob. Stage duration: 23 days.
August 29–September 15 2013	**Ornithology** Survey of the autumn migration and stopover sites Ornithologists team (2 experts)	Ornithological survey of the Project Licence Area during autumn pre-departure of migrating birds using key habitat points. Stage duration: 18 days.

Detailed methodologies for each of the surveys completed in 2013 are set out in the 2013 FRECOM Survey report.

7.6.2.2 HABITAT EVALUATION CRITERIA

In line with IFC Performance Standard 6[21], the habitats within the Project Licence Area are assessed as being either modified or natural according to the following definitions:

- **Modified**
  'modified habitats are areas that may contain a large proportion of plant and/ or animal species of non-native origin, and/ or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands.'
- **Natural**
  'Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.'

Both modified and natural habitats are also assessed according to critical habitat criteria as defined in Paragraphs 16 of IFC PS6. Critical habitat are areas with high biodiversity value. This includes areas that meet one or more of following criteria:

[21] IFC (2012) Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources

- Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species
- Criterion 2: Endemic and/or restricted-range species
- Criterion 3: Migratory and/or congregatory species
- Criterion 4: Highly threatened and/or unique ecosystems
- Criterion 5: Key evolutionary processes

As specified by paragraph GN56 of IFC Guidance Note 6[22], the determination of critical habitat can also include other recognised high biodiversity values, which are evaluated on a case-by-case basis. IFC Guidance Note 6 recognises that there are gradients of critical habitat based on relative vulnerability (degree of threat) and irreplaceability (rarity or uniqueness). For criteria 1-3 listed above, quantitative thresholds are provided to assign critical habitat into either Tier 1 or Tier 2 (Table 7.6.4).

Table 7.6.4 Quantitative thresholds for Tiers 1 and 2 of Critical Habitat Criteria 1 - 3

	Tier 1	**Tier 2**
1. Critically Endangered (CR)/ Endangered (EN) Species	(a) Habitat required to sustain ≥ 10 percent of the global population of a CR or EN species/subspecies where there are known, regular occurrences of the species and where that habitat could be considered a discrete management unit for that species. (b) Habitat with known, regular occurrences of CR or EN species where that habitat is one of 10 or fewer discrete management sites globally for that species.	(c) Habitat that supports the regular occurrence of a single individual of a CR species and/or habitat containing regionally-important concentrations of a Red-listed EN species where that habitat could be considered a discrete management unit for that species/ subspecies. (d) Habitat of significant importance to CR or EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species. (e) As appropriate, habitat containing nationally/regionally important concentrations of an EN, CR or equivalent national/regional listing.

[22] IFC (2012) Guidance Note 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources

Table 7.6.4 Quantitative thresholds for Tiers 1 and 2 of Critical Habitat Criteria 1 - 3		
	Tier 1	**Tier 2**
2. Endemic/ Restricted Range Species	(a) Habitat known to sustain ≥ 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species (e.g., a single-site endemic).	(b) Habitat known to sustain ≥ 1 percent but < 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species, where data are available and/or based on expert judgment.
3. Migratory/ Congregatory Species	(a) Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 95 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle where that habitat could be considered a discrete management unit for that species.	(b) Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent but < 95 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle and where that habitat could be considered a discrete management unit for that species, where adequate data are available and/or based on expert judgment. (c) For birds, habitat that meets BirdLife International's Criterion A4 for congregations and/or Ramsar Criteria 5 or 6 for Identifying Wetlands of International Importance. (d) For species with large but clumped distributions, a provisional threshold is set at ≥5 percent of the global population for both terrestrial and marine species. (e) Source sites that contribute ≥ 1 percent of the global population of recruits.

Footnote 11 of the IPC PS 6 defines Critically Endangered and/or Endangered species as species either:

i) *listed on the IUCN Red List of Threatened Species. The determination of critical habitat based on other listings is as follows: (i) If the species is listed nationally / regionally*[23] *as Critically Endangered or Endangered, in countries that have adhered to IUCN guidance, the critical habitat determination will be made on a project by project basis in consultation with competent professionals; and*

ii) *in instances where nationally or regionally listed species' categorizations do not correspond well to those of the IUCN (e.g., some countries more generally list species as "protected" or "restricted"), an assessment will be conducted to determine the rationale and purpose of the listing. In this case, the critical habitat determination will be based on such an assessment.*

The identification of globally, nationally and regionally listed Critically Endangered and Endangered species has been completed with reference to the following sources:

- International Union for Conservation of Nature (IUCN) Red List (RL) of Threatened Species[24]
- Red Data Book of the Russian Federation (RDB RF)[25]
- Red Data Book of Yamal-Nenets Autonomous Region (RDB YNAO)[26]

Both the RDB RF and RDB YNAO use criteria that correspond well to those of the IUCN, although the resulting classifications use slightly different nomenclature. Table 7.6.5 details the alignment of the three sets of classification.

Table 7.6.5: IUCN RL, RDB RF and RDB YNOA classification

IUCN RL	RDB RF	RDB YNAO
Extinct in the Wild (EXW)	Probably extinct (0)	Probably extinct in the region (0)
Critically Endangered (CR): facing an extremely high risk of extinction in the wild	Endangered (1)	Endangered (1)

[23] According to the IUCN "the word *regional* is used here to indicate any sub-global geographically defined area, such as a continent, country, state, or province." IUCN. (2012). Guidelines for Application of IUCN Red List Criteria at Regional and National Levels: Version 4.0. Gland, Switzerland and Cambridge, UK: IUCN. iii + 41pp

[24] IUCN 2013. The IUCN Red List of Threatened Species. Version 2013.2. <http://www.iucnredlist.org>. Downloaded on 21 November 2013

[25] Iliashenko, V.Yu. and E.I. Iliashenko. (2000). Krasnaya kniga Rossii: pravovye akty [Red Data Book of Russia: legislative acts]. State committee of the Russian Federation for Environmental Protection. Moscow. 143 pp. In Russian. Available on-line: http://biodat.ru/index.htm

[26] The Red Book of the Yamal-Nenets Autonomous Okrug: animals, plants, fungi / Ed. Ed. SN Ektova, DO Zamyatin. - Ekaterinburg: Publishing House "Basco", 2010. - 308 p. / Красная книга Ямало-Ненецкого автономного округа: животные, растения, грибы / Отв. ред. С.Н. Эктова, Д.О. Замятин. – Екатеринбург: Издательство «Баско», 2010. – 308 с.: ил.

Table 7.6.5: IUCN RL, RDB RF and RDB YNOA classification		
IUCN RL	**RDB RF**	**RDB YNAO**
Endangered (EN): Facing a very high risk of extinction in the wild		
Vulnerable (VU) facing a high risk of extinction in the wild	Dwindling in numbers (2)	Dwindling in numbers (2)
Near Threatened (NT) close to qualifying for or is likely to qualify for a threatened category in the near future	Rare (3)	Rare (3)
Data Deficient (DD) Inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status.	Undefined by status (4)	Undefined by status (4)
Least Concern (LC) Widespread and abundant taxa are included in this category	Recovers and restores (5)	Recovers and restores (5)

7.6.2.3 PROTECTED AREAS

There are 18 protected areas within the YNAO[27], as follows (see also Figure 7.6.1):

1. Gyda State Nature Reserve (Yavay peninsula);
2. Gyda State Nature Reserve (Mammoth peninsula);
3. Upper-Taz State Nature Reserve;
4. Kunovatsky State Natural Game Reserve (Kunovatsky site);
5. Kunovatsky State Natural Game Reserve (Bolsheobsky site);
6. Nadymsky State Natural Game Reserve;

[27] http://www.region-yamal.ru/content/view/535/153/,

7. Lower Ob State Natural Game Reserve;

8. Gornohadattinsky Biological (botanical and zoological) Reserve;

9. Mess-Yakhinskiy State Biological Reserve;

10. Poluysky State Biological (botanical and zoological) Reserve;

11. Polar Ural Biological (botanical and zoological) Reserve;

12. Pyakolsky Biological (botanical and zoological) Reserve;

13. Sobty Yugansky- Biological (botanical and zoological) Reserve;

14. Synsko Voykarskaya -ethnic territory with a special mode of natural resources;

15. Harbeysky Geological Monument of Nature;

16. Yamal State Biological Reserve (South Yamal area);

17. Yamal State Biological Reserve (North Yamal area);

18. Verhnepoluysky Biological (botanical and zoological) Reserve.

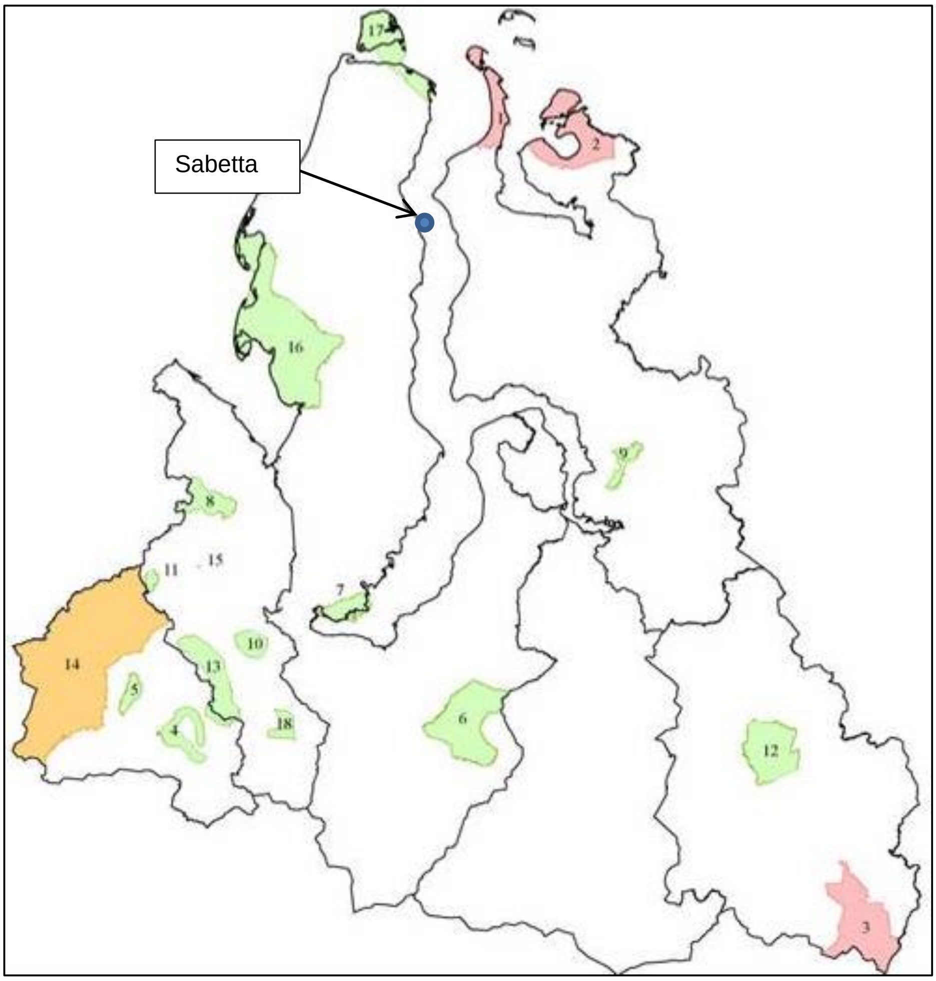

Figure 7.6.1: Protected Areas within the YNAO

None of the protected areas lies within the Project Licence Area. The nearest protected areas to the Project Licence Area are (see also Figure 7.6.2):

- Yamal State Biological Reserve (regional importance) - located 139 km to the north of the proposed facility; and
- Gyda State Natural Reserve (federal significance) - located 119 km to the north of the proposed facility.

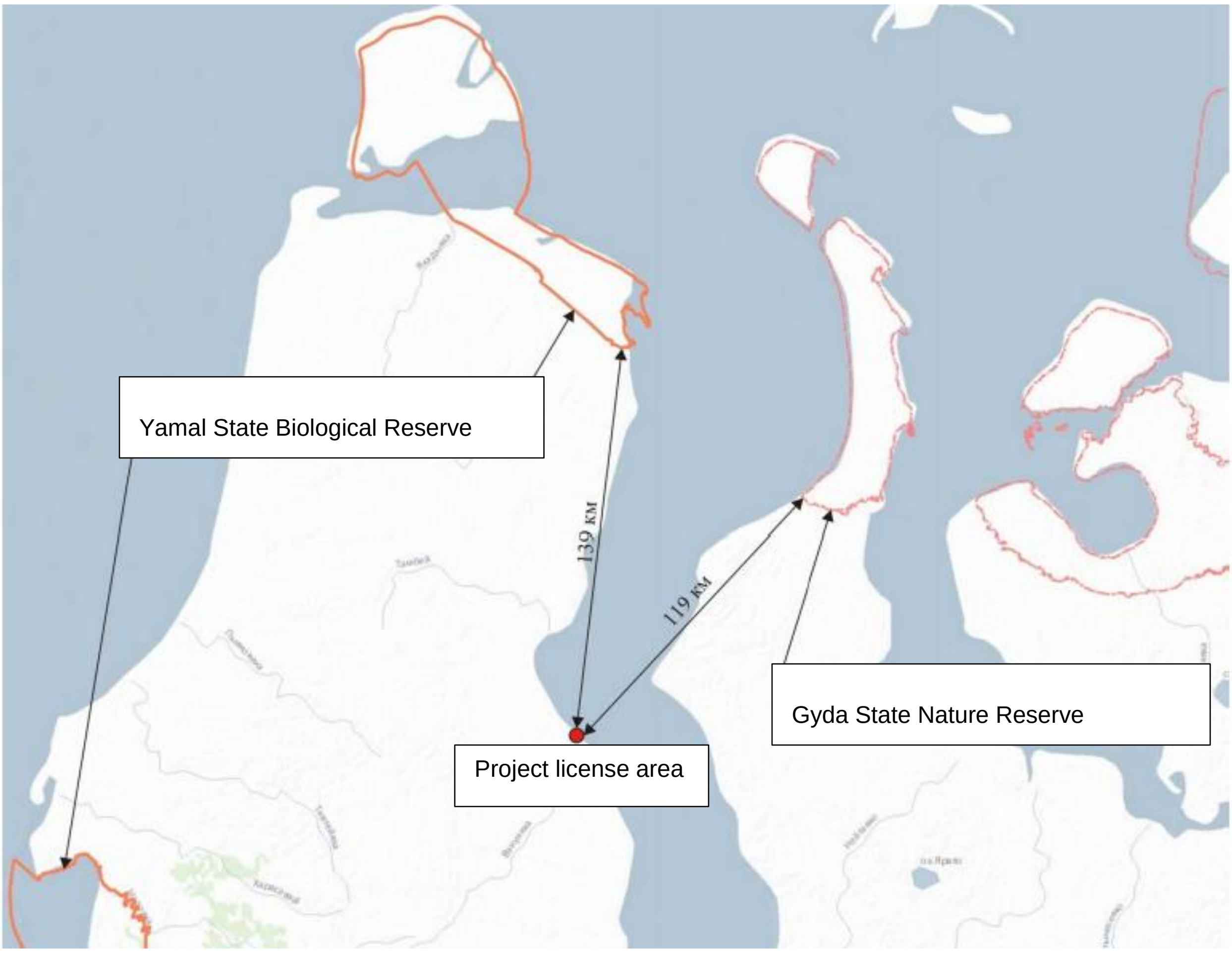

Figure 7.6.2: Protected areas in relation to the Project License Area

The Project Licence Area is not designated as a Ramsar site. The only Ramsar site located on the Yamal Peninsula is the “Islands in Ob Estuary, Kara Sea Ramsar Site”, located in the Lower Ob (66°40'N 070°58'E) over 500 km to the south of the Project Licence Area.

7.6.2.4 HABITATS

Vegetation within the Arctic is strongly influenced by climatic factors and across the region vegetation types display a strong latitudinal climatic gradient. This gradient can be divided into five broad 'bioclimatic zones' (A-E), where A is the coldest and E the warmest [28,29]. The remote sensing work completed by the Circumpolar Arctic Vegetation Map (CAVM) Team (2003) suggests that the Project Licence Area is situated in the transition between zone C and zone D (see Figures 7.6.3a and b). This boundary is broadly equivalent to the boundary between typical hypoarctic (sub-arctic) and arctic tundras as classified by Yurtsev (1994[30]), or between High and Low Arctic tundra as classified by Bliss (1997)[31]. This boundary marks a significant change in vegetation types, influenced by both climate and soils. During the summer, zone D is influenced by periods of relatively warm air from the south. In contrast, zone C experiences predominately colder arctic air masses. The boundary between zones C and D also marks a general shift from relatively moist tundras on peaty soils in the south to drier tundras on mineral soils in the north. Dominant plant growth forms in zone D comprise erect dwarf shrubs, sedges and mosses, whereas zone C is characterised by hemi-prostrate and prostrate dwarf shrubs and sedges. Zone D also tends to have a greater percentage of plant cover (50-70%) compared to zone C (5-50%) and greater species diversity (125-250 species in zone D, compared to 75-150 in zone C).

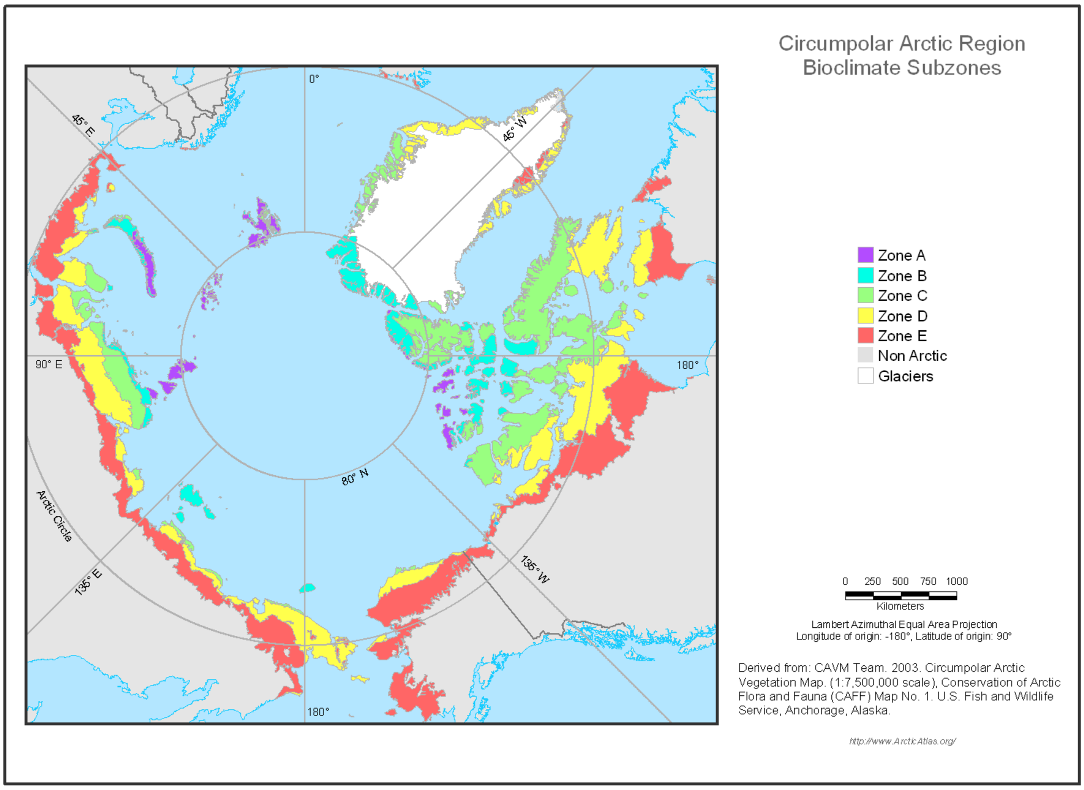

Figure 7.6.3a: Circumpolar Artic Region Bioclimatic Subzones

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[28] Elvebakk, A. 1999. Bioclimatic delimitation and subdivision of the Arctic. I. Nordal, V.Y. Razzhivin (eds.) The Species Concept in the High North - A Panarctic Flora Initiative. The Norwegian Academy of Science and Letters. Oslo. pp. 81-112

[29] Walker, D.A., Raynolds, M.K., Daniëls, F.J.A., Einarsson, E., Elvebakk, A., Gould, W.A., Katenin, A.E., Kholod, S.S., Markon, C.J., Melnikov, E.S., N.G., M., Talbot, S.S., Yurtsev, B.A., CAVM Team 2005. The Circumpolar Arctic Vegetation Map. Journal of Vegetation Science. 16(3):267-282

[30] Yurtsev, B.A. 1994. The floristic division of the Arctic. Journal of Vegetation Science. 5:(6):765-776

[31] Bliss, L.C. 1997. Arctic Ecosystems of North America. F.E. Wielgolaski (eds.) Polar and Alpine Tundra. Elsevier. Amsterdam. pp. 551-683.

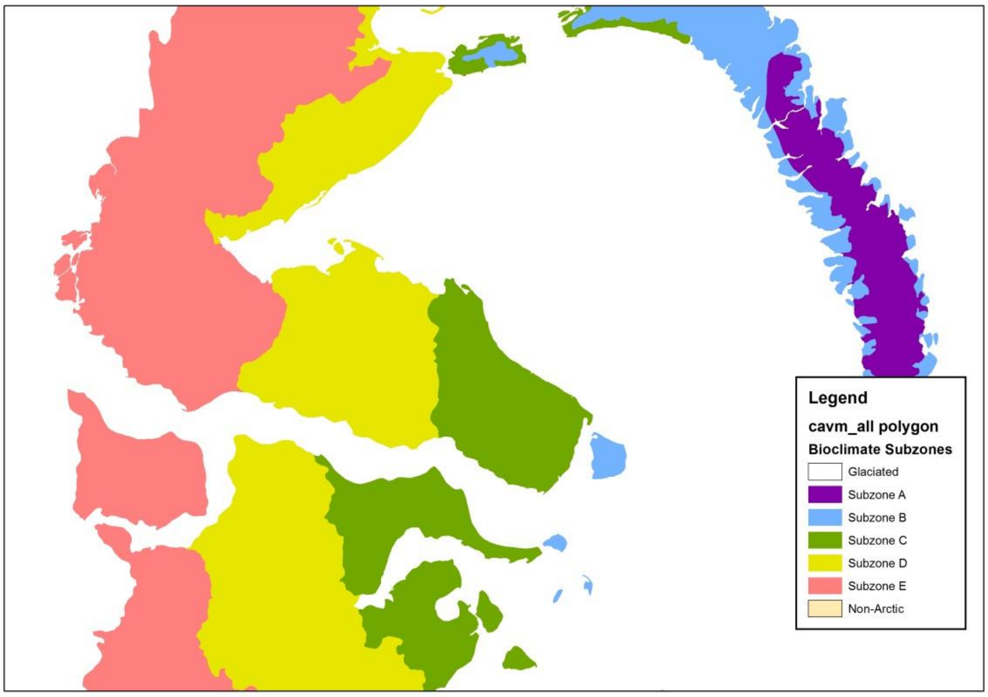

Figure 7.6.3b: Yamal Peninsula Bioclimatic Subzones (CAVM Team, 2003)

Arctic vegetation also shows considerable longitudinal variation where geographical barriers such as mountain ranges have restricted the movement of species. These variations have been classified into five broad sectors or provinces. The Yamal peninsula is situated within the Yamal-Gydan sub-province of the West Siberian province as classified by Yurtev (1994) (see Figure 7.6.4). Yurtev (1994) describes the Yamal-Gydan sub-province has having a relatively low floristic richness, as many species typical of provinces both to the east and to the west are absent. Endemism is also almost totally lacking in the Yamal-Gydan sub-province. This is in part due to the fact that this is a relatively young allochtonic flora undergoing formation. The causes of low species diversity include:

a. The specific nature of surface deposits, which are mainly sands and peatbogs with low mineral levels.
b. Repeated destruction of the plant cover over recent geological history by sea transgressions.
c. divergent migration flows forming the native flora.
d. Low landscape diversity of the area.

The vascular plant flora of the arctic tundra subzone in Yamal is represented by 28 families, 72 genera and 150 species. In addition, there are 133 species of moss, 80 species of liverworts and 105 species of lichen (Morozova and Magomedov, 2004; Magomedov et al, 2006)[32. 33.]

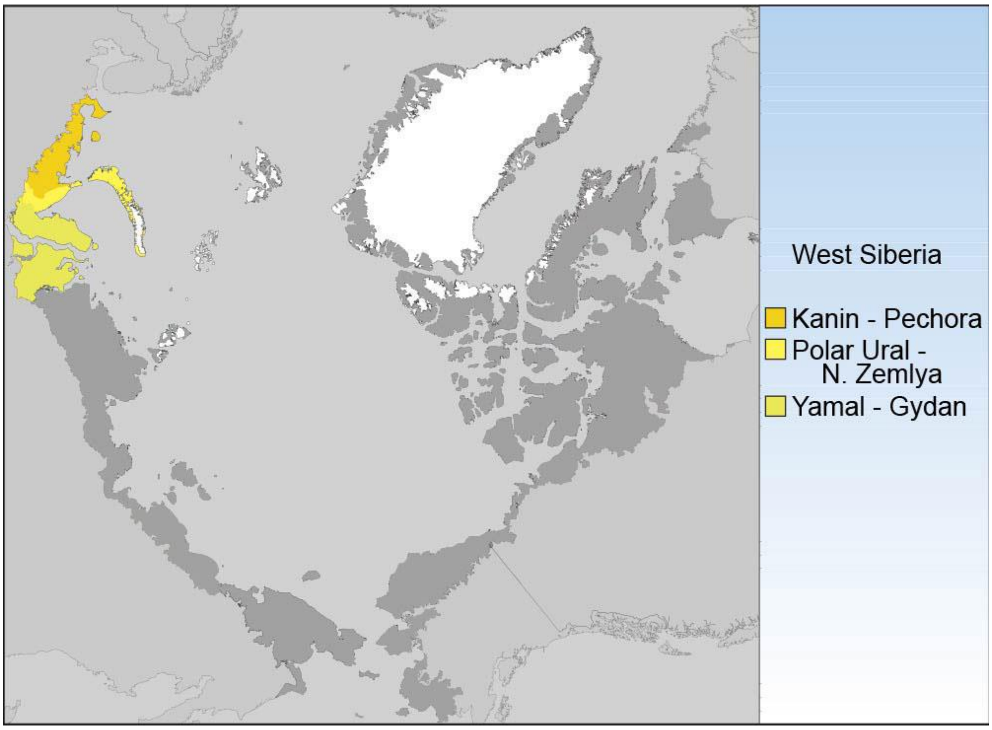

Figure 7.6.4: Yamal Peninsula Floristic Sub-provinces (CAVM Team, 2003)

As a whole, the geographical structure of the Yamal flora (Telyatnikov, 2003[34]), based on latitude groups, is characterized by boreal species (from 34 % in southern tundras, up to 10-20 % in arctic tundras), hypoarctic species (37-22 %) and a gradual increase of arctic species (29 -69 %). The longitude geographical groups are highly dominated by circumpolar species (54-65%), while Eurasian species are constantly present (23-26%) and Siberian flora species are abundant in the typical subarctic tundras (15-18%).

The vegetation of the Arctic region has been mapped at the 1:7,500,000 scale using false colour infrared (CIR) imagery (based on 1 km x 1 km pixel resolution) by the CAVM Team[35]. Vegetation types were classified into five broad physiognomic categories, which were further subdivided into 15 vegetation mapping units. The vegetation within the Project Licence Area includes a number of vegetation categories:

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[32] Morozova, L.M, and Magomedov, M.A. (2004) The structure of the vegetation and plant resources of the Yamal Peninsula. Ekaterinburg: Publishing House of the Ural University. C.1-63.
[33] Magomedov, M.A., Morozova, L.M., Ektova S.N., Chernyadeva, I.V., Эктова, O.V., Potemkin, A.D. and Knyazev, M.S. (2006)The Yamal Peninsula: vegetation. Tyumen City Press, 360
[34] Telyatnikov M.Yu., 2003. Vegetation of Typical Tundras in the Yamal Peninsula [in Russian]. Nauka, Novosibirsk, 121 pp.
[35] CAVM Team. 2003. Circumpolar Arctic Vegetation Map. (1:7,500,000 scale), Conservation of Arctic Flora and Fauna (CAFF) Map No. 1. U.S. Fish and Wildlife Service, Anchorage, Alaska. ISBN: 0-9767525-0-6, ISBN-13: 978-0-9767525-0-9

- S1. Erect dwarf-shrub tundra

  "Moist to dry tundra in Subzone D on acidic soils, dominated by hemiprostrate and erect dwarf shrubs <40 cm tall. Drier, lichen-rich dwarf-shrub tundras are common in many areas, e.g., the sandy soils of the Yamal and Gydan peninsulas in Russia. Plant cover is continuous (80-100%) on zonal sites to sparse (5-50%) on dry ridges."
- G3. Non-tussock sedge, dwarf-shrub, moss tundra

  "Moist tundra mainly in Subzone D on peaty nonacidic soils; also found in Subzones C and E. Frost boils (barren patches of cryoturbated soil) are common on silty soils (spotted tundra in the Russian literature). This is the zonal vegetation for much of Subzone D. Plant cover varies from 50-100%. Plant heights are generally 10-20 cm. Hemiprostrate and erect shrubs, such as Salix richardsonii, S. reptans, S. glauca, S. pulchra, S. krylovii and Rhododendron lapponicum, are common but generally do not form a closed canopy, and some may grow up to 40 cm high at the southern Subzone D boundary. Low-shrub (40-200 cm tall) and some tall (>2 m) willow thickets occur along stream margins. Well-developed moss layers (5-20 cm thick) are common".
- W1. Sedge/grass, moss wetland

  "Wetland complexes in the colder areas of the Arctic, dominated by sedges, grasses, and mosses. Subzone B and Subzone C."
- W2. Sedge, moss, dwarf-shrub wetland

  Wetland complexes in the milder areas of the Arctic, dominated by sedges, grasses, and mosses, but including dwarf shrubs <40 cm tall. Subzone D.

The work completed by the CAVM Team used a low resolution scale which does not capture the complexity of vegetation within the Project Licence Area. Therefore, during 2011, vegetation maps were generated from remote sensing data (Colour synthesized aerial photos, QuickBird 06.07.2003, 14.07.2003, 4 spectral channels, spatial resolution 0.6 m) and 1: 5000 scale topographic maps. The study area for the vegetation mapping included the sites for the proposed LNG facility, the proposed well pads and approximately 500 m either side of the proposed infrastructure routes (e.g. roads, pipelines and transmission lines). During 2013, the remote sensing interpretation was extended to the entire Mining Allotment Area. The interpretation of the remote sensing data was ground-truthed during field surveys completed in 2011 and 2013. Where necessary, the interpretation was updated, especially for areas affected by previous industrial activities. A set of geobotanical maps of the study area were where the main vegetation communities (phytocoenoses) are categorised according to the dominant plant species present. The results of the geobotanical mapping are shown in the 2013 FRECOM Survey report.

As well as describing the main vegetation communities present, the 2011 and 2013 field surveys recorded a list of vascular plants found within the Mining Allotment Area. Between the two surveys, a total of 92 species of vascular plants, 20 species of mosses and 12 species of lichens were recorded. Full lists of the species recorded are provided in Table 7.6.6. The vascular plants show high taxonomic diversity, including 28 families and 57 genera. The most prevalent families in terms of numbers of species are grasses (Poaceae) with 14 species and sedges (Cyperaceae) with11 species. Both Compositae and willows (Salicaceae are represented by 8 species, buttercups (Ranunculaceae) 5 species and Polygonaceae 6 species.

Ericaceae is well represented by the common species Arctic bell-heather (*Cassiopa tetragona*) and cowberry (*Vaccinium vitisidaea*) (Figure 7.6.5), while Northern bilberry (*Vaccinium uliginosum*) is less common. Cloudberry (*Rubus chamaemorus*) is widespread (Figure 7.6.6) and occurs in a variety of habitats from shrub lichen tundra within watersheds to polygonal tundra wetlands and coastal marshes. The most widespread grass species are wideleaf polargrass (*Arctagrostis latifolia*), Arctic bluegrass (*Poa arctica*), northern meadow-grass (*P.alpigena*), Holm's reedgrass (*Calamagrostis holmii*), *Deshampsia borealis*, and *Festuca cryophila*. Pendant grass (*Arctophila fulva*) prevails in depressions and semi-aquatic areas. Species of the Cyperaceae family are abundant in tundras and wetlands. These include *Carex arctisibirica, C.aquatilis, C.rariflora, C.rotundata*, and several species of Cottongrass (*Eriophorum* sp) that occur across the entire subject area.

It should be also noted that some vascular plant species, though not abundant in phytocoenoses, are present in a wide range of habitats. These include drooping saxifrage (*Saxifraga cernua*), hawkweed-leaved saxifrage (*S.hieracifolia*), *Ranunculus borealis*, Lapland buttercup (*R.lapponicus*), alpine bistort (*Polygonum viviparum*), *Pedicularis hirsutum, P.sudetica*, *Luzula confuse*, *L.wahlenbergii* and camphor tansy (*Tanacetum bipinnatum)*. Shrub species as dwarf birch (*Betula nana* – see Figure 7.6.7), bearberry (*Arctous alpine*), crowberry (*Empetrum hermaphroditum*) are rare in the Project Licence Area. These species are common in more southern areas of the Yamal peninsula within typical hypoarctic tundra.

Mosses and lichens play a significant role in the plant cover formation. Hypnum mosses are most prevalent in wetlands, including *Calliergon cavolifolia, Calliergon richardsonii*, *Aulacomnium palustre, Aulacomnium turgidum* and *Sanionia uncinata*. Common species within watershed areas of shrub moss and grass moss tundras are the mosses: *Dicranum congestum, Dicranum flexicaule, Dicranum majus, Hylocomium splendens, Mnium sp.* and *Pleurozium schreberii. Polytrichum juniperum* and *Polytrichum strictum* (Figure 7.6.8) and *Racomitrium lanuginosum* are widespread in more drier moss lichen tundra and on sands. It is interesting to note that sphagnum mosses participate quite actively in plant cover composition, despite the fact that in general, sphagnum mosses are uncommon in arctic tundra. Within the Project Licence Area they are found both in polygonal wetland complexes of foreland and in wetland tundra on marine terraces. *Sphagnum cuspidatum, Sph. warnstorfii, Sph. squarrosum* are constant in a variety of habitats.

The lichen flora of the area has been significantly altered by the grazing of reindeer during the last century. The area of lichen tundra in the Yamal has reduced from 52% in the pre-war period compared to now when there are almost none. Reindeer selectively graze *Cladonia* species (*Cladonia arbuscula, Cladina rangiferina* and *Cl. Stellaris*). When overgrazed, these species disappear and are replaced by *Sphaerophus globosus, Stereocaulon alpinum, Flavocetraria nivalis* and *Fl. cucullata* (Morozova *et al.,* 2006).

Table 7.6.6. Plant Species Recorded Within Mining Allotment Area

Flowering Plants	Mosses	Lichens
Class Lycopodiopsida	**Bryophyta**	
Family Lycopodiaceae	*Aulacomnium palustre*	*Alectoria nigricans*
Lycopodium appressum	*Aulacomnium turgidum*	*Alectoria ochroleuca*
Division Equisetophyta	*Amblystegium serpens*	*Cetraria islandica*
Class Equisetopsida	*Calliergon cavolifolia*	*Cetraria nigricans*
Family Equisetaceae	*Calliergon richardsonii*	*Cladina rangiferina*
Equisetum arvense spp. boreale	*Dicranum congestum*	*Cladonia arbuscula*
Equisetum arvense	*Dicranum flexicaule*	*Cladonia sp.*

Table 7.6.6. Plant Species Recorded Within Mining Allotment Area		
Flowering Plants	**Mosses**	**Lichens**
Division Magnoliophyta	*Dicranum majus*	*Dactylina arctica*
Class Liliopsida	*Hylocomium splendens*	*Flavocetraria nivalis*
Family Poaceae	*Mnium sp.*	*Nephroma arctica*
Alopecurus alpinum	*Polytrichum juniperum*	*Peltigera sp.*
Trisetum spicatum	*Polytrichum strictum*	*Thamnmolia vermicularis*
Poa arctica	*Racomitrium lanuginosum*	
Poa alpina	*Sanionia uncinata*	
Poa alpigena	*Sphagnum cuspidatum*	
Phleum alpinum	*Sphagnum warnstorfii*	
Hierochloa pauciflora	*Sphagnum squarrosum*	
Festuca rubra	*Straminergon stramineum*	
Festuca cryophila	*Warnstorfia sp.*	
Calamagrostis holmii	*Pleurozium schreberii*	
Arctophila fulva		
Arctagrostis latifolia		
Anthoxanthum odoratum ssp. alpinum		
Deshampsia borealis		
Family Cyperaceae		
Eriophorum x medium		
Eriophorum vaginatum		
Eriophorum russeolum		
Eriophorum polystachion		
Carex stans		
Carex rotundata		
Carex rariflora		
Carex nigra		
Carex chondrorhiza		
Carex arctisibirica		
Carex aquatilis		
Family Juncaceae		
Luzula wahlenbergii		
Luzula confusa		
Family Melanthiaceae		
Veratrum lobelianum		
Family Liliaceae		
Lloydia serotina		
Class Magnoliopsida		
Family Salicaceae		
Salix reticulata		
Salix pulchra		
Salix polaris		
Salix phylicifolia		
Salix nummularia		
Salix lanata		
Salix glauca		
Family Betulaceae		
Betula nana		
Family Polygonaceae		

Table 7.6.6. Plant Species Recorded Within Mining Allotment Area		
Flowering Plants	**Mosses**	**Lichens**
Rumex arcticus		
Polygonum viviparum		
Polygonum bistorta		
Polygonum alpinum		
Oxyria digyna		
Bistorta major		
Family Caryophyllaceae		
Minuartia arctica		
Cerastium glabratum		
Cerastium arvense		
Family Ranunculaceae		
Ranunculus pallasii		
Ranunculus lapponicus		
Ranunculus hyperboreus		
Ranunculus borealis		
Caltha palustris		
Family Brassicaceae		
Parrya nudicaulis		
Cardamine pratensis		
Cardamine belidifollia		
Family Saxifragaceae		
Saxifraga hieracifolia		
Saxifraga cernua		
Saxifraga aestivalis		
Chrysosplenium tetrandrum		
Family Parnassiaceae		
Parnassia palustris		
Family Rosaceae		
Rubus chamaemorus		
Dryas octopetala		
Comarum palustre		
Family Fabaceae		
Oxytropis sordida		
Hedysarum arcticum		
Astragalus subpolaris		
Family Empetraceae		
Empetrum hermaphroditum		
Family Hippuridaceae		
Hippuris vulgaris		
Family Apiaceae		
Pachypleurum alpinum		
Family Ericaceae		
Vaccinium vitis-idaea		
Vaccinium uliginosum		
Ledum decumbens		
Cassiope tetragona		
Family Limoniaceae		
Armeria scabra		

Table 7.6.6. Plant Species Recorded Within Mining Allotment Area		
Flowering Plants	**Mosses**	**Lichens**
Family Polemoniaceae		
Polemonium boreale		
Family Boraginaceae		
Myosotis asiatica		
Myosotis arvense		
Family Scrophulaceae		
Lagotis minor		
Pedicularis sudetica		
Pedicularis hirsuta		
Family Valerianaceae		
Valeriana capitata		
Family Campanulaceae		
Campanula rotundifolia		
Family Asteraceae		
Tripleurospermum hookeri		
Tanacetum bipinnatum		
Senecio congestus		
Senecio atropurpureus		
Nardosmia frigida		
Artemisia borealis		
Antennaria dioica		

Figure 7.6.5 *Vaccinium vitis-idaea*

Figure 7.6.6 *Rubus chamaemorus*

Figure 7.6.7 *Betula nana*

Figure 7.6.8 *Polytrichum strictum*

The vegetation within the Mining Allotment Area is strongly influenced by the underlying geology and soils, topography and high water table. The vegetation is highly heterogeneous and influenced by a complex and interlacing series of environmental gradients:

- proximity to the sea;
- salinization;
- drainage;
- soil depth,

- soil type;
- moisture levels;
- duration of snow cover and its thickness; and
- wind erosion.

Overlaying the natural abiotic factors are anthropogenic processes, which often increase erosion from wind and thermal processes.

The complexity of plant cover within the Mining Allotment Area is apparent on both the micro and meso-level in forming different combinations of plant associations. At the meso-level, the community associations are influenced by topographical features such as sea terraces and river valleys, as well as features formed by erosion. At the micro-level, vegetation is affected by small changes in relief from knolls, bumps, and elevations of mostly biogenic or cryogenic origin.

The vegetation types recorded within the Mining Allotment Area, along with the typical species diversity found in each are detailed in Table 7.6.7. The vegetation types present are consistent with the conclusion that the Project Licence Area lies in the transition from hypoarctic tundra to Arctic tundras. Photographs of each of the Vegetation types are shown in Figure 7.6.9 ((a) to (m)).

Table 7.6.7: Vegetation types recorded within the Mining Allotment Area

Broad Vegetation Category	Vegetation Type	Vegetation classification according to CAVM	The number of plant associations within the type	Average species richness (vascular plants / mosses and lichens)	Maximum number of species (vascular plants / mosses and lichens)
Tundra	Polygonal dwarf-shrub cottongrass-lichen-moss tundra along with sedge-moss communities in cracks	G3 Non-tussock sedge, dwarf-shrub, moss tundra	3	15/6 -	19/8
	Dwarf-shrub moss-lichen tundra, spotted	G3 Non-tussock sedge, dwarf-shrub, moss tundra	3	12/6	18/7
	Complex/combination of dwarf-shrub graminoid-cottongrass-moss tussock tundra, with willows and Marsh Cinquefoil-sedge coenoses in depressions, and dwarf-shrub cottongrass-sphagnum	S1. Erect dwarf-shrub tundra	3	12/8	20/11

Table 7.6.7: Vegetation types recorded within the Mining Allotment Area

Broad Vegetation Category	Vegetation Type	Vegetation classification according to CAVM	The number of plant associations within the type	Average species richness (vascular plants / mosses and lichens)	Maximum number of species (vascular plants / mosses and lichens)
	wetland/waterlogged tundra				
	Complex of wetland/waterlogged grass-moss tussocky tundra, sometimes with meadow grasses, and wetland/waterlogged graminoid-cottongrass-moss tundra with arctophila (pendant grass)-sedge-hypnum communities in pools	S1. Erect dwarf-shrub tundra	3	10/6	15/8
	Dwarf-shrub herb/forb-moss-lichen sparse communities, sometimes with patches of bare sand	G3 Non-tussock sedge, dwarf-shrub, moss tundra	2	7/5	10/6
Bogs	Complex of polygonal sedge-sphagnum-hypnum bogs, fringed by cloudberry-lichen-moss communities on the swells, and cottongrass-sedge-hypnum bogs	W2. Sedge, moss, dwarf-shrub wetland	3	9/6	12/7
	Cottongrass-sedge sphagnum-hypnum marshes/eutrophic bogs in depressions and river valley's bottoms	W2. Sedge, moss, dwarf-shrub wetland	4	12/6	20/8
	Arctophila-sedge-hypnum marshes/eutrophic bogs in lacustrine depressions ,	W1. Sedge/grass, moss wetland	2	7/4	12/6

Table 7.6.7: Vegetation types recorded within the Mining Allotment Area

Broad Vegetation Category	Vegetation Type	Vegetation classification according to CAVM	The number of plant associations within the type	Average species richness (vascular plants / mosses and lichens)	Maximum number of species (vascular plants / mosses and lichens)
	ephemeral stream's channels and hollows/pools				
Meadows	Forb-graminoid, horsetail-graminoid meadow communities on the valley slopes	-	4	21/7	33/11
Intrasonal habitats	Floodplain vegetation series in combination with sedge-sphagnum-hypnum and cottongrass-sedge-hypnum bogs	-	1		
Sands	Riparian and lacustrine habitats - bare sands, drift sands and filled sands	-	1		

All of the vegetation types listed in Table 7.6.7 are assessed as being natural habitats as defined by IFC PS6. The area of each vegetation type within the Mining Allotment Area is shown in Table 7.6.8.

Table 7.6.8: Area of Vegetation Types in Mining Allotment Area

Vegetation Type	Area Km^2	Proportion
Polygonal dwarf-shrub cottongrass-lichen-moss tundra along with sedge-moss communities in cracks	52.1	5.4
Dwarf-shrub moss-lichen tundra, spotted	50.2	5.2

Table 7.6.8: Area of Vegetation Types in Mining Allotment Area

Vegetation Type	Area Km^2	Proportion
Complex/combination of dwarf-shrub graminoid-cottongrass-moss tussock tundra, with willows and Marsh Cinquefoil-sedge coenoses in depressions, and dwarf-shrub cottongrass-sphagnum wetland/waterlogged tundra	132.3	13.7
Complex of wetland/waterlogged grass-moss tussocky tundra, sometimes with meadow grasses, and wetland/waterlogged graminoid-cottongrass-moss tundra with arctophila (pendant grass)-sedge-hypnum communities in pools	3.0	0.3
Dwarf-shrub herb/forb-moss-lichen sparse communities, sometimes with patches of bare sand	13.4	1.4
Complex of polygonal sedge-sphagnum-hypnum bogs, fringed by cloudberry-lichen-moss communities on the swells, and cottongrass-sedge-hypnum bogs	263.4	27.3
Cottongrass-sedge sphagnum-hypnum marshes/eutrophic bogs in depressions and river valley's bottoms	32.1	3.3
Arctophila-sedge-hypnum marshes/eutrophic bogs in lacustrine depressions, ephemeral stream's channels and hollows/pools	89.4	9.3
Forb-graminoid, horsetail-graminoid meadow communities on the valley slopes	-	-
Floodplain vegetation series in combination with sedge-sphagnum-hypnum and cottongrass-sedge-hypnum bogs	191.9	19.9
Riparian and lacustrine habitats - bare sands, drift sands and filled sands	135.5	14.1
Total	963.4	100.0

Forb-graminoid, horsetail-graminoid meadow communities on the valley slopes has not been measured as it occurs in unit sizes too small to be mapped from remote sensing techniques.

Aquatic Vegetation

Standing water occupies considerable areas in the Project Licence Area. It is not possible to map aquatic vegetation types from remote sensing data due to the small areas covered. Therefore, specific aquatic plant surveys were completed during 2013. The flora in these water bodies was found to be very limited. During 2013, ten species of plants, which regularly occur in shallow water, were recorded: (*Ranunculus pallasii, R. pallasii var minimus, R. hyperboreus, Carex aquatilis, Carex nigra, Comarum palustre, Arctophila fulva, Hippurus vulgaris, Warnstorfia sarmentosa, Calliergon richardsonii*). These species can also form a coastal community on the banks of freshwater bodies.

The most common type of aquatic and semi-aquatic vegetation is confined to a small lakes surrounded by sedge tundra. In these locations, the vegetation is usually represented by a moss - sedge community with *Carex aquatilis, Carex nigra, Carex rariflora* and to a lesser extent *Eriophorum medium, Eriophorum polystachylon*, *Calliergon richardsonii* and *Warnstorfia sarmentosa*.

Ranunculus pallasii prefers small ponds with peaty bottom. *Arctophila fulva* is characteristic of the larger lakes. *Hippurus vulgaris* is found only in flowing waters with a sandy bottom, while *Comarum palustre* is found in stagnant waters.

Anthropogenically Modified Vegetation

While plant cover within the majority of the Project Licence Area is not currently affected by industrial influence, significant areas of disturbance have been identified resulting differing levels of disturbance to existing vegetation covers. These are areas are shown on Figures 7.4.1 and 7.4.2 (see Section 7.4).

In addition, almost 40 years of development within this area of Yamal has led to significant transformation of parts of its plant cover within the narrow strip of land along the Gulf of Ob and around Sabetta. The plant cover has also been modified along tracks used to access well pads. Off-road vehicle tracks are apparent with the increased apparency of sedges and cotton grass and in the reduction in the covering of mosses and other more sensitive species, especially on drained locations. In disturbed areas, primary communities with a low recovery potential are disappearing, and the role of secondary, post-anthropogenic communities is increasing. The duration of the restoration process, is partially determined by the regeneration potential of the pre-disturbance communities. It is also dependant on the site’s location, physical relief and soil type.

Regeneration potential is higher on loamy sands than on sandy soils (where restoration is slow due to the lack of nutrients and mobility of the substratum). Grass communities, grass-moss bogs and meadows are restored relatively quickly. Tundras are generally restored through the colonisation of grass species and therefore human disturbance tends to lead to a higher proportion of grasses than in undisturbed areas. However, species diversity tends to be lower, with a prevalence of rather simple grass groupings, rather than more complex tundra communities.

Vegetation communities’ resistance to human-induced influences is defined by their ability to preserve structure and composition, as well as their ability to recover after activities cease. Lichens are known to be most sensitive to anthropogenic influences (Magomedova and Morozova, 2002) and the communities with significant lichen coverage are the least resistant to impact. Conversely, some of the bogs and meadow communities are relatively stable communities. It is therefore possible to classify the plant cover into three groups in terms of their resistance to anthropogenic influences based on their ability to naturally recover following disturbance:

1. Very sensitive (shrub-moss-lichen tundra, multi-herb groupings of deflationary exposures, nival meadows);
2. Sensitive (grass-moss moist tundra, polygonal bogs);
3. Relatively stable (grass-moss bogs, meadows).

During the 2011 and 2013 surveys, no alien plant species were observed within the Project Licence Area or Mining Allotment Area. Disturbed areas, where bare substrates appear during various construction activities, are usually colonised by a small range of local plant species. Typically these are *Poa alpigena, Deshampsia borealis, Festuca cryophylla, Tanacetum bipinnatum* and *Equisetum arvense*. Also sporadically occurring are *Senecio congestus* and *Matricaria hookeri*.

Figure 7.6.9 Vegetation Types

Figure 7.6.9a Polygonal dwarf-shrub cottongrass-lichen-moss tundra along with sedge-moss communities in cracks (#1)

Figure 7.6.9b Dwarf-shrub moss-lichen tundra, spotted (#2)

Figure 7.6.9c Complex/combination of dwarf-shrub graminoid-cottongrass-moss tussock tundra, with willows and Marsh Cinquefoil-sedge coenoses in depressions, and dwarf-shrub cottongrass-sphagnum wetland/waterlogged tundra (#3)

Figure 7.6.9d Complex of wetland/waterlogged grass-moss tussocky tundra, sometimes with meadow grasses, and wetland/waterlogged graminoid-cottongrass-moss tundra with arctophila (pendant grass)-sedge-hypnum communities in pools (#4)

Figure 7.6.9e Dwarf-shrub herb/forb-moss-lichen sparse communities, sometimes with patches of bare sand (#5)

Figure 7.6.9f Complex of polygonal sedge-sphagnum-hypnum bogs, fringed by cloudberry-lichen-moss communities on the swells, and cottongrass-sedge-hypnum bogs (#6)

Figure 7.6.9g Arctophila-sedge-hypnum marshes/eutrophic bogs in lacustrine depressions, ephemeral stream's channels and hollows/pools (#7) – (1)

Figure 7.6.9h Arctophila-sedge-hypnum marshes/eutrophic bogs in lacustrine depressions, ephemeral stream's channels and hollows/pools (#7) – (2)

Figure 7.6.9i Cottongrass-sedge sphagnum-hypnum marshes/eutrophic bogs in depressions and river valley's bottoms (1)

Figure 7.6.9j Forb-graminoid, horsetail-graminoid meadow communities on the valley slopes (no number in the Legend because of local occurrence) (1)

Figure 7.6.9k Forb-graminoid, horsetail-graminoid meadow communities on the valley slopes (no number in the Legend because of local occurrence) (2)

Figure 7.6.9l Floodplain vegetation series in combination with sedge-sphagnum-hypnum and cottongrass-sedge-hypnum bogs (#9)

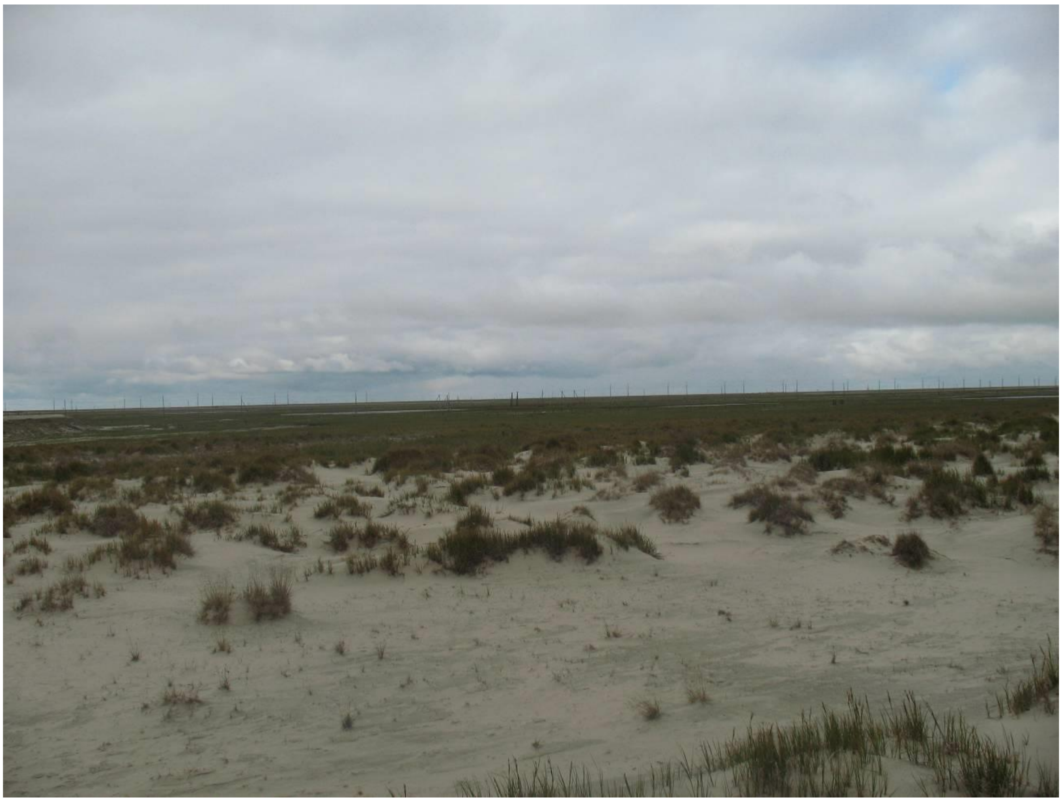

Figure 7.6.9m Riparian and lacustrine habitats - bare sands, drift sands and filled sands (#10)

7.6.2.5 RARE PLANTS AND RARE VEGETATION COMMUNITIES

In the course of field observations conducted around the South Tambey Gas Condensate field facilities in 2011 and 2013, no plants included on the list IUCN RL or in the RDB RF were recorded.

During previous fieldwork conducted in 2010, a single species listed in the RDB YNAO was recorded: northern jacob's ladder *Polemonium boreale*, (status 3 - a rare species – see Figure 7.6.10). This species was not recorded during the 2011 field work, although *Polemonium acutiflorum* was recorded in 2011. According to Tolmachev (1974)[36], these two species often generate hybrid forms in the Arctic region. However, *Polemonium boreale* was recorded again during 2013. *Polemonium boreale* is a circumpolar arctic species found in Northern Europe, the Urals, Siberia and North America.

This grass species *Bromopsis vogulica* (see Figure 7.6.11) was not found during field surveys in either 2011 or 2013. However, according to Rebristaya (1999)[37] and the RDB YNAO, the species may grow within the YTF (Yuzhno-Tambey field). *Bromopsis vogulica* is listed within the RDB YNAO as status 3 - a rare species. It was previously considered as a high mountain endemic of the Urals, but has now also been found in the north of Western Siberia.

Parrya nudicaulis (see Figure 7.6.12) and Snowy buttercup (*Ranunculus nivalis*) were recorded in both 2010 and 2013. Both species are recommended for protection by the RDB YNAO (Appendix 1 to RBD YNAO). *Parrya nudicaulis* is a widespread species found in the Urals, Siberia and North America. Snowy buttercup is also a widespread species with a pan-arctic distribution.

Two species registered in the previous edition of Red Data Book of YNOA (1997)[38], but subsequently excluded from it within the 2010 edition, were recorded: small lagotis (*Lagotis minor* – see Figure 7.6.13) and Asian forget-me-not (*Myosotis asiatica*).

Most of the vegetation communities recorded have widespread distributions. However, the Forb-graminoid, horsetail-graminoid meadow communities on the valley slopes has a limited distribution. The vegetation type meets criteria C: Small current distribution and decline (in distribution or ecological function), as described by Rodriguez *et al.* (2011) as draft proposals for IUCN classification of threatened habitats. This community also supports several of the less common plant species (*Polemonium boreale, Parrya nudicaulis, Lagotis minor, Myosotis asiatica, Hedysarum arctica, Oxytropis sordida* and *Lloydia serotina*).

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[36] Tolmachev, A.I. (1974) Flora of the Northeast of the USSR European part (Flora regionis boreali-orientalis territoriae europaeae URSS) #1
[37] Rebristaya O.V (1999) New data on Yamal Peninsula flora (Western Siberian Arctic region) / "Krylovia". Sibearian Botanic Magazine, 1999, vol.1, №1, p.92-101.
[38] The Red Book of the Yamal-Nenets Autonomous District. Ekaterinburg: Publishing House of the Ural University. 1997. 240s.

Figure 7.6.10 *Polemonium boreale*

Figure 7.6.11 *Bromopsis vogulica*

Figure 7.6.12 *Parrya nudicauls*

Figure 7.6.13 *Lagotis minor*

7.6.2.6 TERRESTRIAL INVERTEBRATES

The 2013 surveys identified 85 terrestrial invertebrate species within the Mining Allotment Area (Table 7.6.9). None of these are Red Data list species. The main groups of invertebrate identified are: oligochaete (earthworms, including lumbricidae and enchytraeidae), araneae (spiders) and insects including hemiptera (true bugs, including heteroptera), homoptera (leafhoppers), coleoptera (beetles), hymenoptera (sawflies, wasps, bees and ants), lepidoptera (butterflies and moths), and diptera (true flies).

There is a relatively limited invertebrate diversity in the study area. The area lacks a number of common soil invertebrate groups such as millipedes, molluscs and ants. Many of the groups present area represented by a small number of species, and often only a single species.

Dwarfism, which is characteristic of tundra vegetation, is also characteristic of invertebrates on the Yamal peninsula. Several of the spider, beetle, and hymenoptera species present are amongst the smallest representatives of their families. Another characteristic is flightlessness, with several flightless species of otherwise largely flying groups. The typical northern tundra conditions lead many invertebrate species to have a decelerated lifecycle, with an increased number of instars between larval stages, and adult stages reached after several years.

Within the Mining Allotment Are the most numerous groups of invertebrate species by both composition and abundance are the spiders (largely pygmy spider (linyphiidae) and wolf spider (lycosidae) families), rove beetles (staphylinidae), ground beetles (carabidae) and leaf bugs (lygaeda). In a number of communities, cicadas (homoptera), lace bugs (tengidae), mosquitoes (culicidae) and crane flies (tipulidae) are also common.

The most numerous and species-rich invertebrate communities inhabit the sloped areas, usually encompassing a large mixture of meadow elements, as well as the green moss communities on the slopes and on elevated, well-drained hills. More species-rich groups are also noted on well-drained terraces. Open tundra habitat and wetland areas are generally low in invertebrate diversity.

Table 7.6.9: Invertebrate Species recorded in the Mining Allotment Area

English	Class/Order	Family	Species	Distribution and Habitat
Earthworm	Oligochaeta	Lumbricidae	*Eisenia nordenskioldi*	
Spider	Araneae	Linyphiidae	*Arcterigone pilifrons*	Arctic, Siberian species
Spider	Araneae	Linyphiidae	*Bathyphantes humilis*	Arctic-boreal, Siberian species
Spider	Araneae	Linyphiidae	*Dactylopisthes video*	Arctic-boreal, Siberian-western arctic species
Spider	Araneae	Linyphiidae	*Diplocephalus barbiger*	Arctic-boreal, Siberian-Nearctic species
Spider	Araneae	Linyphiidae	*Erigone arctica Palaearcticica*	Arctic-boreal, eastern European species
Spider	Araneae	Linyphiidae	*Erigone psychrophila*	Arctic-boreal, Holarctic species
Spider	Araneae	Linyphiidae	*Erigone remota*	Arctic-alpine, palearctic species
Spider	Araneae	Linyphiidae	*Gibothorax tchernovi*	Arctic, Siberian species

Table 7.6.9: Invertebrate Species recorded in the Mining Allotment Area

English	Class/Order	Family	Species	Distribution and Habitat
Spider	Araneae	Linyphiidae	*Halorates holmgreni*	Arctic-alpine, Holarctic species
Spider	Araneae	Linyphiidae	*Halorates spetsbergensis*	Arctic, Holarctic species
Spider	Araneae	Linyphiidae	*Hilaira glacialis*	Arctic-boreal, Siberian species
Spider	Araneae	Linyphiidae	*Hilaira incondite*	Arctic-boreal, Siberian-Nearctic species
Spider	Araneae	Linyphiidae	*Hilaira proletaria*	Arctic-boreal, Siberian-western Nearctic
Spider	Araneae	Linyphiidae	*Hilaira vexatrix*	Arctic-boreal, Siberian-western Nearctic
Spider	Araneae	Linyphiidae	*Masikia indistincta*	Arctic-boreal, Siberian-Nearctic species
Spider	Araneae	Linyphiidae	*Mecynargus tundricola*	Arctic-boreal, Siberian species
Spider	Araneae	Linyphiidae	*Pelecopsis parallela*	Polyzonal, Palaearctic species
Spider	Araneae	Linyphiidae	*Perro Polaris*	Arctic-boreal, Siberian-western Nearctic
Spider	Araneae	Linyphiidae	*Semljicola alticola*	Arctic-boreal, Fennoscandian-Siberian species
Spider	Araneae	Linyphiidae	*Semljicola arcticus*	Arctic-boreal, Siberian species
Spider	Araneae	Linyphiidae	*Semljicola barbiger*	Arctic-alpine, Fennoscandian-Siberian species
Spider	Araneae	Linyphiidae	*Semljicola simplex*	Arctic-alpine, Siberian species
Spider	Araneae	Linyphiidae	*Silometopoides pampia*	Arctic-boreal, eastern Siberian-western Nearctic species
Spider	Araneae	Linyphiidae	*Tarsiphantes latithorax*	Arctic-alpine, Siberian-Nearctic species
Spider	Araneae	Linyphiidae	*Tmeticus nigriceps*	Arctic-alpine, Siberian species
Spider	Araneae	Linyphiidae	*Walckenaeria clavicornis*	Arctic, Holarctic species
Spider	Araneae	Lycosidae	*Alopecosa mutabilis*	Arctic, Holarctic species
Spider	Araneae	Tetragnathidae	*Pachygnatha clercki*	Polyzonal, Holarctic species
Spider	Araneae	Gnaphosidae	*Micaria constricta*	Arctic, Holarctic species
Spider	Araneae	Xysticus albidus	*Xysticus albidus*	Arctic, Palearctic species
Beetles	Coleoptera	Carabidae	*Amara quenseli*	Euro-Siberian
Beetles	Coleoptera	Carabidae	*Amara glacialis*	Siberian species
Beetles	Coleoptera	Carabidae	*Curtonotus alpinus*	Siberian species
Beetles	Coleoptera	Carabidae	*Bembidion sp.1*	
Beetles	Coleoptera	Carabidae	*Bembidion sp. 2*	
Beetles	Coleoptera	Carabidae	*Carabus truncaticollis*	Northern tundra, Euro-Siberian.
Beetles	Coleoptera	Carabidae	*Nebria nivalis*	Boreal, Palearctic

Table 7.6.9: Invertebrate Species recorded in the Mining Allotment Area

English	Class/Order	Family	Species	Distribution and Habitat
Beetles	Coleoptera	Carabidae	*Notiophilus aquaticus*	Boreal and tundra
Beetles	Coleoptera	Carabidae	*Patrobus septentrionis*	Boreal, Palearctic
Beetles	Coleoptera	Carabidae	*Pelophila borealis*	Boreal, Palearctic
Beetles	Coleoptera	Carabidae	*Pterostichus macrothorax*	North, Siberian species, Palearctic
Beetles	Coleoptera	Carabidae	*Pterostichus brevicornis*	North-taiga species, and Bor-Montana view, Palearctic
Beetles	Coleoptera	Carabidae	*Pterostichus pinguedineus*	Northern tundra species, Siberian
Beetles	Coleoptera	Carabidae	*Pterostichus ventricosus*	Northern, boreal-Montana, Siberian
Beetles	Coleoptera	Carabidae	*Pterostichus vermiculosus*	Northern tundra species, Siberian
Beetles	Coleoptera	Carabidae	*Pterostichus haematopus*	Boreal, Euro-Siberian
Beetles	Coleoptera	Hemiptera	*Eremocoris abietis*	Wide ranging
Beetles	Coleoptera	Hemiptera	*Acalypta carinata*	Taiga species, and penetrating to the north , marked in many areas of tundra.
Beetles	Coleoptera	Staphylinidae	*Phyllodrepa angustata*	Northern, East Siberian and North America
Beetles	Coleoptera	Staphylinidae	*Omalium curticolle*	Northern , Palaearctic
Beetles	Coleoptera	Staphylinidae	*Micralymma brevilingue*	East Siberian and North America
Beetles	Coleoptera	Staphylinidae	*Cylletron nivale*	Taimyr, Euro- Siberian
Beetles	Coleoptera	Staphylinidae	*Olophrum fuscum*	Circumpolar and boreal, mountains of Siberia, Holarctic
Beetles	Coleoptera	Staphylinidae	*Olophrum boreale*	Circumpolar,Holarctic
Beetles	Coleoptera	Staphylinidae	*Eucnecosum brachypterum*	Circumpolar and boreal , mountains of Siberia, Holarctic
Beetles	Coleoptera	Staphylinidae	*Holoboreaphilus nordenskioldi*	Northern, East Siberian and North America
Beetles	Coleoptera	Staphylinidae	*Bledius bernhaueri*	Northern, Northern Europe
Beetles	Coleoptera	Staphylinidae	*Tachinus brevipennis*	Northern, east Siberian
Beetles	Coleoptera	Staphylinidae	*Tachinus arcticus*	Northern, Palearcticic
Beetles	Coleoptera	Staphylinidae	*Atheta insecuta*	Northern, arctic-montana, Holarctic
Beetles	Coleoptera	Staphylinidae	*Atheta subplana*	Northern , Holarctic
Beetles	Coleoptera	Staphylinidae	*Atheta vega*	Northern, siberia
Beetles	Coleoptera	Staphylinidae	*Atheta graminicola*	Tundra, the most northern species of rove beetle, Palaearctic
Beetles	Coleoptera	Staphylinidae	*Atheta sibirica*	Northern to the Novaya Zemlya East Siberian - North America
Beetles	Coleoptera	Staphylinidae	*Gnypeta sellmani*	Circumpolar

Table 7.6.9: Invertebrate Species recorded in the Mining Allotment Area

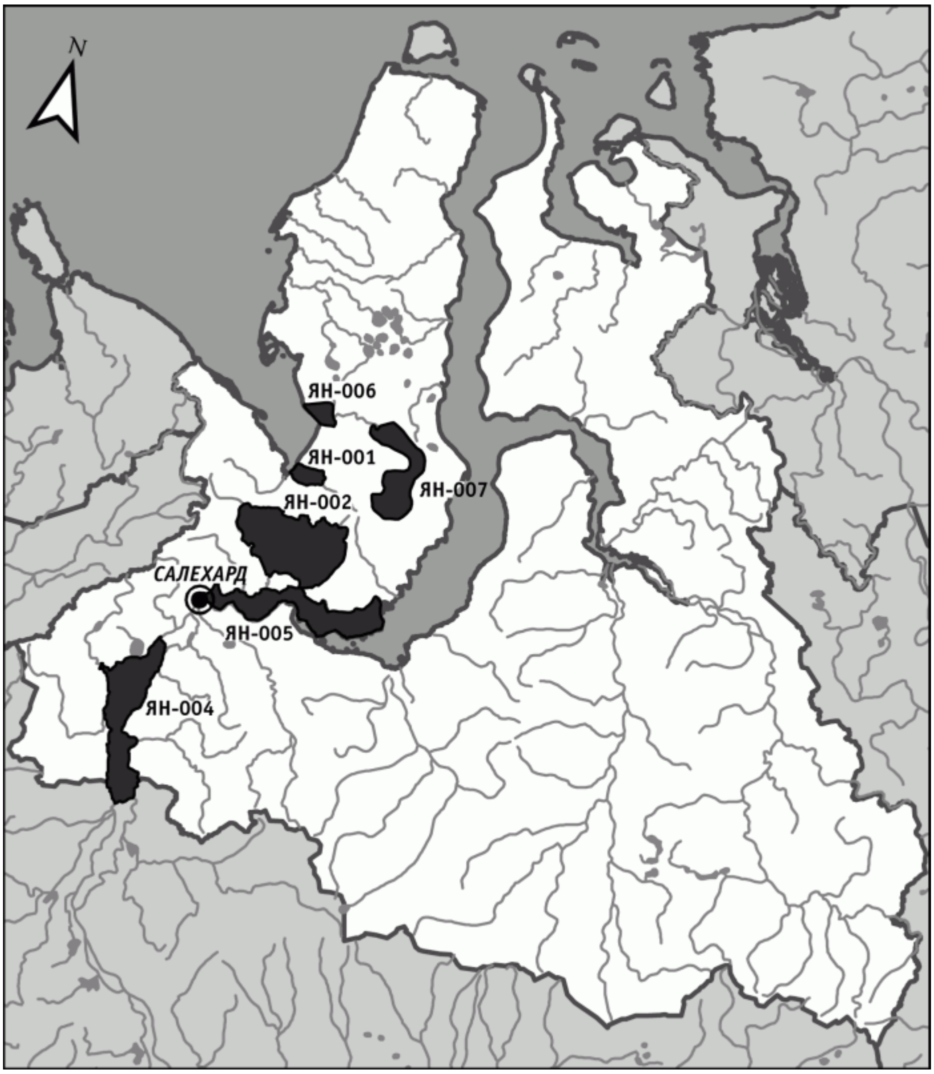
English	Class/Order	Family	Species	Distribution and Habitat
Beetles	Coleoptera	Staphylinidae	*Stenus labilis*	Circumpolar
Beetles	Coleoptera	Staphylinidae	*Stenus frigidus*	Northern, Siberia
Beetles	Coleoptera	Staphylinidae	*Lathrobium polarnis*	Northern, northern Europe . Western Siberia
Beetles	Coleoptera	Dytiscidae	*Hydroporus acutangulus*	Tundra, polar species, Palaearctic
Beetles	Coleoptera	Dytiscidae	*Hydroporus lapponum*	Tundra, polar species, Palaearctic
Beetles	Coleoptera	Dytiscidae	*Hydroporus morio*	Boreal species, Palaearctic
Beetles	Coleoptera	Dytiscidae	*Agabus thomsoni*	Tundra species, Palaearctic
Beetles	Coleoptera	Dytiscidae	*Agabus sp.*	
Beetles	Coleoptera	Hydrophilidae	*Helophorus bergrothi*	Tundra, Euro-Siberian
Beetles	Coleoptera	Leiodidae	*Colon curvipes*	North, Euro-Siberian
Beetles	Coleoptera	Leiodidae	*Colon sp.*	
Beetles	Coleoptera	Byrrhidae	*Simplocaria elongata*	North, Euro-Siberian
Beetles	Coleoptera	Chrysomelidae	*Chrysolina marginata*	Boreal species, Palaearctic
Beetles	Coleoptera	Byrrhidae	*Chrysomelidae gen., sp.*	
Beetles	Coleoptera	Byrrhidae	*Phaedon concinnus*	Euro-Siberian taiga
Beetles	Coleoptera	Byrrhidae	*Hydrothassa hannoveriana*	Boreal species, Palaearctic
Moths and butterflies	Lepidoptera	Family Bear, Arctiidae	*Phagmatobia fuliginosa*	
Moths and butterflies	Lepidoptera	Family Satire, Satyridae	*Oeneis norna*	Common species
Moths and butterflies	Lepidoptera	Family Satire, Satyridae	*Erebia Polaris*	Common species

7.6.2.7 HERPTILES

No reptiles and amphibians occur in the Project License Area.

7.6.2.8 BIRDS

The Project License Area is not located within an Important Bird Areas (IBAs). The closest IBAs to the Project License Area are Jan-006 and Jan-007, located over 250 km to the south (Figure 7.6.14).



Source: Yamal LNG OVOS documentation

Figure 7.6.14: Location of Important Bird Areas

The majority of Arctic bird species occurring on the Yamal Peninsula have a palearctic or circumpolar distribution. The avifauna in the Arctic tundra subzone in the north-eastern parts of the Yamal peninsula includes about 80 bird species, of which 52 are likely to breed (46 confirmed and six probable), five species are transient migratory and around 25 species are vagrant. The proximity of the coast, together with the large area of wetlands means that aquatic and semi-aquatic bird species are common in the Yamal. This is reflected in the relative diversity of wetland bird species, including 30 species of waders (*Charadriiformes*), of which 21 breed and 18 species of geese and ducks (Anseriformes), of which 11 breed (Rutilevsky, 1977)[39]. The absence of trees and low density of shrubs in the tundra habitats limits the populations of species typical of sub-arctic tundra. This is reflected by the relatively low diversity of passerine species (*Passeriformes)* (20 in total, of which 11 breed). Most bird species are migratory summer visitors, with only around ten species wintering in the area.

[39] Rutilevsky G.L. (1977) Wildlife - Yamal Gydanskaya area. Gidrometeoizdat. Pp. 226-260.

Ornithological studies were carried out within the Project Licence Area between 1988 to 1991 at the Yaibari station (71°04'N, 72°20'E), at the lower reaches of the Venuymuyeyakha river, 19 km south of Sabetta. The Yaibari station recorded mean breeding bird densities within survey plots ranging between 1 – 25 km^2 (Table 7.6.10). Breeding bird surveys were completed close to Sabetta in 2008, and densities from these are also presented in Table 7.6.10. However, the precise locations and survey methodologies employed are not known during the performance of the surveys in 2008 and hence these data need to be treated cautiously. The 2011 field survey was completed too late in the year (September) to record breeding bird densities, although a total of 27 species were observed (marked in bold typeface in Table 7.6.10).

Table 7.6.10: Bird species diversity and population density (breeding pairs per km^2) in the Project License Area

Species	Habitats	Bird density* at Yaibari station (1988-1991)	Bird density** near Sabetta
Red-throated diver (*Gavia stellata*)	Common across the whole Arctic, usual habitat is lakes	0.04	0.01-0.17
Black-throated diver (*Gavia arctica*)	Populates tundra lakes	0.24	0.1-0.5
Bewick's swan (*Cygnus bewickii*)	Populates lakes in lowland tundra and wet forest tundra. Rare	-	0.002-0.01
Bean goose *(Anser fabalis)*	Nests on lakes in dry lowland tundra	-	0.09-0.27
Greater white-fronted goose *(Anser albifrons)*	Populates dry lowland shrub tundra	0.25	1.4-1.5
Brent goose (*Branta bernicla*)	Occurs on laidas, nests on open dry locations	0.04	-
Northern pintail *(Anas acuta)*	Populates open water bodies with shallows	0.2	-
Greater scaup (*Aythya marila*)	Nests on overgrown lakes in shrub tundra	0.7	0.1
King eider (*Somateria spectabilis*)	Populates sea and lake shores	1.2	0.8-4.8
Steller's eider *(Polysticta stelleri)*	Nests in pairs on lake shores and rivers in wet tundras	0.17	0.03
Long-tailed duck *(Clangula hyemalis)*	Sighted on lakes and rivers. Game species	5.9	3.0-16.12
Rough-legged buzzard (*Buteo lagopus*)	Choose dry and elevated spots in tundra for nesting	0.04	0.03-0.08
Peregrine (*Falco peregrinus*)	Omnipresent, nests on high rocks and cliffs. Rare	-	0.04

Table 7.6.10: Bird species diversity and population density (breeding pairs per km^2) in the Project License Area

Species	Habitats	Bird density* at Yaibari station (1988-1991)	Bird density** near Sabetta
Willow ptarmigan *(Lagopus lagopus)*	Nests chiefly in moss tundra. In winter, migrates to south	5.6	2.5-3.0
Rock ptarmigan (*Lagopus mutus*)	Nests primarily in stony tundra.	-	0.3
Ringed plover *(Charadrius hiaticula)*	Sighted on the shores of Arctic seas and bodies of water	0.06	3.5
Grey plover (*Pluvialis squatarola*)	Nests in dry tundras and rubbly highlands	2.7	1.1-2.4
Pacific golden plover *(Pluvialis fulva)*	Rare, dry tundras	0.17	-
Red-necked phalarope *(Phalaropus lobatus)*	Sighted on spongy lake banks and boggy lake beds	4.7	5.0-20.5
Red phalarope (*Phalaropus* fu*licarius*)	Sighted on lake shores and in waterlogged areas	-	0.45-0.5
Ruddy turnstone (*Arenaria interpres*)	Common along the whole Arctic shore	0.05	0.05
Dunlin (*Calidris alpina)*	Common across the whole tundra zone	28.5	28.8-47.7
Curlew sandpiper (*Calidris ferruginea)*	Hummock tundra	0.8	-
Little stint *(Calidris minuta)*	Populates chiefly dry tundras	64.4	0.5-164.8
Temminck's stint (*Calidris temminckii*)	Common across the whole tundra zone	8.1	2.2-14.0
Ruff *(Philomachus pugnax)*	Omnipresent, resident of marshes, meadows, seashores	3.0	0.01-0.15
Long-tailed skua *(Stercorarius longicaudus)*	Sighted across the whole tundra zone	0.07	0.06-0.08
Pomarine skua (*Stercorarius pomarinus*)	Common across the whole tundra zone	0.8	2.8-3.2
Arctic skua	Sighted across the whole	0.75	0.06-0.12

Table 7.6.10: Bird species diversity and population density (breeding pairs per km²) in the Project License Area

Species	Habitats	Bird density* at Yaibari station (1988-1991)	Bird density** near Sabetta
(Stercorarius parasiticus)	tundra zone		
Heuglin's gull ***(Larus heuglini)***	Seas, lakes, and rivers across the whole tundra zone	0.05	-
Glaucous gull ***(Larus hyperboreus)***	Chooses seashores for nesting, rarer within tundra	-	0.005-0.12
Arctic tern (*Sterna paradisaea*)	Omnipresent, populates tundra lake and sea shores	0.17	0.06-1.2
Snowy owl ***(Bubo scandiaca)***	Nests across the whole tundra zone	0.02	0.02-0.04
Horned lark (*Eremophila alpestris*)	Common in dry stony tundra.	5.7	1.5-4.4
Red-throated pipit ***(Anthus cervinus)***	Populates wet hummock tundra	5.6	1.2-45.5
White wagtail ***(Motacilla alba)***	Nests in river floodplains, lake shores and human settlements	0.5	12.5
Citrine wagtail (*Motacilla citreola*)	Nests in marshes and dry meadows	-	1.0
Common wheatear (Oenanthe oenanthe)	Nests in tundra, meadows, abandoned construction sites	0.2	12.0
House sparrow (*Passer domesticus*)	Nests mainly in villages/towns	-	2.0
Lapland bunting (*Calcarius lapponicus*)	Common across the whole tundra zone	25.6	70.4-120.0
Snow bunting (Plectrophenax nivalis)	Common across the whole tundra zone	0.2	18.5

In addition to the birds highlighted bold, red-breasted merganser (*Mergus serrator*), meadow pipit (*Anthus pratensis*) and common redpoll (*Carduelis flammea*) were also observed in 2011.

Table 7.6.10: Bird species diversity and population density (breeding pairs per km^2) in the Project License Area

Species	Habitats	Bird density* at Yaibari station (1988-1991)	Bird density** near Sabetta
Note: * - the number of pairs, nests per 1 km^2, counted using reference sites with an area of 1 to 25 km^2 depending on species, in the lower reaches of the River Venuymuyeyakha, 19 kilometres south of the village of Sabetta (Ryabitsev, 1993)[40] ; ** - Technical Report, 2008.			

Of the birds having been previously recorded breeding within the Project Licence Area, a number have been assessed as threatened by either the IUCN, RDB RF and RDB YNOA.

- **Black-throated diver** *(Gavia arctica)* assessed as category 2 (by the RDB RF). Not included in RDB YNAO and assessed as Least Concern by IUCN RL.
- **Brent goose** (*Branta bernicla*) assessed as category 3 by the RDB RF. Not included in RDB YNAO and assessed as Least Concern by IUCN RL.
- **Steller's eider** (*Polysticta stelleri*). Not included in RDB RF or RDB YNAO. Assessed as Vulnerable (VU) by IUCN RL.
- **Long-tailed duck** (*Clangula hyemalis*). Assessed as Vulnerable (VU) by IUCN RL. Not included in RDB RF or RDB YNAO.
- **Peregrine** (*Falco peregrinus*). Included in the RDB RF (category 2) and RDB YNAO (category 3) and assessed as Least Concern by IUCN RL.
- **Snowy owl** (*Bubo scandiaca*). Listed within RDB YNAO (category 2). Not included in RDB RF and assessed as Least Concern by IUCN RL.

Additional breeding bird surveys were completed in 2013. However, 2013 proved to be an atypical breeding season due to the cold spring weather conditions and a late heavy snowfall on the 27th May. The tundra only became completely free of snow in the third week of June (Figure 7.6.15) . The low temperatures also preserved ice cover on the lakes for longer than normal, with only a few lakes with open areas of water by the third week of June. By the 30th June, 30 percent of the lakes were still completely covered with ice.

Under these conditions, the number of nesting birds was limited by lack of available nesting habitat and lack of prey. The ice cover on the lakes probably significantly affected the nesting density of several species including black-throated diver and red-throated diver, as well as long-tailed duck.

In addition to the adverse weather conditions in 2013, the very low abundance of lemmings and voles, possibly explains the complete absence of nesting predatory bird species such as rough-legged buzzard, snowy owl and long-tailed skua.

Another factor likely influencing the density and breeding success of birds are the very high densities of reindeer which have caused overgrazing and degradation of the tundra vegetation in upland areas (Figure 7.6.16). This has reduced the area of suitable bird breeding habitat.

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[40] Ryabitsev V.K. (1993) Territorial relations and the dynamics of bird populations in the Subarctic. Ekaterinburg: Nauka, 296 p.

Figure 7.6.15: Snow conditions in the lower reaches of the river Venuymuyeyakha 8 June 2013.

Figure 7.6.16: The degradation of vegetation cover due to overgrazing deer, north-western part of the field in the field camp number 2 (UT13-B2)

During 2013, it was only possible to calculate breeding densities for five species of bird from direct nest recording. However, later in the summer, it was possible to provide breeding density estimates for a wider range of species based on the observed numbers of hatched broods of young. However, the counting of number of broods of chick will underestimate of number of breeding pairs, as it would not record those pairs that nested but failed to produce young (e.g. predated nests). The 2013 breeding bird density estimates are shown in Table 7.6.11. The low densities recorded are likely to reflect the abnormal conditions and are therefore considered to represent minimum densities.

Table 7.6.11: 2013 Breeding bird densities estimates

Species	**Density based on number of nests (pairs/km2)**	**Density based on number of broods (pairs/km2)**
Red-throated diver	-	0.01
Black-throated diver	-	0.14
White-fronted goose	2.15	0.25
King eider	-	0.08
Greater scaup	-	0.02
Long-tailed duck	-	0.57
Grey plover	1.035	
Dunlin	3.2	
Little stint	12.51	
Lapland bunting	5.397	-

Definition of Discrete Management Units (DMU) and breeding bird populations within them is currently difficult due to a number of significant uncertainties and in particular:

- Uncertainties in the breeding density, and in particular results from 2013, which was an atypical breeding season due to the cold spring weather conditions and a late heavy snowfall; and
- Uncertainties in the extrapolation of the breeding densities from the survey areas, either over the Project Licence Area or the Mining Allotment Area. This is especially the case given highly patchwork nature of the bird habitat (e.g. see Figure 7.6.17).

In order to define relevant DMUs and the breeding bird habitats within them, further surveys will be required (see Figure 7.6.17), and these will be developed as part of a Biodiversity Action Plan (BAP).

Key

Habitat Type	Bird
Polygonal tundra	King Eider, Dunlin, Little stint, Long-tailed duck, Grey plover, Dunlin, Pomarine Skua, Red-throated pipit, Lapland Longspur
Grumous suffruticous tundra and suffruticous-lichenous-mossy tundra	Grey plover, Little stint, Rough-legged buzzard, Snowy owl, Pomarine Skua, Lapland Longspur
Sedgy-sphagnous-hypnum bogs	Little stint, Temminck's Stint, Ruff, Red-throated Pipit, Lapland Longspur
Flood-lands and semi-aquatic	Greater White-fronted Goose, Long-tailed Duck, Ruff, Little Stint, Pomarine Skua, Parasitic Jaeger, Red-throated Pipit, Lapland Longspur
Lake complexes	Red-throated Loon, Black-throated Loon
Coastal, river and lake sands, lacking vegetation, sand blown and land fills	Ringed plover, Heuglin's Gull, Glaucous Gull, Arctic Tern

Lake with identified high numbers of birds (including red-throated diver, black-throated diver, eider and long-tailed duck)

Avifauna areas to be subject to further surveys (1 and 2)

Figure 7.16.17: Bird Habitats in the Mining Allotment Area (FRECOM 2013)

Peregrine was not recorded breeding in 2013 or during the four years of operation of the Yaibari station, although breeding was confirmed in 2008. In 2013, a single non-breeding peregrine was noted on September 3 in the south field off the coast of the Gulf of Ob (N 71.166624, E 72.388938). The Project Licence Area is not considered to support a significant population of peregrine. Snowy owl was also not recorded breeding in 2013. It was only recorded in one year out of four by the Yaibari station, although it was recorded at a low density in 2008. The Project Licence Area is not considered to support a significant population of snowy owls.

Migrating Birds

The Yamal peninsula is located on a bird migration route that links nesting areas in Gydan and Taymyr with European wintering areas. The species involved largely include geese, ducks and wading birds.

The white-fronted goose *Anser albifrons* is the most numerous goose species passing through the Project Licence Area. This is due to a large and growing population (Goose populations, 1999), as well as to the fact that Taymyr peninsula, to the east of Yamal, is not just a nesting area for the species, but also a moulting area for non-breeding birds[41]. Satellite tagging results has shown that the main migration corridor of the white-fronted geese wintering in Western Europe passes through the Yamal (Figure 7.6.18(1)-(4)).

White fronted geese wintering in Eastern Europe and nesting on Gydan and Taymyr are not thought to pass through Yamal, although may occasionally enter the south-easternmost area at the Gulf of Ob coast. Geese of this migration route fly across West Siberia, Kazakhstan and the Kumo-Manych depression, i.e. the entire area of Yamal peninsula lies outside of their migration territory (Figure 7.6.18(5)).

According to local workers, in the spring of 2013, the first single white-fronted goose appeared in the Project Licence Area on 18 May. However, no white fronted geese were recorded between 22nd and 25th May, probably due to the cold weather. A small number of white-fronted geese were observed on 26 May 2013. Migration was then disrupted by a strong snowstorm in the northeastern Yamal on 27 May. Following this date, no marked spring migration was observed. A group of approximately 400 white-fronted geese were observed in early June, on thawed floodplains of the Venuymuyeyakha River in the south of the Project License Area. According to the satellite tagging results from 2013, white-fronted geese were already breeding on Gydane and Taymyr at this time, so it can be assumed that the geese in Project Licence Area were not actively migrating but belonged to a group nesting locally.

In 2013, autumn migration through the Project Licence Area was extremely extended in time. The first small transition groups of white-fronted geese (10-15 birds) were detected on 18th August. But the peak occurred in early September. The density of migration was rather low, with flocks mostly comprising between 10-20 birds. However, the overall number of birds passing through may be high as the migration may occur day and night with any flocks being detected at night (22-23 pm). Most of the migrating birds were observed flying to the south-west and don’t stop in the Project

[41] www.blessgans.de, accessed 28th November 2013

Licence Area. However, there were several large flocks of resting white-fronted geese (150-700 birds) observed during the period. Almost all the resting flocks were observed near the Gulf of Ob coast, next to rivers and large lakes. The largest flocks were located next to the new port (under construction) in the valley of the Sabbetayakha river and in interfluve of the Sabbetayakha and Nedarmayakha rivers.

Satellite tagging has also been used to track red-breasted geese (*Branta ruficollis*) between wintering areas in Bulgaria and breeding areas in Taymyr. This has shown that their migration route passes only through the southernmost parts of the Gulf of Ob at the south-eastern coast of Yamal (Figures 7.6.18(6)-(7))[42]. The species was not observed during the work completed by the Yaibari Station, although in 2011, a group of 15 red-breasted geese was observed on September 2 north of Sabetta (N 71.269738, E 72.034367). The species was not observed during 2013. Therefore, the species is considered to only likely occur in the Project Licence Area sporadically. Red-breasted goose is classified as Endangered (EN) by the IUCN RL and it is included on the RDB RF and RDB YNAO as Rare (category 3).

Migration of brent geese on the East Atlantic Flyway (an internationally important flyway) from Western Europe was tracked by satellite transmitters in 1999. This showed that their migration route tends to pass to the north of the Project Licence Area (Green et al., 2002)[43]. The west coast and the northern tip of the Yamal were both identified as important stop-over locations. Only small numbers of brent geese were recorded within the Project Licence Area during 2013. No brent geese were detected during the spring migration period. A group of 3 birds was observed next to the trading station in the south of the Project Licence Area on 19 August 2013. Later a group of 50 Black brent geese was observed feeding in the lake near the port construction site north of Sabetta (71.276205N, 72.036956E). The absence of large migration colonies of brent geese may explained by the lack of suitable saltmarsh habitats which the species favours.

The migration routes of the Bean Goose *Anser Fabalis* through the north-eastern Yamal are not well understood. During the spring migration period, low numbers were observed, mostly as single birds or small groups of 2-5 individuals (maximum 30 individuals). The Bean Goose was not observed during the autumn migration period in 2013.

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[42] www.redbreastedgoose.org, accessed 28th November 2013

[43] Green, M., Alerstam, T., Clausen, P., Drent, R. & Ebbinge, B.S. 2002: Site use by dark-bellied brent geese Branta bernicla bernicla on the Russian tundra as recorded by satellite telemetry: implications for East Atlantic Flyway conservation. Wildl. Biol. 8: 229-239.

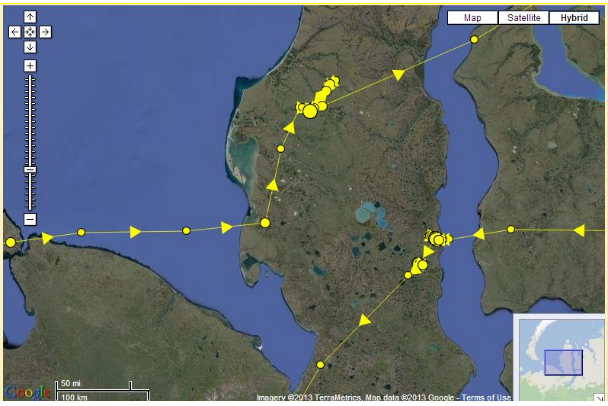


Figure 7.6.18 (1)

Figure 7.6.18 (2)

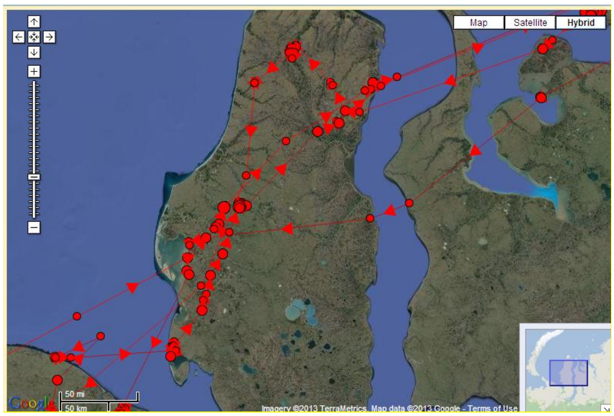
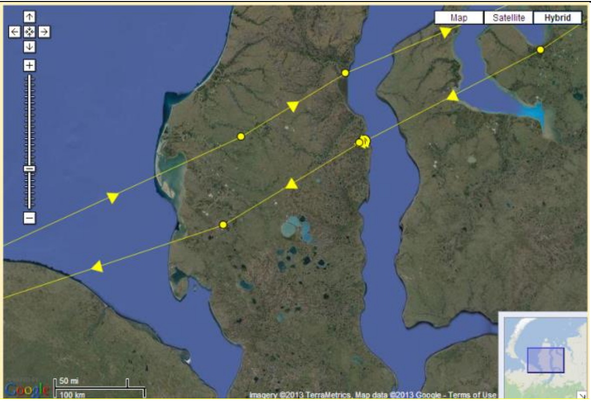


Figure 7.6.18 (3)



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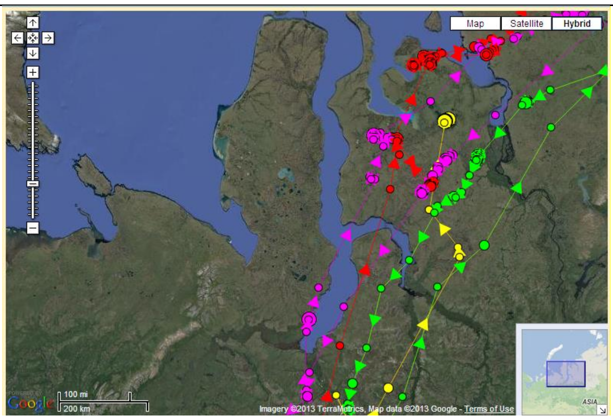

Figure 7.6.18 (5)

Figure 7.6.18 (6)

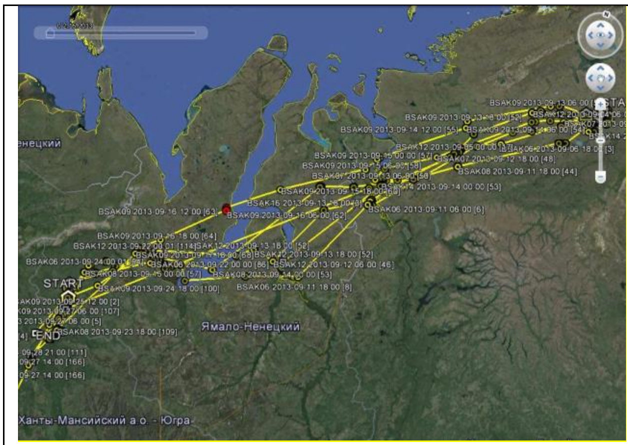

Figure 7.6.18 (7)

Figures 7.6.16(1) – 7.6.16(4) Satalite tagged white fronted geese from Western Europe

Figures7.6.16(5) Satalite tagged white fronted geese from Eastern Europe

Figures7.6.16(6) Migration of Red-breasted Geese marked on the wintering grounds in Bulgaria

Figures7.6.16(7) Migration of Red-breasted Geese marked nesting in eastern Taimyr in 2013

Unfortunately, no satellite tracking data on duck migration through the north-eastern Yamal is available. However, the migration routes of long-tailed duck, king eider and the Steller's eider are all expected to pass through the Project Licence Area. In spring 2013 the migration of duck was influenced by the unfavourable weather conditions of late May and early June. During May, flocks of duck were observed in open water in the Venuymuyeyakha River. They consisted of 500 long-tailed duck 150-200 king eider and up to 45 Steller's eider. During autumn migration, Pintail *Anas acuta* was relatively numerous. Small groups of 5-15 birds were identified from mid-August. In early September, concentrations of 150 birds were observed. These were both single groups on lakes and in mixed flocks with white-fronted geese and brent geese. The number of pintail, identified from 15 August to 14 September, totaled 400 birds. No migrating king eiders or long-tailed ducks were identified during autumn.

Based on ringing recoveries between nesting colonies of wading birds on Taymyr and their European wintering grounds it is likely that species such as grey, golden plover, little stint, dunlin pass through the Yamal territory (Soloviev *et al*., 2012)[44]. No evidence was obtained during the 2013 survey to confirm that the migration of wading birds pass through the Project Licence Area, either in spring or in autumn. During spring no significant concentrations of any species were identified, except for small groups of 4-5 birds. Most probably, these were birds of the local nesting population. During autumn, Sanderlings were often found in the Venuymuyeyakha estuary in early September. These were mostly small groups of several birds. However, on 3 September a group of 41 birds was observed. Some mixed concentrations of wader were identified in the Project Licence Area, in shallow waters and on banks of big lakes, often near sites and facilities of human activity. They consisted mainly of little stints, dunlin and Temminck's stints, with occasional curlew sandpipers and ruffs. The total number of birds in these flocks usually did not exceed 50 individuals although in early September, about 400 mixed waders were recorded in the Venuymuyeyakha River estuary. The lack of large concentrations of waders may be due to the

[44] Soloviev, M.Y., Tomkovich, P.S., Popovkina, A.B. & Golovnyuk 2012. Recent advances in understanding of migratory links of waders (Charadrii) breeding on the Taimyr peninsula, Siberia. Zoolog. Zhurnal 91: 831-842.

lack of large silted shallows and littoral zones of marine coasts rich in invertebrates which are the main stop-over locations for these species. No such habitats exist at the Gulf of Ob coast.

Moulting Birds

Until the mid-1970s, large moulting grounds of the white-fronted geese existed in the northeast of Yamal, concentrated mostly in lower reaches of large rivers (Danilov et al., 1984). By the end of 1980-s large moulting areas apparently disappeared, and there were only small groups of several dozens of birds (Ryabitev, 1993; Tarasov, pers comm.). In 2013, no large moulting colonies of geese were detected. The three biggest detected flocks were found in the south of the Project Licence Area (about 50 bird individuals located at 71.12018°N, 72.24605°E), to the south of Sabetta town (about 30 bird individuals located at 71.12018N, 72.24605E) and in the northwest (35 bird individuals located at N 71.385040, 71.568158).

No large moulting flocks of ducks were observed during 2013, although small flocks of moulting long-tailed ducks and king eiders could be found almost everywhere, mostly in small groups of 5-7 birds. The largest group of moulting king eiders consisting of 25 birds, was found in the lake next to the Venuymuyeyakha River mouth. The largest flock of long-tailed ducks (up to 40 birds) was identified at the lake used for water intake for Sabetta.

7.6.2.9 MAMMALS

The Project Licence Area had not been historically investigated in respect of its zoogeographical aspects and there is very limited published research to provide specific baseline information on mammals. However, details surveys were undertaken of the Mining Allotment Area in 2013, as described below. The Project Licence Area is characteristic of tundra fauna to be distributed unevenly, to have considerable cyclical population fluctuations, and large changes in species diversity from season to season. During winter, larger mammal species typically migrate southwards in search of food. Only small mammal species stay in the tundra throughout in winter and generally do not hibernate. This is because the summer period is not long enough to build up the necessary fat reserves for hibernation and the permafrost prevents digging of burrows that could sustain life over winter. The mammal species composition is relatively poor due to the unfavourable natural conditions such as long cold winters, permanently frozen ground, low summer temperatures and the poor species composition and growth-rate of plants.

The Project Licence Area's extensive wetlands are key in determining the faunal structure and its general characteristics and result in slightly depleted range of faunal species. From previous studies (Technical Report, 2008)[45], it is known that the mammal fauna of the region potentially includes 26 species of mammals in six orders: *Rodentia, Lagomorpha, Soricomorpha* (formally included in *Insectivora*) *Carnivora, Pinnipedia*, *Artiodactyla* (even-toed ungulate) and *Cetacea* (see also Table 7.6.12).

[45] Technical Report (2008) renovation project site facilities fishing South Tambey gas field. Ltd. "GCE - ecology", St. Petersburg.

Additional detailed surveys for mammals were completed in 2013. This include an aerial survey for marine mammals along the Bay of Ob. The surveys were completed by helicopter and included 30 overflights along the coastline and waters of the Ob Bay, totalling 3,000 km. Observations were conducted by at least 2 observers on both sides of the helicopter. The width of the survey band was approximately 500 meters, providing a total survey area of about 1,500 km2.

The most common mammal species in the area are Arctic shrew (*Sorex arcticus*), pigmy shrew (*Sorex minutus*), polar hare (*Lepus timidus*), collared lemming (*Dicrostonix torquatus*), Siberian lemming (*Lemmus sibiricus*), narrow-skulled vole (*Microtus gregalis*), Middendorff's vole (*Microtus Middendorffi*), common wolf (*Canis lupus*), Arctic fox (*Alopex lagopus*), ermine (*Mustela erminea*) and weasel (*Mustela nivalis*).

Reindeer (*Rangifer tarandus*), the two lemming species and arctic fox are considered to be essential to the functioning of the tundra ecosystems.

Few species were identified during 2013 surveys: Siberian lemming, collared lemming, tundra shrew (*Sorex tundrensis*), Arctic fox and reindeer.

Table 7.6.12: Faunal diversity in the Project License Area and adjacent Gulf waters

Objects	**Land**	**Marine**
Rodentia		
Collared lemming - *Dicrostonis torquatus*	+	-
Siberian lemming - *Lemmus sibiricus*	+	-
Middendorff's vole - *Microtus Middendorffi*	+	-
Narrow-skulled vole - *Microtus gregalis*	+	-
Lagomorpha		
Polar hare - *Lepus timidus*	+	–
Soricomorpha		
Tundra shrew - *Sorex tundrensis*	+	-
Carnivora		
Common wolf - *Canis lupus*	+	-
Arctic fox - *Alopex lagopus*	+	-
Red fox - *Vulpes vulpes*	+	-
Polar bear - *Ursus maritimus*	+	+
Wolverine - *Gulo gulo*	+	-
Weasel - *Mustela nivalis*	+	-
Stoat (ermine) - *Mustela erminea*	+	-

Table 7.6.12: Faunal diversity in the Project License Area and adjacent Gulf waters

Objects	Land	Marine
Pinnapedia		
Walrus - *Odobenus rosmarus*	-	+
Bearded seal - *Erignathus barbatus*	-	+
Ringed seal - *Phoca hispida*	-	+
Harp seal - *Phoca groenlandica*	-	+
Artiodactyla		
Reindeer – *Rangifer tarandus*	+	-
Cetacea		
White whale or beluga- *Delphinapterus leucas*	-	+
Bowhead whale - *Balaena mysticetus*	-	+
Finwhale - *Balaenoptera physalus*	-	+
Note: + Present, - Absent.		

Rodents

The two most numerous rodents are collared lemming and Siberian lemming, both species being distributed widely across the Yamal peninsula. Most biotopes have Siberian lemming as the dominant rodent species. Its populations vary according to a three year cycle. At a population peak, Siberian lemmings breed throughout the winter and after a break in May, produce 2-3 litters during the summer (Danilov, 1984). During the population troughs, the number of litters is small, with reduced breeding levels in the summer and winter breeding is absent. Collared lemmings are present in almost every tundra biotope, avoiding only waterlogged and open dry upland lichen tundra areas. It is most populous in the shrub tundra sub-zone. It is more common in hummock tundra on hills and floodplain terraces under shrubs. Distribution in the study area is more sporadic than that of Siberian lemmings. Reproduction cycles and population fluctuations are similar to those of the Siberian lemming.

Narrow-skulled vole is a dominant species together with lemmings and likewise, has fluctuations in population size. It is distributed locally within the study area, inhabiting small hummocks and avoiding the flat tundra. They have also been recorded within the village of Sabetta. Middendorff's vole is rare, occurring only along the border with dwarf shrub tundra (Schwartz, Pyastolova, 1971)[46]. Due to historical human developments in the Project Licence Area, some synanthropic species are also found, including house mouse (*Mus musculus*) and brown rat (*Rattus norvegicus*).

[46] Schwartz, S.S. and Pyastolova O.A (1971) Middendorf Vole - Mammals Yamal and Polar Urals. Sverdlovsk. T. 1. Pp. 108-126.

Lagomorphs

Lagomorphs are represented in the Project Licence Area by a single species, the polar hare. The largest populations of this species in Western Siberia are found in river floodplains and valleys. With populations occurring up to the shores of the Kara Sea, the northern parts of the global range see the species at significant numbers only during years of peak population cycles. The Yamal population is limited by the availability of shrubby vegetation, with the forests, scrub, coastal marsh and tundra habitats of the southern Yamal holding the most favourable polar hare habitat (Yamal Nature, 1995)[47]. Population the density estimates for this species ranges between 0.1 per km^2, [48] and 0.35 per km^2. [49] Hares in the subarctic area are known to migrate north in the winter from the subzone tundra of the Yamal Peninsula to upland slopes where wind exposes food from under snow cover.

Insectivores

Tundra shrew is one of the most common tundra mammal species. In polar regions, tundra shrew, can have numbers comparable with those of the dominating rodent species (outside their population cyclical peaks). The species was not recorded in the Mining Allotment Area during 2013 surveys.

Carnivores

In the Kara Sea during the winter and spring, polar bears have mostly been observed in the southwestern part of the sea and along the eastern coast of Novaya Zemlya. There have been relatively few sightings on the fast ice along the north-western coast of the Taimyr Peninsula. (Belikov *et al.* 1996)[50]. In the Russian Arctic, polar bears spend most of the year out to sea, although it also occur on-land depending on the abundance of food or the incidents of unusual ice conditions (Belikov *et al.* 1996). Along the Russian coastline, sea ice retreats from the coast during the summer (Figure 7.6.19). During this time, polar bears either come ashore, largely fasting until the ice returns, or migrate with the retreating pack ice. With climate change, the loss of sea ice along the Kara Sea is projected to increase, reducing polar bear habitat and increasing energetic challenges faced by this population (Durner *et al.,* 2007)[51].

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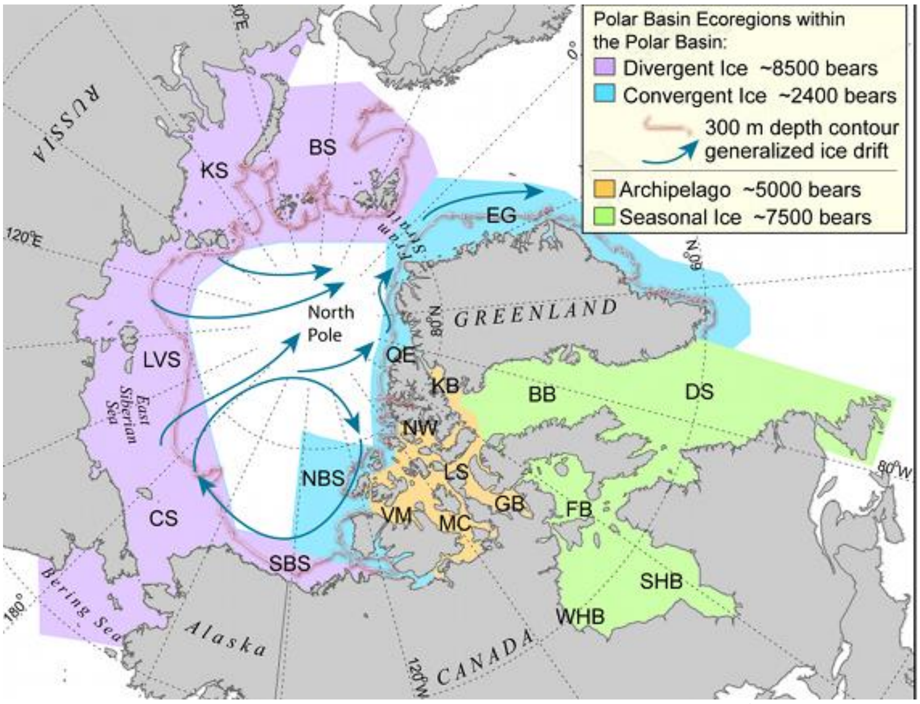
[47] Yamal Nature (1995) Clearing. Order. L.H. Dobrinskiй. - Yekaterinburg: Science. 436 s.
[48] Resource status of game animals in the Russian Federation in 2000-2003. Information and analytical materials. Ed. Candidate. geogr. IK Sciences Lomanova. - M.: Tsentroohotkontrol 2004. - 211.
[49] Resource status of game animals in the Russian Federation in 2003-2007. Information and analytical materials. Ed. YP Gubar. - M.: Tsentroohotkontrol, 2007. - 162.
[50] Belikov, S. Belikova, A and Gorbunov Y (1996) Distribution And Migration Of Polar Bears, Pacific Walruses And Gray Whales Depending On Ice Conditions In The Russian Arctic. Proc. NIPR Symp. Polar Biol., 9, 263-274,
[51] Durner, G.M., Douglas, D.C., Nielson, R.M., Amstrup, S.C. and McDonald, T.L. (2007) Predicting the Future Distribution of Polar Bear Habitat in the Polar Basin from Resource Selection Functions Applied to 21st Century General Circulation Model Projections of Sea Ice. U.S. Geological Survey, Reston, Virginia

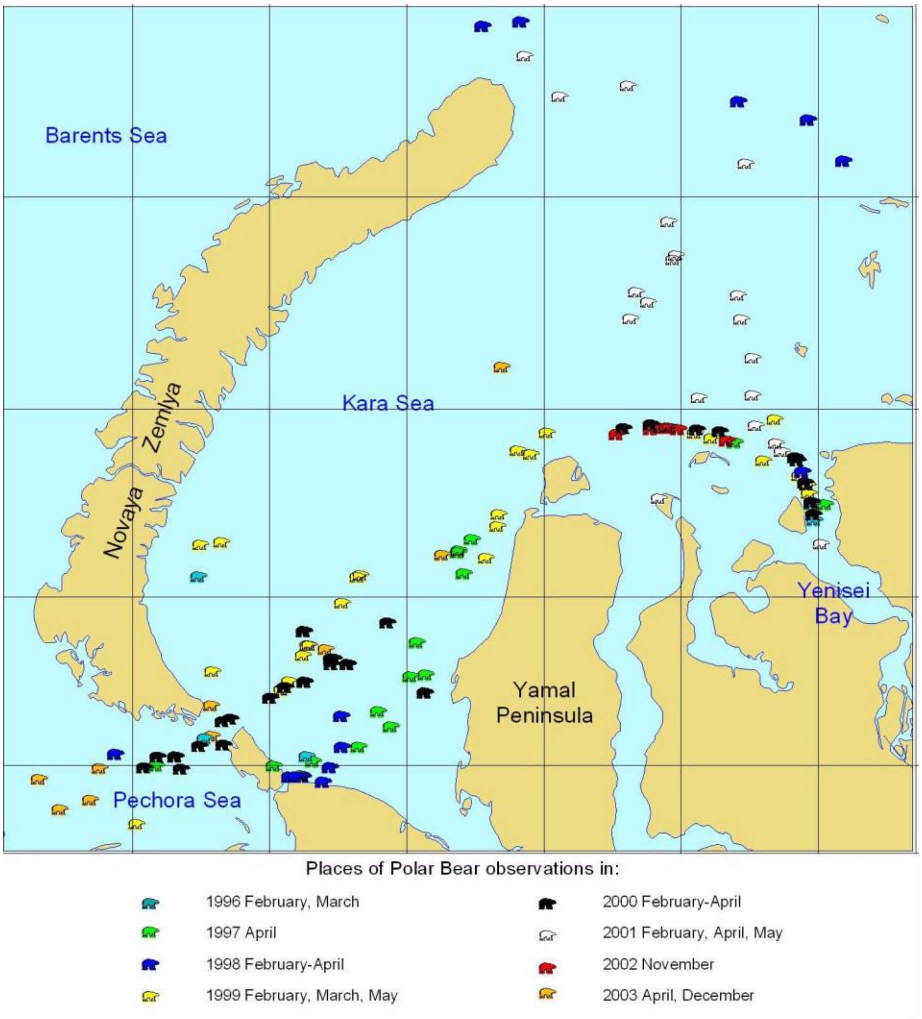


Source: (Polar Bears International Website)[52]

Figure 7.6.19: Polar Basin Eco-Regions within the Polar Basin

The detailed distribution of polar bears within the Kara Sea is not known, although sightings from vessels using the northern sea route show that they occur along the northern shore of the Yamal Peninsula (Figure 7.6.20). They have been recorded on the islands surrounding the Yamal sometimes remaining for discrete periods of time (Yamal Nature, 1995). The population in the Kara Sea has been previously estimated (based on aerial surveys 1970-1984) to occur at a density of 0.43 individuals per 1000 km^2 (Gorbunov *et al.* 1987)[53], although a higher density of between 5.0 - 18.0 individual per 1000 km^2 were recorded from surveys from vessels between 1997-1999 (MMBI, undated). However, the IUCN Species Survival Commission (SSC) Polar Bear Specialist Group currently consider there to be insufficient data to provide an overall population estimate[54]. Polar bears have been recorded in the territory of the Project License Area, with more frequent sightings in winter following the return of sea ice covering the Gulf of Ob and the Kara Sea (Technical Report, 2008). In April 2013, a single polar bear was reported at the seaport site within the Project Licence Area.

[52] http://www.polarbearsinternational.org/about-polar-bears/sea-ice
[53] Gorbunov, Yu. A., S.E. Belikova, NDV .I. Shilnikov (1987) Vliyaniye ledovykh usloviy na raspredeleniye i chislennost belogo medvedya v moryakh Sovetskoy Arktiki. Bull.Moskovskogo Obshchestva Ispytatelei Prirody. Biol.87(5):19-28.
[54] http://pbsg.npolar.no/en/status/status-table.html



Source: MMBI, undated[55]

Figure 7.6.20: Occurrence of the polar bear along the Northern Sea Route in 1996-2003

Since 1976, the Polar bear has been under international protection and is assessed as Vulnerable (VU) on the IUCN RL. The RDB RF remains uncertain regarding the status of the Kara-Barents population (category 4) and the RDB YNAO assesses polar bear as a Rare species (category 3).

Wolf (subspecies *Canis lupus albus*) and Arctic fox are the two most common predator species in the north of Yamal. The tundra wolf populates the tundra zone up to the Arctic coast, but breeding occurs chiefly in the south of Yamal. Outside their breeding season, wolves occur in the study area as they follow their reindeer prey. Wolf population density is low, at 0.1 animals per 1 km^2. Human hunting pressure for reindeer protection has caused wolf numbers to fluctuate in the area. Arctic fox is the most common predator in northern Yamal, but the main breeding population is located further south. Their population density follows a cycle with lemming populations. The favoured location for maternity earths is sandy-hummock tundra. Increased numbers of Arctic fox

[55] MMBI (undated) Information on Polar Bears (Ursus maritimus) for the Kara-Barents Sea Region, *available at http://transeff.npolar.no/transport/Phase%202/Filer%20for%20lenking/MMBI%20Report.pdf*

are reported at the sea shores. Typical tundra has a maximum density of breeding earths reaching as high as 3.0-3.5 earths/10 km^2, though the density was estimated to be lower during the 2013 surveys, which may be a reflection of a population decline in recent decades. At least five breeding earths are known to be present in the Project Licence Area, with four of these used for breeding in 2011. Arctic fox can migrate over long distances, with variations in numbers and distance migrated depending on food availability. Within the Project Area, migration tends to be directed westwards towards the sea coast in years with low lemming populations and high fox populations.

Common fox, stoat (ermine), weasel and wolverine may be sighted in Arctic tundra. Stoat and weasel can occur up to the coast in northern Yamal. However, the distribution of these small rodent-eaters in the tundra is determined by that of their rodent prey, so they tend to occur at highest densities near the shore. During lemming population boom years, the numbers of these predators can increase considerably. The density of ermine in the region is circa 0.1 per km^2. Weasel are rarer in the Yamal peninsula. Wolverines have naturally low populations and in the Yamal are present at 0.015 to 0.025 per km^2. They migrate following winter concentrations of domestic reindeer herds. Common fox are thought to be expanding their range north into arctic habitats including on the Yamal, possibly with climate change. There is some evidence that common fox may outcompete arctic fox where their ranges overlap (Rodnikova et al. 2011).

Pinnipeds

Bearded seal (IUCN RL category Least Concern) and ringed seal (IUCN RL category Least Concern) are the two most common species of seal found along the coastline of the Gulf of Ob and Kara Sea. Harp seal (IUCN RL category Least Concern) is also present. However, the main area for these species in the region is on the northern border of the Yamal Peninsula (Heptner, *et al.,* 1976[56]; Rutilevsky, 1977[57]). Ringed seal were regularly recorded at sea and on the coast of the Gulf of Ob during 2013. They also enter the mouths of a number of rivers on the coast, particularly at high tide (Frecom, 2013).

Atlantic walrus (*Odobenidae*) occurs in eight sub-populations around the Arctic region (Figure 7.6.21). The nearest sub-population to the Project Licence Area is the Kara Sea-Southern Barents Sea-Novaya Zemlya sub-population. No accurate population data is available for this sub-population, although estimations have ranged from less than 500 (NAMMCO, undated)[58] to approximately 2000 (Boltinov*, et al.* 2010[59]).

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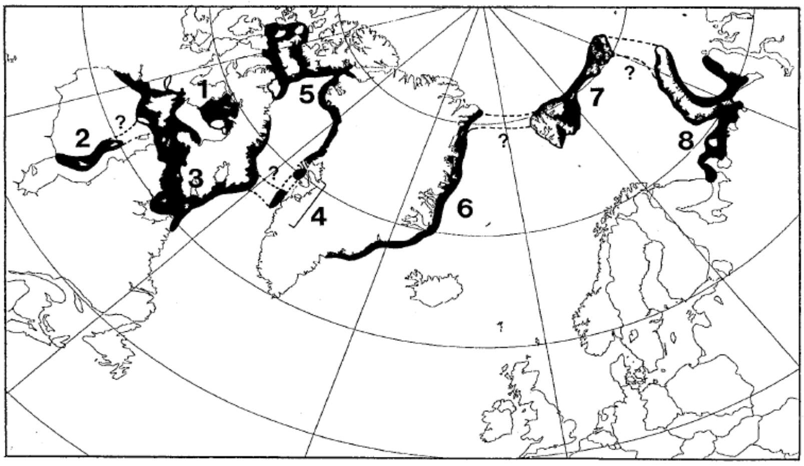
[56] Heptner V.G., Czapski, K.K., Arsenyev, V.A., Sokolov, V.E. (1976) Mammals of the Soviet Union. T. 2/3. Pinnipeds and toothed whales. Moscow High School. 718
[57] Rutilevsky G.L. (1977) Wildlife - Yamal Gydanskaya area. Gidrometeoizdat. Pp. 226-260.
[58] North Atlantic Marine Mammal Commission. (undated) Status of Marine Mammals of the North Atlantic: The Atlantic Walrus. Polar Environmental Centre N-9296 Tromsø, Norway
[59] Boltinov, A.N, Belikov, S.E., Gorbunov, Yu. A., Menis, D.T. and Semenova, V.S.(2010) The Atlantic walrus of the southeastern Barents Sea and adjacent regions: Review of the present-day status. WWF, Moscow



Key

1. Foxe Basin
2. Southern and Eastern Hudson Bay
3. North Hudson Bay - Hudson Strait - North Labrador - Southeast Baffin Island
4. Central West Greenland
5. North Water (Baffin Bay)
6. East Greenland

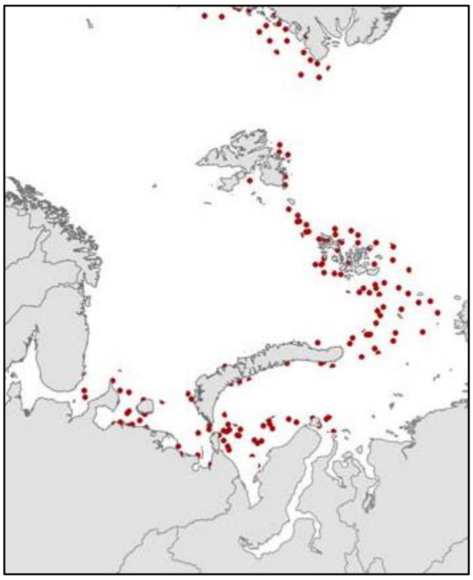
Source: NAAMCO 1995[60]

Figure 7.6.21: Global distribution of sub-populations of Atlantic Walrus

The population in the south eastern Barents Sea is present all year round and is presumed not to migrate long distances, although some are thought to move to the south western Barents Sea during the summer (Boltinov*, et al.* 2010). They commonly occur on sea ice to the west of Yamal as early as March and April (Voronsov *et al.* 2007). The distribution of walrus within the Kara Sea and Barents Sea has to some extent been investigated from aerial surveys of animals hauled-out on sea ice. However, the distribution extending to the east of Vaigach Island is not well studied, although extends at least to the west coast and northern tip of the Yamal Peninsula (Figure 7.6.22). No recent estimates of the population of the Yamal could be found, however during the 1950's reported interviews with local hunters suggested that the Yamal's walrus population was no more than 200-300 (Bel'kovich and Khuzin, 1960).[61] Sea ice plays an important role in the lifecycle of the walrus, which it uses as a haul out between November and June. Walrus also give birth on sea ice during this period. During the summer, walrus move to haul outs at costal locations (Boltinov*, et al.* 2010).

[60] North Atlantic Marine Mammal Commission. 1995. Report of the third meeting of the Scientific Committee. In: NAMMCO Annual Report 1995, NAMMCO, Tromsø, pp. 71–127.

[61] Bel'kovich, V. M. & Khuzin, R. S. 1960: The Atlantic walrus: to save and increase a valuable animal of the North. Fish. Res. Board. Can. Transl. Ser. 345. 4 pp, see also *http://walrus.2mn.org/documents/atl_walr_worksh_2009_paper.pdf*



Source WWF/MMC 2009[62].

Figure 7.6.22: Atlantic Walrus Range in Kara Sea

Incidental records suggest that the Atlantic walrus is only an occasional visitor to the vicinity of the Project Licence Area and does not breed in the area. In December 2005, a single adult male stayed in the Gulf of Ob near Seyakha. In 2013, walruses were observed in early summer to the north of the seaport. Walrus is classified by the IUCN RL as Data Deficient (DD) and is listed in the RDB RF as decreasing population (category 2) and the RDB YNAO as an Endangered species (category 1).

Hunting of Atlantic walrus in Russia is prohibited, with the exception of a limited subsistence harvest for native people (NAMMCO, undated).

Ungulates

The ungulates are represented by a single species, namely reindeer. The domestic reindeer population in the Yamal is over 280,000 animals, whilst the population of wild animals is believed to be around 50-80 individuals, confined to the north of the Yamal Peninsula and the island of Belyy (Yamal Nature 1995). Presence of the wild form of the species was not confirmed during the 2013 surveys.

Cetaceans

Three species of whales are thought to have the potential to occur in the Gulf of Ob, although year round use is excluded by fast sea ice. No cetaceans were recorded during the 2013 marine mammal survey. The abundance of marine mammals in the Kara Sea has been found to be less than in the Barents Sea. This is believed to be due to a reduced food availability (Decker *et al*.,

[62] WWF and MMC (2009) Materials for the working meeting: Saving walrus southeastern Barents Sea in intensification of economic development of the region. Moscow. *available at http://walrus.2mn.org/documents/atl_walr_worksh_2009_paper.pdf*

1995)[63]. According to (Reilly *et al.* (2013)[64], the main range of fin whale does not extend into the Kara Sea although anecdotal reports of fin whale occur from the northern end of Yamal peninsula. Almost nothing is known about population abundance of beluga in the Russian sector of the Arctic, in a continuum including the Kara, Laptev and East Siberian Seas (Reid *et* al, 2013.). They are the most abundant cetacean in the Kara Sea, which provides an important summer feeding area for the species. Kara Sea beluga whale populations over winter in the Barents Sea (Culik, 2010)[65]. The bowhead whale population in Svalbard-Barents Sea area has not been estimated due to low numbers, although up to 17 bowhead whales were sighted on summer surveys between 2006 and 2008 in NE Greenland and the Fram Strait, indicating that whales do persist in this area (Rugh *et al.* 2003, Boertmann *et al*. 2009, Wiig *et al*. 2010 in Reid *et al,* 2013). There is a small population in the Sea of Okhotsk that likely numbers < 400 animals but no recent surveys have been conducted (Ivaschenko & Clapham 2009, in Reid *et al*, 2013)[66]. The beluga whale is classified on the IUCN RL as Near Threatened (NT), but is not included in the RDB RF and is included in the RDB YNAO as insufficiently studied and uncertain in status (category 4). The fin whale is classified by the IUCN RL as Endangered (EN) and category 2 in the RDB RF. The bowhead whale is assessed of being of Least Concern by the IUCN RL, but is assessed as category 1 on the RDB RF. Based on the survey evidence and available information it is considered unlikely that ceceans occur regularly within the Project Licence Area.

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[63] Decker,M.B., Gavrilo, M., Mehlum, F., and Bakken, V. (1998) Distribution and abundance of birds and marine mammals in the eastern Barents Sea and the Kara Sea, late summer, 1995. Meddelelser No. 155, Norsk Polarinstitutt, Oslo.
[64] Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. & Zerbini, A.N. 2013. Balaenoptera physalus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 28 November 2013.
[65] Culik, (2010) Odontocetes. The toothed whales: "Delphinapterus leucas". UNEP/CMS Secretariat, Bonn, Germany. http://www.cms.int/reports/small_cetaceans/index.htm
[66] Donald G. Reid, Dominique Berteaux and Kristin L. Laidre (2013) Mammals in Arctic Biodiversity Assessment 2013 http://www.arcticbiodiversity.is./index.php/the-report/chapters/mammals downloaded 29/11/13

7.6.2.10 FRESHWATER AQUATIC ECOLOGY

Freshwater Phytoplankton

Phytoplankton in the region as a whole is diverse with least 448 taxa of algae. The greatest diversity is observed in green algae and diatoms which make up 33-51 percent of the total composition (Aleksyuk, 1988)[67]. Spring development of phytoplankton in the waters begins in June, just after the opening and the release of water in areas of ice, and the duration of the growing season is less than 4.5 months. Characteristic green algae include the genera *Elacatotrix*, *Ankistrodesmus*, *Dictyophaerium*, *Gloeotila* and *Oocystis*. Two of the more common diatoms species are *Asterionella formosa* and *Tabellaria floculosa*. Blue-green algal species are dominated by *Anabaena sp*. The relative dominance of individual species changes month by month. In summer, blue-green algae dominate, forming 72-99% of the total algae. Lakes in autumn are dominated by green algae and diatoms dominate in the rivers (Research Report, 1989-1991)[68]. Maximum development of phytoplankton occurs in lakes in July and in the rivers in August. Average abundance and biomass of phytoplankton in lakes is generally higher than in the rivers, as river flow conditions are less favorable for the development of many types of algae.

Additional field surveys on the phytoplankton of freshwater in the Mining Allotment Area were carried out during the summer of 2013. 28 sample areas were selected, comprising four lake sampling stations, 19 river sampling stations and five coastal (Gulf of Ob) sampling stations. Species recorded belonged to the groups bacillariophyta, chlorophyta, dinophyta, cyanophyta, chrysophyta and euglenophyta. Summaries of the results are shown in Table 7.6.13.

A total of 76 species of phytoplankton were recorded from the lake sampling stations, with the lowest diversity (34 species) in lake Pidarmato and the highest (56 species) in Lake Yavhevto. It should be noted that difference in diversity could be associated with lake characteristics (e.g. depth, closed or flow-through, etc.), factor of single study (not monitoring study) and has no direct relation to chemical pollution.

The average number of phytoplankton in the lakes ranged from 45.6×10^6 cells/m^3 to 439.2×10^6 kl/m^3, reaching an average of 242.4×10^6 kl/m^3. The average biomass of phytoplankton in lakes ranged from 89.91 mg/m^3 to 773.78 mg/m^3, averaging 431.85 mg/m^3. The index of species diversity (Shannon index) ranged from 2.35 to 4.78, averaging 3.57.

A total of 316 species of phytoplankton were recorded from the river sampling stations. River Partyavyaha had the least diversity with 15 phytoplankton species whilst River Venuymuyeyakha had the most with 89 species. The average number of phytoplankton in rivers ranged from 189×10^6 k./m^3 to 1097×10^6 kl/m^3, averaging 565.37×10^6 kl/m^3. The average biomass of phytoplankton in rivers ranged from 282.77 mg/m^3 (River Partyavyaha) to 4639.04 mg/m^3 (River Naharvangotoyaha), amounting to an average of 1357.3 mg/m^3. The index of species diversity (Shannon index) ranged from 0.87 to 4.63, averaging 3.44.

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[67] Aleksyuk, V.A.(1988) Zooplankton and water quality of the Lower Ob. Report. SibrybNIIproekt funds.120..
[68] Research Report of the Environmental Research Hospital Institute of Plant and Animal Ecology UB RAS, 1989-1991

44 species of phytoplankton were recorded in the Gulf of Ob. The average number was 351.8 × 10^6kl./m^3, the average biomass was 903.07 mg/m^3. The index of species diversity (Shannon index) averaged 2.65.

Table 7.6.13: Summary of 2013 Phytoplankton survey results

Water body	**Number of samples**	**Number of species**	**The average number kl/m^3**	**Average biomass, mg/m^3**	**Shannon index**
Lake ecosystems					
Lake Yavhevto	1	56	439.20 x 10^6	773.78	4.78
Lake Pidarmato	3	34	45.60 x 10^6	89.91	2.35
Total	*4*	*76*			
Average		*45*	*242.40·* x 10^6	*431.85*	*3.57*
River ecosystems					
Partyavyaha	1	15	402.40 x 10^6	282.77	0.87
Sabetayaha	2	58	189.00 x 10^6	454.43	4.63
Ham Yaviyaha	2	63	1078.40 x 10^6	1807.39	3.56
Nedarmayaha	2	59	326.20 x 10^6	735.89	3.71
Venuymuyeyakha	4	89	350.80 x 10^6	508.22	4.25
Salyamlekabtambadayaha	4	82	513.8 x 10^6	1073.38	3.64
Naharvangotoyaha	4	75	1097.00 x 10^6	4639.04	3.42
Total	*19*	*316*			
Average		*63*	*565.37·* x 10^6	*1357.30*	*3.44*

Table 7.6.13: Summary of 2013 Phytoplankton survey results					
Water body	**Number of samples**	**Number of species**	**The average number kl/m³**	**Average biomass, mg/m³**	**Shannon index**
Coastal ecosystems					
Gulf of Ob	5	44	351.80×10^6	903.07	2.65
Total	*5*	*44*			
Average		*22*	*351.80* x 10^6	*903.07*	*2.65*

None of the species recorded are listed as threatened by the IUCN RL, RDB RF or RDB YNAO.

Additional field surveys on the phytobenthos of freshwater in the Mining Allotment Area were carried out during the summer of 2013. A total of 28 sample areas were surveyed, from three lake, 19 river and five coastal sampling stations. A total of 54 species were recorded from the groups Bacillariophyta, Chlorophyta, Cyanophyta and Euglenophyta (Table 7.6.14).

Table 7.6.14: Summary of the phytobenthos recorded in the Mining Allotment Area in June-August 2013					
Water body	**Number of samples**	**Number of species**	**Average number, cells/m³**	**Average biomass, mg/m³**	**Shannon index**
Lake ecosystems					
Lake Yavhevto	1	22	465.94×10^6	2.37	3.82
Lake Pidarmato	2	31	76.25×10^6	0.18	3.09
Lake total	*3*	*43*			
Lake average		*27*	*271.11×10^6*	*1.28*	*3.46*
River ecosystems					
Partyavyaha	1	23	74.84×10^6	0.13	3.63

Table 7.6.14: Summary of the phytobenthos recorded in the Mining Allotment Area in June-August 2013

Water body	Number of samples	Number of species	Average number, cells/m^3	Average biomass, mg/m^3	Shannon index
Sabetayaha	2	34	97.68 x 10^6	0.29	3.76
Ham Yaviyaha	2	35	491.55 x 10^6	1.82	3.54
Nedarmayaha	2	45	117.82 x 10^6	0.17	3.48
Venuymuyeyakha	4	48	64.85 x 10^6	0.38	2.40
Salyamlekabtambadayaha	4	44	206 x 10·10^6	0.39	3.44
Naharvangotoyaha	4	54	183.29 x 10^6	0.67	3.42
River total	*19*	*54*			
River average		*40*	*176.59 x 10^6*	*0.55*	*3.38*
Coastal ecosystems					
Gulf of Ob	5	40	6.85 x 10^6	0.02	3.40
Total	*5*	*40*			
Average		*40*	*6.85 x 10^6*	*0.02*	*3.40*

None of the species recorded are listed as threatened by the IUCN RL, RDB RF or RDB YNAO.

Further details of the phytoplankton and phytobenthos recorded, including a species list, is provided in the 2013 FRECOM Survey report.

Freshwater Zooplankton

More than 130 species of zooplankton have been recorded in the waters of the Yamal Peninsula, including 49 rotifers, 54 cladocerans and 29 copepods (Research Report, 1989-1991). The distribution of zooplankton in the waters of the region is uneven. Some types of water bodies are richer than others due to the peculiarities of the hydrological and hydrochemical conditions. However, the cold climate limits the species present to those that can withstand the low water temperatures (Savchenko, 2008)[69]. The zooplankton species in the region belong to those typically widespread in northern latitudes. These include: the rotifers (*Asplanchna priodonta*, *Bipalpus hudsoni, Kellicottia longispina* and *Keratella cochlearis*)*;* cladocerans (*Bosmina obtusirostris var. arctica* and *Holopedium gibberum*); and copepods (*Eudiaptomus gracilisI and Euritemora lacustris*). There are also the two endemic species *Daphnia arctica* and *Daphnia longiremis brevicristata* (Savchenko, 2008).

Additional field surveys for zooplankton of freshwater locations in the Mining Allotment Area were carried out in summer 2013.

A total of 28 sample areas were selected, comprising four lake sampling stations, 19 river sampling stations and five coastal (Gulf of Ob) sampling stations. Species of the groups cladocera, cyclopoida, calanaoida, rotatoria, branchiopoda and harpacticoida were recorded. Summaries of the results are shown in Table 7.6.15.

A total of 17 species of zooplankton were recorded from the lake sampling stations, with the lowest diversity (10 species) in lake Pidarmato and the highest (12 species) in Lake Yavhevto.

The average number of zooplankton in the lake sampling stations ranged from 2450 specimens (sp.)./m^3 to 5600 sp./m^3, averaging 4025 sp./m^3 . The average biomass of zooplankton in lakes ranged from 47.3 mg/m^3 to 161.5 mg/m^3, averaging 104.4 mg/m^3.The index of species diversity (Shannon index) ranged from 1.95 to 2.49, averaging 2.22.

A total of 36 species of zooplankton were recorded in the river sampling stations, with the least diversity (1 species) found in the River Sabetayaha, and most (23 species) in the River Ham Yaviyakha. The average number of zooplankton in rivers ranged from 100 sp./m^3 in River Sabetayakha to 13800 sp./m^3 in River Venuymuyeyakha, amounting to an average of 3259 sp./m^3. The average biomass of zooplankton in rivers ranged from 0.4 mg/m^3 in River Sabetayaha to 186.1 mg/m^3 in River Venuymuyeyakha, amounting to an average of 53.6 mg/m^3. The index of species diversity (Shannon index) ranged from 1.0 to 2.99, averaging 2.13.

A total of 15 zooplankton species were recorded in the Gulf of Ob. The average number of zooplankton in the coastal waters of the Gulf of Ob ranged from 248 sp./m^3 to 1,720 sp./m^3, amounting to an average of 807 sp/m^3 . The average biomass of zooplankton ranged from 15 mg/m^3 to 315.6 mg/m^3, averaging 146.3 mg/m^3. The index of species diversity (Shannon index) ranged from 1.36 to 2.35, averaging 1.9.

[69] Savchenko, N.V. (2008) Hydrobiology alpine lakes complex Northwestern Altai and Western Siberian Subarctic (comparative aspect). 2008. http://e-lib.gasu.ru/konf/biodiversity/2008/1/45.pdf

Table 7.6.15: Summary of 2013 zooplankton Survey results

Water body (Station)	**Number of samples**	**Number of taxons**	**The average number, specimens/m³**	**Average biomass, mg/m³**	**Shannon index**
Lake ecosystems					
Lake Yavhevto	1	12	5600	161.5	2.49
Lake Pidarmato	3	10	2450	47.3	1.95
Total	*4*	*17*			
Average			*4025*	*104.4*	*2.22*
River ecosystems					
Venuymuyeyakha	4	16	13800	186.1	2.99
Ham Yaviyaha	2	23	3600	96.2	2.21
Naharvangotoyaha	4	8	2620	51.4	2.35
Salyamlekabtambadayaha	4	14	1780	19.3	2.44
Nedarmayaha	2	19	710	15.6	2.95
Partyavyaha	1	2	200	5.9	1.0
Sabetayaha	2	1	100	0.4	1.0
Total	*19*	*36*			
Average			*3259*	*53.6*	*2.13*
Coastal ecosystems					
UT 13-H10	1	5	248	15.0	1.36
UT 13-H18	1	7	270	74.2	2.35
UT 13-H19	1	9	1720	315.6	2.21
UT 13-H13	1	8	1490	302.3	2.15
UT 13-H6	1	5	305	24.5	1.44
Total	*5*	*15*			
Average			*807*	*146.3*	*1.9*

None of the species recorded are listed as threatened by the IUCN RL, RDB RF or RDB YNAO.

Further details of the zooplankton recorded, including a species list, is provided in the 2013 FRECOM Survey report.

Freshwater Benthic Fauna

The freshwater benthic fauna of the Yamal Peninsula comprise 55 species and forms of chironomid larvae, 33 species of molluscs, 19 species of oligochaetes, 6 species of leeches, 8 species of larvae of caddis flies, 7 genera of beetles and 3 species of crustaceans.

Additional field surveys for freshwater benthos of the Mining Allotment Area were carried out in summer 2013.

A total of 44 sample areas were selected, comprising six lake sampling stations, 33 river sampling stations and five coastal (Gulf of Ob) sampling stations. Groups present were nematode, oligochaeta, calanoida, cladocera, apodidae, diptera larvae, chironomidae larvae, chironomidae pupae, coleoptera imago, bivalvia, izopoda, branchipodidae, ostracoda, amphipoda, polichaeta, hydrocarina, trichoptera larvae and nematomorpha. Summaries of the results are shown in Table 7.6.16.

A total of 9 species of freshwater benthos were recorded from the lake sampling stations, with the lowest diversity (3 species) in Lake Pidarmato and the highest (9 species) in Lake Yavhevto. The index of species diversity (Shannon index) ranged from 0.2 to 0.96, averaging 0.58.

A total of 14 species of freshwater benthos were recorded from the river sampling stations, with the lowest diversity (2 species) in River Sabetayaha and the highest (7 species) in River Ham Yaviyaha. The index of species diversity (Shannon index) ranged from 0.63 to 1.43, averaging 1.05.

Five species of freshwater benthos were recorded from the Gulf of Ob sampling stations. The index of species diversity (Shannon index) ranged from 0 to 1.52, averaging 0.56.

These results are characteristic of polar ecosystems.

Table 7.6.16: Freshwater benthos diversity in the Mining Allotment Area

Water body	**Number of samples**	**Number of taxons**	**The average number, kl./m^3**	**Average biomass, mg/m^3**	**Shannon index**
Lake ecosystems					
Lake Yavhevto	3	9	4692	1,21	0,96
Lake Pidarmato	3	3	220	0,28	0,2
Total	6	9			
Average			2456	0,75	0,58
River ecosystems					
Venuymuyeyakha	10	6	38	0,05	1,43
Ham Yaviyaha	2	7	1180	0,1	1,37
Naharvangotoyaha	6	4	463	0,2	0,96
Salyamlekabtambadayaha	4	6	980	0,89	1,2

Table 7.6.16: Freshwater benthos diversity in the Mining Allotment Area					
Water body	**Number of samples**	**Number of taxons**	**The average number, kl./m^3**	**Average biomass, mg/m^3**	**Shannon index**
Nedarmayaha	4	5	2285	1,62	0,66
Partyavyaha	1	5	1900	3,13	0,63
Sabetayaha	6	2	60	0,07	0,65
Total	33	14			
Average			631	0,43	1,05
Coastal ecosystems					
UT 13-H10	1	1	80	0,11	0,00
UT 13-H18	1	1	80	0,1	0,00
UT 13-H19	1	1	20	0,03	0,00
UT 13-H13	1	4	320	0,24	1,32
UT 13-H6	1	3	100	0,69	1,52
Total	5	5			
Average			120	0,23	0,56

None of the species recorded are listed as threatened by the IUCN RL, RDB RF or RDB YNAO.

Further details of the freshwater benthos recorded, including a species list, is provided in the 2013 FRECOM Survey report.

Water Quality Indicators

Benthic fauna indicator species can be used to asses water quality. Several methods have been developed to analyse the condition of water using indicator species, including the Biological Monitoring Working Party (BMWP) Index and the Oligochaete Index (Goodnight and Whitley, 1961[70]). Both of these methods have been used to assess water quality at the locations surveyed during the 2013 field surveys of the Project Licence Area.

The BMWP Index uses a score ranging between 1 and 10 for each taxa present, with 1 indicating species present in poor water quality and 10 indicating species present in very good water quality. The scores are summed to give an overall value for the site. In temperate regions a score of less than 2 indicates very bad water quality, whereas a score more than 150 indicates very good quality. Whilst the scores obtained for the waterbodies in the Project Licence Area cannot be compared to temperate waterbodies, they provide a useful relative quality index that can be used

[70] Goodnight C. G., Whitley L. S. (1961): Oligochaetes as indicators of pollution. Proc.15th. Ind Waste Conf., Pardue Univ. Ext., Ser., Vol. 106: 139–142.

to compare within the Project area and act as a baseline for future monitoring. All the sites surveyed had a value of less than 25, with the highest being lake Yavhevto with a score of 18 and the lowest being Lake Pidarmato with a score of just 1 in July and 6 in August.

The Oligochaete Index, also known as the Goodnight and Whitley Index (Goodnight and Whitley, 1961). This method uses the ratio of oligochaetes (which are particularly tolerant to, and even thrive in, polluted conditions) to other benthic macroinvertebrate taxa to assess surface water pollution. An index value of less than 60% indicates a river is in a good condition, 60-80% indicates it is in a doubtful condition, and more than 80% indicates it is in a critical condition. The analysis results show that almost all of the water bodies surveyed are characterized by good water quality with the exception of the Pidarmato Lake where water quality was assessed as doubtful.

Both methods indicated that the Lake Pidarmato is in the worst condition for water quality. This correlates with the Shannon Index for diversity for benthic fauna at this location, which was lowest out of the all the locations surveyed, as well as for phytoplankton where this location was the second lowest. However, for zooplankton the Shannon Index for diversity was above the average of all the locations surveyed.

Fish fauna

According to the Western-Siberian zoogeographic zoning, the fish fauna of the study area falls in the northern Ob sub-region of the Primorsk-Ob District (Pavlov and Mochek, 2006)[71]. In general, the rivers in the sub-region are relatively small, low in invertebrate food densities and in winter the watercourses can completely freeze offering limited unfrozen water for freshwater fish. Ciscos predominate amongst local freshwater fish species. In terms of their lifecycles, most fish species in the Gulf of Ob northern sector are resident, but numerous groups of semi-anadromous species, primarily of the Cisco family, winter in brackish water and migrate to feeding and spawning grounds in rivers.

Key watercourses in the study area on the eastern shore of Yamal Peninsula (see also Section 7.5) are the Nganorihayakha, Nyaharvangotayakha, Nedarmayakha, Sabettayakha, Venuymuyeyakha and Paruiyakha, which belong to the northern sector of the Gulf of Ob in the Kara Sea. The Project License Area also has a large number of lakes, the largest of which are Ngamdeto, Ngevadedato, Yavheto, Nyamdngevato, Haeseito and Eserotato (see also Section 7.5).

Based on the available literature and previous studies in the region, the rivers and lakes within the Project Licence Area may have up to 27 fish species, of 14 families (Table 7.6.17). Some of these fish species populate brackish coastal waters of the Gulf of Ob, in river deltas, and the adjoining lower reaches of rivers (in Table 7.6.17 referred to as sea species). Navaga (*Eleginus navaga)*, four-horned sculpin (*Triglopsis quadricornis*) and Arctic flounder (*Liopsetta glacialis*) visit river estuaries and lower reaches from the sea. Anadromous and semi-anadromous fish (salmons, ciscos, and smelts) spend a portion of their life cycle in the sea, while using river systems for reproduction.

[71] Pavlov, DS, Мочек AD (2006) Fish ecology Ob - Irtysh basin. M: IEEP them. Severtsov Russian Academy of Sciences, Pp. 3-535.

Siberian sturgeon (*Acipenser baerii*) may occur also in coastal waters of the Gulf of Ob near the Project License Area, although no sturgeon were recorded in the fish surveys undertaken by the Project. Siberian sturgeon is listed as Endangered (EN) on the IUCN RL, Category 2 in the RDB RF and Category 1 in the RDN YNAO. This species can be found in all types of freshwater benthic habitats in large rivers and lakes. It spawns in strong-current habitats in the main stream of large and deep rivers on stone or gravel bottom. From the 1930s to 1990s annual sturgeon catches have declined in the Ob (which is estimated to contain 80 percent of the global population) by 99.5 percent. Water pollution from mining has caused abnormalities in reproductive systems of female Siberian sturgeon in Ob populations. Natural reproduction of the Ob River population has significantly decreased mainly due to damming (Ruben and Bin Zhu, 2010)[72]. While Siberian sturgeon are likely to pass through the Gulf of Ob, they are unlikely to regularly occur within the rivers or lakes in the Project Licence Area, and therefore the Licence Area is not considered as critical habitat for sturgeon.

Sterlet (*Acipenser ruthenus*) is found in large rivers, usually in the current and in deep water. It is present in Siberia from Ob eastward to Yenisei drainages. The Ob population is believed to have suffered a 50% decline (Gesner *et al,* 2010)[73]. The sterlet is listed as Vulnerable (VU) by the IUCN RL and Category 1 in the RDB RF. It is not included in the RDN YNAO.

Table 7.6.17: Northern Yamal fish and cyclostomes species

№	Species	Latin name	Lifecycle	Conservation Status (IUCN)
		***Cyclostomata* – Cyclostomes**		
		Fam. *Petromyzontidae* - Lampreys		
1	Arctic lamprey	*Lethenteron japonicum*	Anadromous	Least Concern
2	Kessler's lamprey	*Lethenteron kessleri (reissneri)*	Freshwater	Least Concern
		***Pisces* - Fish**		
		Fam. *Acipenseridae* - Sturgeons		
3	Siberian sturgeon	*Acipenser baerii*	Semi-anadromous	Endangered
4	Sterlet	*Acipenser ruthenus*	Freshwater	Vulnerable
		Fam. *Clupeidae* - Herrings		
5	Herring	*Clupea pallasi suworovi*	Sea	Least Concern

[72] Ruban, G. & Bin Zhu 2010. *Acipenser baerii*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 28 November 2013.
[73] Gesner, J., Freyhof, J. & Kottelat, M. 2010. Acipenser ruthenus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 28 November 2013.

Table 7.6.17: Northern Yamal fish and cyclostomes species

№	Species	Latin name	Lifecycle	Conservation Status (IUCN)
Fam. *Salmonidae* - Salmons				
6	Arctic char	*Salvelinus alpinus*	Anadromous and freshwater	Least Concern
Fam. *Coregonidae* - Ciscos				
7	Arctic cisco	*Coregonus autumnalis*	Semi-anadromous	Least Concern
8	Muksun	*Coregonus muksun*	Semi-anadromous	Least Concern
9	Round-nosed whitefish	*Coregonus nasus*	Semi-anadromous and freshwater	Least Concern
10	Siberian whitefish	*Coregonus lavaretus pidschian*	Semi-anadromous and freshwater	Least Concern
11	Vendace	*Coregonus sardinella*	Semi-anadromous and freshwater	Least Concern
12	Peled	*Coregonus peled*	Semi-anadromous and freshwater	Least Concern
13	Siberian white salmon	*Stenodus (leucichtys) nelma*	Semi-anadromous and freshwater	Least Concern
Fam. *Thymallidae* - Graylings				
14	Arctic grayling	*Thymallus arcticus* .	Freshwater	Least Concern
Fam. *Osmeridae* - Smelts				
15	Arctic smelt	*Osmerus (mordax) dentex*	Semi-anadromous	Least Concern
Fam. *Esocidae* - Pikes				
16	Pike	*Esox lucius*	Freshwater	Least Concern
Fam. *Cyprinidae* - Carps				
17	Siberian dace	*Leuciscus (leuciscus) baicalensis*	Freshwater	Not assessed
18	Lake minnow	*Phoxinus percnurus*	Freshwater	Least Concern
Fam. *Gadidae* - Codfishes				
19	Arctic cod	*Boreogadus saida*	Sea	Not assessed
20	Navaga	*Eleginus navaga*	Sea	Not assessed
21	Burbot	*Lota lota*	Freshwater	Least Concern

Table 7.6.17: Northern Yamal fish and cyclostomes species				
№	**Species**	**Latin name**	**Lifecycle**	**Conservation Status (IUCN)**
Fam. *Gasterosteidae* - Sticklebacks				
22	Nine-spined stickleback	*Pungitius pungitius*	Sea and freshwater	Least Concern
Fam. *Percidae* - Perches				
23	Pope	*Gymnocephalus cernua*	Freshwater	Least Concern
24	Perch	*Perca fluviatilis*	Freshwater	Least Concern
Fam. *Cottidae* - Gudgeons				
25	Staghorn sculpin	*Gymnocanthus tricuspis*	Sea	Not assessed
26	Four-horned sculpin	*Triglopsis quadricornis*	Sea	Least Concern
Fam**. *Pleuronectidae*- Flounders**				
27	Arctic flounder	*Liopsetta glacialis*	Sea	Least Concern

Fish species diversity in lakes depends on the nature of their linkage with nearby rivers, noting that most of floodplain lakes are inundated by floodwater with varying regularity. In lakes which are not inundated every year, and provided there are suitable breeding conditions, local cisco fish communities can form. Larger lakes in northern Yamal tend to have similar fish diversity, almost all have populations of vendace, round-nosed whitefish, peled, Siberian whitefish, Arctic char, pike, burbot, and Arctic grayling (Melnichenko, 2008). Nine-spined stickleback is the main resident of inland lakes that are isolated from the river system.

Some fish species have adopted more than one biological form. For example, muksun and vendace, in addition to their more common semi-anadromous form, have adopted a freshwater lake form. Similarly round-nosed whitefish and Siberian whitefish have adopted a lake-river form.

It is characteristic of most fish species in the region to undertake seasonal migrations. The following are reported:

1) springtime migrations of cisco fish leaving large lakes for rivers to proceed then to their respective feeding grounds;
2) in summer, following drying up of ditches and some lakes, upstream and downstream migrations for feeding or reproduction;
3) in the autumn - anadromous migrations (from the sea into the rivers) of grown-up anadromous cisco fish for reproduction;
4) migrations of vendace and smelt breeding stock immediately after spawning (from the rivers to the sea);
5) fry emigration downstream during the vegetation season;
6) anadromous migrations of fish headed for their wintering grounds.

Larger rivers are reported to have all the above type of migrations. Anadromous migrations to feeding grounds are observed from shallow watercourses, and catadromous migrations to wintering grounds.

With these migratory behaviours in mind, depending on the time of the year, some water areas undergo changes in species diversity, age and population density of fish. Since the range of cisco fish is divided into feeding, wintering and reproduction grounds, their spatial distribution is the most complex. Fish winter in areas of deeper water within the upper and mid-stream reaches of rivers and in large upland lakes. In the delta and lower reaches of the river, it is only Arctic cisco that winters, with navaga and Arctic flounder coming from the sea in large numbers. In spring, following ice drift, fish leave upstream lakes and, together with fish that have wintered in river hollows, travel downstream. During the process, the fish populates inundated floodplains in the mid and lower reaches of the rivers. With the flood water, the hatched cisco larvae migrate downstream. As the flood recedes, the fish either remain in floodplain lakes or travel to the delta. In July to August, mature fish begin to swim upstream to breeding grounds in the upper and midstream reaches of the rivers and some lakes. The watercourses with river forms of fish have no breeding in lakes, and feeding takes place chiefly in the delta, creeks and river bed. Seasonal events in the fish life cycle in Yamal Peninsula are summarized in Table 7.6.18.

Table 7.6.18: Seasonal events in fish life cycle in Yamal Peninsula

Season	Estuarial sea areas	Rivers and lakes
Springtime	Entry into rivers of peled, round-nosed whitefish, Siberian whitefish, loach, and smelt from estuarial sea areas for feeding into sor and lake systems of the rivers.	Hatching of larvae of cisco fish (muksun, Siberian whitefish, round-nosed whitefish, peled), feeding and growth of larvae and fry. Feeding of fry and adult cisco fish in floodplain-sor systems of the rivers.
Summer	Summer entry of cisco breeding stock (Arctic cisco, muksun, round-nosed whitefish, vendace, Siberian white salmon) into rivers. Feeding of the young and adult fish of Siberian white salmon, Arctic cisco, muksun, round-nosed whitefish, Siberian whitefish, vendace near-estuary. Entry of navaga, polar cod, polar flounder, horned sculpin from the sea into near-estuary sections of the rivers.	Feeding and growth of fry of Siberian white salmon, muksun, Siberian whitefish, round-nosed whitefish, peled, vendace, smelt in rivers and lakes. Fry migration to lower reaches and near estuary.
Fall	Entry of Arctic cisco into rivers in the fall. Migration downstream of spawned-out breeding stock of Arctic cisco, muksun, peled, round-nosed whitefish, vendace to the sea. Feeding of Siberian white salmon near estuary.	Spawning of round-nosed whitefish, Arctic cisco, Siberian white salmon, muksun, Siberian whitefish, peled in rivers and lakes Migration of fry of ciscos, loach, smelt to the sea.

Additional fish surveys were undertaken during summer 2013. Marine fish species recorded in the Gulf of Ob were Navaga *Eleginus navaga* and Fourhorn Sculpin *Triglopsis quadricornis polaris.*

Fourteen species of freshwater/ anadromous/semi-anadromous fish were recorded within the Project Licence Area in 2013. These are:

<u>Salmonids *Salmonidae*</u>
1. Pink salmon *Oncorhynchus gorbuscha* (non-native)
<u>Whitefishes *Coregonidae*</u>
2. Arctic cisco *Coregonus autumnalis*
3. Siberian whitefish *Coregonus lavaretus pidschian*
4. Peled *Coregonus peled*
5. Round-nosed whitefish *Coregonus nasus*
6. Sardine cisco (least cisco) *Coregonus sardinella*
7. Tugun *Coregonus tugun*
<u>Smelts *Osmeridae*</u>
8. Arctic smelt *Osmerus mordax dentex*
<u>Graylings *Thymallidae*</u>
9. Arctic grayling *Thymallus arcticus*
10. European grayling *Thymallus thymallus*
<u>Minnows or carps *Cyprinidae*</u>
11. Roach *Rutilus rutilus*
<u>Perches *Percidae*</u>
12. Ruffe *Gymnocephalus cernua*
<u>Sticklebacks *Gasterosteidae*</u>
13. Nine-spined stickleback *Pungitius pungitius*
<u>Hakes and burbots *Lotidae*</u>
14. Burbot *Lota lota*

Neither Siberian sturgeon or sterlet were recorded during surveys undertaken in 2013. Neither species is considered likely to regularly occur within the Project Licence Area rivers of lakes.

Pink salmon make extensive feeding migrations in the south-western part of the Kara Sea, stopping at all bays. In the northern part of the Gulf of Ob it is distributed along its western and eastern coasts. In 2013 they were recorded in the Gulf area within Naharvangotoyaha and Sabettayakha river estuaries. Arctic cisco were recorded in both feeding and breeding condition migrating within the coastal area and in the majority of the rivers surveyed, with greater concentrations in the lower reaches of rivers. Siberian whitefish were recorded in both feeding and breeding condition within the coastal area and in the majority of the rivers surveyed, with greater concentratons in the lower reaches of rivers. Peled were recorded in feeding condition migrating in inland waters during the months of June and July only. They were recorded in the middle reaches of the Nedarmayaha River and in the Pidarmato Lake. Round-nosed whitefish were recorded in feeding and breeding condition, and were fairly evenly distributed within the coastal area and in the lower reaches of rivers. Sardine cisco is the most common fish in the Gulf of Ob, present in the Gulf of Ob, and in rivers and lakes. It was recorded in both feeding and breeding condition during the surveys and was fairly evenly distributed within the coastal area and in the lower reaches of rivers. Tugun were sporadically recorded in all inland water bodies, with the exception of the Rivers Ham-Yaviyaha and Partyavyaha. They were not recorded in breeding condition, indicating that foraging migrations only are carried out in this area. Arctic smelt was recorded mainly in the coastal zone of the Gulf of Ob and in the lower reaches of the rivers. Arctic grayling individuals were recorded in both feeding and breeding condition migrating in the rivers of the Project Licence Area. They were recorded in the Rivers Nedarmayaha and Sabetayaha rivers. European grayling individuals were recorded in both feeding and breeding condition migrating in the rivers of the Project Licence Area, with recordings only made during June and July. They were recorded in the Rivers Nedarmayaha, Sabetayaha, Venuymuyeyakha, Partyavyaha and Salyamlekabtambadayaha. During the survey period Ruffe was caught at two stations in the Venuymuyeyakha River and at one station in the Gulf of Ob. Burbot and Roach were both recorded at just one location, the River Venuymuyeyakha.

Table 7.6.19 shows the distribution of fish species within the locations surveyed. The Venuymuyeyakha River had the greatest number of species recorded with 11 different species, whilst the Partyavyaha River had the least with just 1 species recorded.

Table 7.6.19: Location of fish species recorded in the Project License Area

	Fish species																Total species
	Arctic Cisco	Whitefish	Peled	Round nosed Whitefish	Arctic Smelt	Tugun	Arctic Smelt	Siberian Grayling	European Grayling	Roach	Ruffe	Burbot	Stickleback	Sculpin	Navaga	Pink Salmon	
Gulf of Ob	65	15		2	174		24				1			6	262	2	9
Lake Pidarmato		1	6	2	2	2											5
River Venuymuyeyakha	11	4		2	108	5	123		24	1	2	9	13				11
River Naharvangotoyaha	23				8	1	9						2	65			6
River Nedarmayakha	2		1		4	2		7	4				6				7
River Partyavyakha									1								1
River Sabetayakha	9				19	1	1	9	2								6

Table 7.6.19: Location of fish species recorded in the Project License Area

	Fish species																
	Arctic Cisco	**Whitefish**	**Peled**	**Round nosed Whitefish**	**Arctic Smelt**	**Tugun**	**Arctic Smelt**	**Siberian Grayling**	**European Grayling**	**Roach**	**Ruffe**	**Burbot**	**Stickleback**	**Sculpin**	**Navaga**	**Pink Salmon**	**Total species**
River Salyamlekab-tambadayakha	37	18		10	80	137	42		1				3	6			9
River Ham-Yaviyakha	101			1	38		123							45	3		6
Number of sites recorded (non-marine)	*6*	*3*	*1*	*4*	*7*	*6*	*5*	*2*	*5*	*1*	*1*	*1*	*4*	*3*	*1*	*0*	
Total number of individuals recorded	*248*	*38*	*7*	*17*	*433*	*148*	*322*	*16*	*32*	*1*	*3*	*9*	*24*	*122*	*265*	*2*	*14*

See also Chapter 8 for description of fishing activities.

7.6.2.11 MARINE HABITATS

Overview

The Kara Sea ecosystem is characterised by a large participation of Arctic biota as its waters are practically isolated from the influence of the Atlantic. The development of phytoplankton within the sea in most part of the area is limited to 2-3 months ice-free period. Therefore, the total biological productivity is extremely low and biodiversity of marine organisms half that found within the Barents sea. Macroalgae tend to be absent due to scouring action of ice. The bottom sediments are soft rocks, mainly sand, silt and clay. The marine communities are also significantly influenced by the variation in salinity caused by variation in river flow. The Gulf of Ob can be divided into three areas:

- Freshwater (salinity <1 ‰)
- Brackish water (1-30 ‰)
- Saline (> 30 ‰).

The most intense, geochemically and biologically significant processes occur in the brackish part of the estuary, where there are several environmental barriers. An important place in the estuarine ecosystems is occupied by euryhaline species which are adapted to the wide fluctuations in salinity. Euryhaline marine species are represented by molluscs, crustaceans and fish. These are found in the bottom of the estuary ecosystems. The Gulf of Ob is relatively warm due to continental run-off of freshwater, which determines its important role in the life cycle of fish as a winter refuge where the younger generation of fish spends the first few years of life prior to migration. Euryhaline freshwater species of insect larvae, amphipods and some freshwater fish (Burbot, pike and whitefish) are common in the upper part of the estuarine ecosystems. Usually brackish species occur only in estuaries, missing the open sea areas; these types are rare, but can produce high biomass. Most characteristic are crustaceans, including Sadur *Saduria entomon*, or sea cockroaches (Isopodae) and gamarakantusy (Amphipoda), martselyarii (Polychaeta), slingshot *Triglopsis quadricornis* (Pisces).

The flora and fauna in the northern part of the Gulf of Ob is subjected continuously to impacts of stamukha and is capable to recover after such impacts. However, the recovery processes at higher latitudes is slower and due to this reason the biodiversity in the subject area is significantly lower than in the middle and southern parts of the Gulf of Ob.

Zoobenthos

Benthic invertebrates of the Kara Sea number about 1600 species. Marine benthos is characterized by an almost total absence of the macrophytes. Zoobenthos is represented by both arctic and boreal species. Kara Sea macrobenthos is marked by the abundance of echinoderms; numerous bivalves, including *Portlandia*, *Macoma*, *Astarte*, *Pecten*, inhabit shelf shallow water areas. However the biomass of the zoobenthos is generally low: from 1.5 to over 400 g/ m2. In the south-western part of the Kara Sea biomass peaks amounting to 100-300 g/ m2 were observed in the Baydaratskiy Gulf and shallow waters adjacent to Yamal and are predominantly comprised of molluscs *Serripes groenlandicus*, *Ciliatocardium ciliatum*, *Astartidae spp*. Extremely high biomass rates were registered in the area adjacent to Mare-Sale.

The peculiarity of the Gulf of Ob as a northern estuary is the vulnerability of its nature and slow recovery processes. Diversity of benthic animals in the Gulf of Ob grows from the south to the north simultaneously to the water salinity increase. Southern edge of marine water ingress to the estuary is due to the hydrogeological conditions. In summer marine species can be found in the zoobenthos of Tambey and Cape Drovyanoy surroundings; during the subglacial period in conditions of significant salinization – nearby Tedebyakhi and even at Cape Tryohbugorniy.

According to the previous scientific surveys (years 1982-1996 and 2000-2009), zoogeographical composition of the zoobenthos is the following: arctic species – 20%, boreal-arctic – 77%, boreal species – 3%, with predominance of the last two groups in more open and brackish water areas. Main biocoenosis in the Gulf is the oligohaetes-molluscan. In the southern part of the Gulf oligohaetes are dominating, in the middle part nectobenthic crustaceans appear and in the northern part – cumaceans, crustaceans, polychaetes, bivalvs *Portlandia arctica* and echinoderms.

Benthic fauna composition of the middle Gulf of Ob coastal shallow waters is monotonous and poor through all the seasons of the year. Three species of *Crustacea* and two species of *Diptera* are identified in the area. In the subglacial period benthic fauna is represented solely by the crustaceans. Crustaceans (*Pontoporeia affinis u Mesidothea entomon)* are predominant by abundance; crustaceans, less often polychaetes, are prevailing by biomass. Freshwater fauna is replaced by the brackish water species; small-size bivalves are gone, chironomid larvae are becoming scarcer and fewer in numbers, oligohaetes population also decreases.

In the Tambey area zoobenthos rates are slightly below than in the middle part of the Gulf of Ob: peak biomass – 10 g/m^2; abundance of the benthic fauna – 107-1143 species/m^2. Polyhaetes or sometimes crustaceans prevail by numbers; and polyhaetes are predominant by biomass. Brackish water and marine invertebrates inhabit the benthic zone of this part of estuary. Farther to the north brackish water species are replaced by marine ones.

Two northern profiles in the Gulf of Ob baymouth show the highest average benthic biomass rate – about 80 g/m^2, and up to 188 g/m^2 at certain sampling stations. Polyhaetes and crustaceans, less often – molluscs, prevail by numbers; and molluscs are predominant by biomass. The following species are the flagship among the benthic fauna: large-size bivalves *Portlandia arctica,* marine crustaceans, polychaetes, echinoderms, nemerteans. Brackish water species become rarer and fewer in numbers.

The relict crustaceans fauna[74] is preserved in the Gulf of Ob (*Mesidotea entomon L., Mysis relicta Loven, Gammaracanthus lacustris Sars, Pontoporeia affinis Lindstrom*); the most common and abundant species is *P. affinis*. Long-term data analysis shows that the abundance of this glacial relic has not changed substantially over the last 35 years. Taking into account that relic species are highly sensitive to any variations of the aquatic environment caused particularly by the human economic activities one can believe that the environmental situation in the Gulf of Ob is rather good. These species have not been assessed by IUCN, but are unlikely to be endangered given their wide distribution and hence are not considered to meet criteria for Critical Habitat.

During surveys in 2000-2009 it was specified that there had been no evidence of zoobenthos biomass decrease and also no changes in the dominating groups and species composition in the last 50 years. The most abundant species groups were amphipods (60-100%) and oligohaetes (55-100%), notably that crustaceans predominated at 4 to 7 m depth and oligohaetes at more deep-water (to 17 m) stations. All the benthic species serve as the food for fish. Southern and middle parts of the Gulf of Ob are of the most importance for the fish nutrition where in summer young ciscos, popes and smelts gain weight and where semi-anadromous fish are wintering. In the subglacial period the main food source for the ciscos and popes are the amphipods.

Benthic communities' recovery goes slowly taking not less than 5 years and is followed by the loss of some species and decrease (to 60% from the initial value) of the benthic biomass.

The northern part of the Gulf of Ob with saline water prevalence is characterised by the low biomass and abundance rates and poorness of species composition. In the euhaline area an estuarial community is developing; it is characterized by polyhaetes and crustaceans predominance, minimal number of species (about 6) and low biomass (2-3 g/m^2). The macrozoobenthos spatial distribution is irregular. Most of the benthic aquatic organisms were

[74] The term relict comes from the fact that these species are found in areas such as the Baltic were they are a relict of the last ice age.

found at the depth of 6-8 m. Density of benthic organisms amounted from 100 to 4824 ind./m^2, biomass – from 1.6 to 63.1 g/m^2. Average rates of zoobenthos abundance and biomass within this area of the Gulf of Ob in the summer period amounted to 952 species/m^2 and 18.0 g/m^2 respectively. Bivalves and isopods (*Saduria*) are prevailing by biomass with 42.9% and 30.1% respectively.

In the zone of the ***planned navigation route*** in the northern part of Gulf of Ob area there were 8 taxonomic groups detected: *Oligochaeta, Polychaeta, Amphipoda, Mysidacea, Cumacea, Foraminifera, Isopoda and Copepoda.* At the seaport construction site there were 5 taxonomic groups detected: *Oligochaeta, Polychaeta, Amphipoda, Mysidace and Isopoda*. Isopods and polyhaetes were prevailing in the biomass composition with 30-90% and 30-60% respectively. Average zoobenthos abundance and biomass rates at this area of the Gulf of Ob amounted to 143 ind./m^2 and 7.6 g/m^2 respectively. Isopods of the *Saduria* genus are predominant with the share of 73.3%; subdominant groups are polyhaetes (16.0%) and amphipods (10.5%).

During additional hydrobiological survey in summer 2013 there were 5 zoobenthos samples collected at 5 stations of the Gulf of Ob. The results have shown that benthic community was found to be lacking diversity and was represented by 5 groups of invertebrates: *Oligochaeta, Polychaeta, Nematomorpha, Amphipoda (Gammaridae и Gammarus), Isopoda* (*Saduria entomon*). Isopods were the prevalent group by abundance and biomass and only at the station UT13-H13 polyhaetes were predominant by abundance and amphipods – by biomass (see Table 7.6.20). No protected benthic species were identified during the survey.

Table 7.6.20: Shares of different taxonomic groups in the Gulf of Ob zoobethos abundance and biomass rates, 2013

Taxonomic groups	Sampling station									
	UT13-H10		UT13-H18		UT13-H19		UT13-H13		UT13-H6	
	Abundance, %	Biomass,%	Abundance, %	Biomass,%	Abundance, %	Biomass,%	Abundance, %	Biomass,%	Abundance, %	Biomass,%
Oligochaeta									20,0	0,3
Polychaeta							68,8	25,0		
Nematomorpha							6,3	0,8		
Amphipoda							18,8	64,2	40,0	28,6
Izopoda	100,0	100,0	100,0	100,0	100,0	100,0	6,3	10,0	40,0	71,1

Overall, average quantity of zoobenthos in near-shore area of the Gulf of Ob varied from 20 ind./m^2 to 320 ind./m^2, biomass average value varied from 0,03 g/m^2 to 0,69 mg/m^2. Diversity index (Shannon index) varied from 0 to 1,52 with average value of 0,56. This indicator value of zoobenthos development is very low, which indicates that the studied areas of the Gulf of Ob lacks food sources for fish populations.

7.6.2.12 EVALUATION OF HABITAT TYPES

This section provides an assessment of critical habitat applicable to the Yamal LNG Project. IFC Performance Standard 6 provides five main criteria for the determination of critical habitat: (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.

The scale at which the Critical Habitat determination takes places depends on underlying ecological processes for the habitat in question and is not necessarily limited to the footprint of the project. Paragraph GN65 of IFC's Guidance Note 6 states that for Criteria 1-3, the determination of Critical Habitat should be based on a “discrete management unit” (DMU) which is an area that has a definable boundary within which the biological communities have more in common with each other than they do with those outside the boundary. Paragraph GN65 goes on to provide the following additional guidance on the selection of the DMU:

‘A discrete management unit may or may not have an actual management boundary (e.g., legally protected areas, World Heritage sites, KBAs, IBAs, community reserves) but could also be defined by some other sensible ecologically definable boundary (e.g., watershed, interfluvial zone, intact forest patch within patchy modified habitat, seagrass habitat, coral reef, concentrated upwelling area, etc.). The delineation of the management unit will depend on the species (and, at times, subspecies) of concern’.

Where necessary, the appropriate DMU is defined in the following sections.

Criterion 1: Critically Endangered and/or Endangered species

A single Critically Endangered/Endangered species was recorded in the Project Licence Area during the course of field work completed in 2011 and 2013:

- Red-breasted goose (Branta ruficollis) IUCN RL Endangered (EN). This species was only recorded once during autumn migration in 2011 as a small flock of 15 birds. The main migration route for this species is thought to fall outside the Project Licence Area. The species is unlikely to breed in the Project Licence Area. Therefore it is not possible to define a plausible DMU for red-brested goose in relation to the Project Licence Area. It is clear that the Project Licence Area does not regularly support a regionally or nationally important concentration of this Endangered species. Therefore, critical habitat determination has not been triggered by red-brested goose.

Neither Siberian Sturgeon nor Sterlet have been recorded within the Project Licence Area and neither species are considered likely to occur regularly.

Neither fin whale nor bowhead whale have been recorded within the Project Licence Area and are considered unlikely to occur regularly within it.

Criterion 2: Endemic and restricted-range species

The IFC Guidance note 6 defines an endemic species as: "one that has ≥ 95 percent of its global range inside the country or region of analysis". A restricted-range species is defined as follows:

- "For terrestrial vertebrates, a restricted-range species is defined as those species which have an extent of occurrence of 50,000 km2 or less.
- For marine systems, restricted-range species are provisionally being considered those with an extent of occurrence of 100,000 km2 or less.

For freshwater systems, standardized thresholds have not been set at the global level. However an IUCN study of African freshwater biodiversity applied thresholds of 20,000 km^2 for crabs, fish, and mollusks and 50,000 km^2 for odonates (dragonflies and damselflies). These can be taken as approximate guidance, although the extent to which they are applicable to other taxa and in other regions is not yet known.

For plants, restricted-range species may be listed as part of national legislation. Plants are more commonly referred to as "endemic," and the definition provided in paragraph GN79 would apply".

The Yamal peninsula as a whole supports low levels of endemism and the species present tend to have large geographic ranges. No endemic or range restricted species have been recorded within the Project Licence Area. Therefore, critical habitat determination has not been triggered by the either endemic or range restricted species.

Criterion 3: Migratory species and congregatory species

IFC Guidance Note 6 defines migratory and congregatory species in the following way:

Migratory species:

- any species of which a significant proportion of its members cyclically and predictably move from one geographical area to another (including within the same ecosystem).

Congregatory species:

- species whose individuals gather in large groups on a cyclical or otherwise regular and/or predictable basis.
- Species that form colonies.
- Species that form colonies for breeding purposes and/or where large numbers of individuals of a species gather at the same time for non-breeding purposes (e.g., foraging, roosting).
- Species that move through bottleneck sites where significant numbers of individuals of a species pass over a concentrated period of time (e.g., during migration).
- Species with large but clumped distributions where a large number of individuals may be concentrated in a single or a few sites while the rest of the species is largely dispersed (e.g., wildebeest distributions).

- Source populations where certain sites hold populations of species that make an inordinate contribution to recruitment of the species elsewhere (especially important for marine species).

To meet the criteria for Tier 2 critical habitat, the habitat needs to support ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle. None of the non-avifauna migratory or congregatory species recorded within the Project Licence Area would meet this criteria.

As described in Section 7.6.2.8, due to the atypical breeding season in 2013 the survey data is not sufficiently detailed to define Discrete Management Units (DMUs) in relation to the assemblage of breeding migratory birds, and to provide an estimation of the size of the bird populations within them. In order to provide information on which to define DMUs and the potential breeding bird habitats within them, further surveys will be required, and these will be developed as part of a Biodiversity Action Plan (BAP).

Criterion 4: Highly threatened and/or unique ecosystems

IFC Guidance Note 6 defines highly threatened or unique ecosystems as:

- at risk of significantly decreasing in area or quality;
- with a small spatial extent; and/or
- containing unique assemblages of species including assemblages or concentrations of biome-restricted species.

A working group has been established by the IUCN to develop a system of quantitative categories and criteria, analogous to those used for species, for assigning levels of threat to ecosystems at local, regional, and global levels (Rodriguez *et al.,* 2011) . Full details of the proposed system are set out in the 2013 FRECOM Survey report. In summary they are based on four main criteria:

A: Short-term decline in distribution or function (over 50 years);

B: Long-term decline in distribution or function (over 500 years);

C: Small current distribution and decline (in distribution or ecological function) or very few locations; and

D: Very small current distribution.

Due to lack of evidence of ecological change, the very long time frame involved and the inherent large amount of uncertainty resulting from this, it is not practical to estimate changes over the last 500 years. Therefore, only criteria A, C and D have been used for the assessment of Critical Habitat. Ecosystems that fall within the study areas and meet the definition of a threatened according to Rodriguez et al., 2011 are assumed to meet Criterion 4 for Critical Habitat.

Most of the vegetation communities recorded have widespread distributions. However, the Forb-graminoid, horsetail-graminoid meadow communities on the valley slopes has a limited distribution. The vegetation type meets criteria C: Small current distribution and decline (in distribution or ecological function), as described by Rodriguez *et al.* (2011). Therefore, Forb-graminoid, horsetail-graminoid meadow communities are considered to meet Criterion 4 as critical habitat.

Criterion 5: Key Evolutionary Processes

Evolutionary processes are often strongly influenced by structural attributes of a region, such as its topography, geology, soil and climate over period of time. IFC Guidance Note 6 suggests that this criterion is defined by:

- "*the physical features of a landscape that might be associated with particular evolutionary processes; and/or*
- *sub-populations of species that are phylogenetically or morphogenetically distinct and may be of special conservation concern given their distinct evolutionary history*."

The Project Licence Area is not considered to meet criterion 5 Key evolutionary processes for the following reasons:

- *Low level of isolation: The Project Licence Area is situated on the mainland of a large continent and has no physical barriers to movement, dispersal or colonisation.*
- *Low spatial diversity: flat landscape with relatively uniform soils and vegetation types (albeit highly heterogeneous at the micro and meso levels).*
- *Low levels of endemism – the Yamal peninsula has a history of marine transgressions which means the flora and faunal communities are relatively young.*
- *Low levels of species diversity.*
- *Lack of sub-populations of species that are phylogenetically or morphogenetically distinct from those in surrounding regions.*

8 SOCIO-ECONOMIC BASELINE

8.1 INTRODUCTION

This chapter describes the social and economic baseline relevant to the Yamal LNG Project and its direct and indirect Area of Influence (AoI) as defined in Chapter 4. It also described the regional-scale socio-economic characteristics necessary to support the assessment of wider cumulative impacts (see Chapter 13 for further details).

The information presented this chapter covers the following aspects:

- the socio-economic and demographic profile;
- information about indigenous peoples that lead traditional nomadic lifestyle and are engaged in traditional economic activities in the Project area and their livelihoods;
- data on the labour market and employment;
- details of land use, including areas of traditional (customary)[1] use;
- social infrastructure;
- cultural and historical heritage, including its tangible and intangible forms.

Potential social impacts associated with the Project are detailed and evaluated in Chapter 10 of this ESIA. Chapter 5 describes Yamal LNG's past and ongoing efforts towards stakeholder engagement, disclosure of information about the Yamal LNG Project, and further plans for stakeholder involvement going forward. Details of the stakeholder consultation programme and the public grievance mechanism are described in the Stakeholder Engagement Plan which is a separate document that complements the ESIA.

The following information sources were used for the preparation of this chapter, including:

- the Project design documentation:
  - Environmental Action Plan, including the EIA for the Yamal LNG Project ("Project for the Production, Preparation, Liquefaction and Export of LNG and Gas Condensate from the South-Tambey GCF", 2012);
  - Construction of Facilities for the Production, Preparation, Liquefaction and Export of LNG and Gas Condensate from the South-Tambey GCF. Engineering Survey for the LNG Plant Construction. Technical Report. Social studies, 2012;
  - Construction of Facilities for the Production, Preparation, Liquefaction and Export of LNG and Gas Condensate from the South-Tambey GCF: Technical Report on the engineering survey for the LNG Plant construction. Social studies, 2012;
  - Life Support Facilities of the South-Tambey GCF, Volume 6: Environmental Protection, Book 1: Environmental Impact Assessment, 2010;
  - Construction of the Sea-Port Facilities near Sabetta Village on Yamal Peninsula, including a Navigable Approach Channel in the Gulf of Ob (early seaport and main seaport facilities), Environmental Impact Assessment, Environmental Action Plan;

[1] Land tenure enforceable through customary structures in a community as opposed to through formal statutory mechanisms.

  - Construction of Facilities for the Production, Preparation, Liquefaction and Export of LNG and Gas Condensate from the South-Tambey GCF. Engineering Survey for the LNG Plant Construction. Technical Report. Social studies, FRECOM, 2012;
- A wide range of public information sources:
  - Report on the Social and Economic Situation in Yamalsky Municipal District in2010 and 2011, Administration of Yamalsky Municipal District;
  - Strategy of the Social and Economic Development for YNAO till 2020;
  - District Long-Term Target Programme “Conservation of Traditional Way of Life, Culture and Language of Indigenous Small-Numbered Peoples of YNAO for 2012-2015”;Report on Health Status and Public Health Care in YNAO in 2010, YNAO Health Department, 2011;
  - Indigenous Small-Numbered Peoples of the North, Siberia and Far East of the Russian Federation. Review of the Current Situation. R.V. Sulyandziga, D.A.Kudryashova, P.V. Sulyandziga, Moscow, 2003;
  - International Energy and Environmental Programme “Energy of the Arctic”. Scientific Report “Current Situation and Prospects for the Development of Agriculture and Food Industries in the Russian Arctic (YNAO as a Case Study)”. Published under the supervision of E.N. Krylatykh, Professor and Member of the Russian Academy of Agricultural Sciences, December 2011;
  - T.N. Vasilkova, A.V. Evay, E.P. Martynova, N.I. Novikova. The Indigenous Small-Numbered Peoples and Industrial Development of the Arctic. Ethnological Monitoring in the Yamal-Nenets Autonomous Okrug. Federal State Institution Scientific Centre of Prophylactic and Clinical Nutrition. Tyumen Scientific Centre, Siberian Branch of the Russian Academy of Medical Sciences. Ethnology and Anthropology Institute of the Russian Academy of Sciences, OOO “Ethnoconsulting”, Moscow–Shadrinsk 2011.
  - G.P. Kharyuchi, Places of worship and sacred sites in traditional Nenets’ view of the world;
  - The research materials by the YNAO "Arctic Research Centre" (Salekhard)[2];
  - District Target Programme “Development of Agricultural Sector in YNAO for 2011- 2013;
  - Official web-site of the Government of Yamal-Nenets Autonomous Okrug;
  - Official web-site of Yamalsky Municipal District Administration;
  - Official web-site of Yar-Sale Municipal Administration;
  - Data from the YNAO Department of Employment;
- Other project-related documents provided by the Company and other relevant information available in the public domain (referenced in the text within this Chapter).

This chapter is also based on the information obtained from interviews with representatives of the Indigenous Peoples of the North (IPN) conducted in December 2012 as part of the Project-related surveys. These interviews were undertaken as part of a series of consultations with the local

[2]The research centre conducts studies of the public health of the population living in the Seyakha tundra area (including the effect of the following factors on human health: residence location of a patient, degree of vocational / occupational hazard, predilection for tobacco smoking / alcohol consumption, eating habits and food quality, level of physical activity, etc.).

stakeholders and included interviews with 38 representatives of the IPN who live and conduct their activities in the vicinity of the Project area[3]. The average age of the respondents is approximately 37 years; the overwhelming majority (32 individuals) are male members of migratory Nenets ethnic communities.

The survey was carried out using a questionnaire consisting of a set of nearly 50 questions, including both ‘closed’ and ‘open' questions. The questionnaire included items related to: basic social and demographic characteristics; type of occupation/employment; basic means of subsistence; standards of living; and practices of visiting sacred sites.

Based on the literacy levels of the interview group, as well as the context of the survey (i.e. the nomadic style of life of the indigenous peoples and the associated logistical difficulties with circulation of the questionnaires to herders migrating in the remote areas of the tundra), the questionnaires were personally handed out to each of the respondents. This enabled explanations to be provided and assistance given in the process of filling in the questionnaires, thereby improving the validity of the survey[4].

The results of the survey are presented by topic in the relevant subsections in this Chapter.

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[3]Each respondent represented, in turn, his family (consisting on average of 6 persons). Thus, based on the collected data, it may be concluded that the results obtained can be extrapolated to the respondents' families and describe in an indirect way the household practices and lifestyle of more than 200 members of the ethnic communities living and carrying out their activities in the vicinity of the Project area.

[4]Where validity is a measure of suitability of methodologies used in the applied sociology for solution of specific research problems; degree of agreement of variables and indicators with empirical data making it possible to obtain reliable, representative and valid results of sociological studies and avoid systematic errors (http://www.socium.info/dict.html).

8.2 POPULATION AND DEMOGRAPHY

This section contains information and statistical data on size and distribution of the population in the Okrug and across the Project area of influence, including key demographic parameters.

8.2.1 POPULATION OF YAMAL-NENETS AUTONOMOUS OKRUG. GENERAL OVERVIEW

The Project licence area is situated within Yamal-Nenets Autonomous Okrug[5] (YNAO) in the Tyumen Oblast of the Russian Federation (see Figure 8.1). YNAO occupies an area of 769,300 km^{2}in the Arctic zone, which is characterised by extreme climatic and geographic conditions and a very low population density averaging 0.7 people/km^2.

Administratively, YNAO consists of a regional centre in the city of Salekhard (42,845 population) and seven municipal districts[6] (see Figure 8.2), including Yamalsky District where the Yamal LNG licence area is located, eight urban settlements (towns)[7] and 84 rural settlements[8], with some smaller communities being incorporated into larger settlements. The Okrug as a whole is generally characterised by the presence of numerous small populated areas (with the number of inhabitants in many settlements less than 200 persons) that are difficult to access and where people live in isolation for prolonged periods of time. Average distances from such remote settlements to the respective district centres vary from several tens to hundreds of kilometres. The low density/widely dispersed population is typical for the Arctic regions in general.

Yamalsky District is situated in the northern part of YNAO and includes Bely Island which is the largest island in the region.

[5] Autonomous Okrug is a statutory administrative formation that is a constituent entity of the Russian Federation. Originally devised during the Soviet period, Autonomous Okrugs were formed to guarantee the resident minorities, including the Indigenous Peoples of the North, Siberia and Far East, preservation of their political and territorial identity. The Autonomous Okrug has its own executive body (government) and legislative power. Yamal-Nenets Autonomous Okrug is a Federal subject and, together with Khanty-Mansi Autonomous Okrug, is part of Tyumen Oblast and of the Ural Federal Okrug.

[6] Municipal districts: Purovsky (51,280 people), Nadymsky (19,919), Priuralsky (14,995), Tazovsky (16,537), Yamalsky (16,310), Shuryshkarsky (9,814), and Krasnoselkupsky (6,204). A district is an administrative territorial unit which comprises within its boundaries geographically and economically interlinked urban and rural settlements united under one administrative centre.

[7] Towns of the okrug-level significance: Salekhard (42,845 people), Gubkinsky (23,335), Muravlenko (33,391), Nadym (46,611), Novy Urengoy (104,107), Noyabrsk (110,620), Labytnangi (26,936), and Tarko-Sale (18,517).

[8] Law on the administrative-territorial system of Yamal-Nenets Autonomous Okrug #42-ZAO of 6 October 2006 (with the latest amendments as of 06.12.2012). Note that the Russian Federal Statistics Service indicates 79 rural settlements in the YNAO, based on the results of the All-Russia Population Census-2010 (Source: Federal State Statistics Service, http://www.gks.ru).

Figure 8.1: Map of YNAO and Yamalsky District

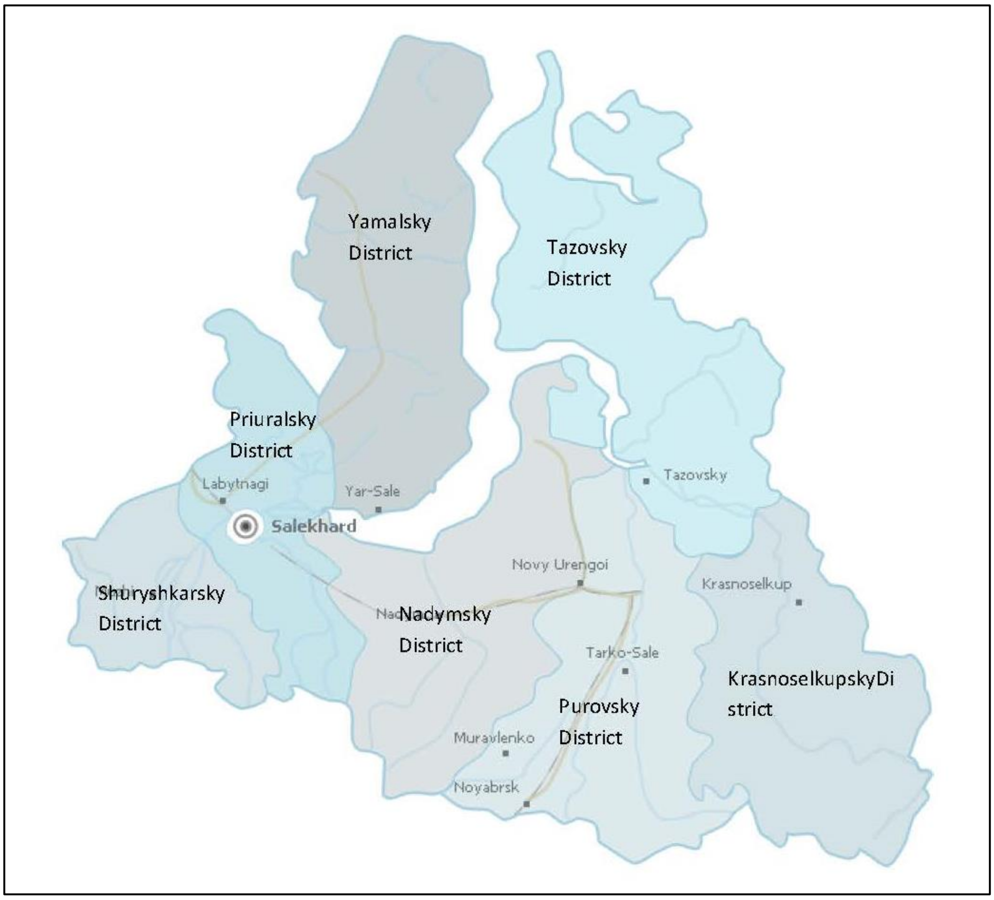

Figure 8.2: Map of YNAO Municipal Districts

According to the latest All-Russia Population Census (ARPC) of 2010, the population of YNAO totalled 525,094 people (0.37% of the Russian population[9]) in that year, including 522,904 permanent residents and 2,190 temporary visitors[10]. In comparison with the results of the 2002 ARPC, as of the beginning of 2010, the population of YNAO increased by more than 18,000 people, or 3.5%[11]. In the last 50 years, since the population census of 1959, the resident population of YNAO has increased eightfold.

The size of the Okrug's permanent population and of its administrative units based on the 2010 Census data is shown in Table 8.1.

Table 8.1: Permanent population of YNAO and administrative units, APRC-2010 data

Yamal-Nenets Autonomous Okrug	**522,904**
Urban population	443,043
Rural population	79,861
Cities/towns	
Salekhard city and settlements in its jurisdiction	42,845
Gubkinsky	23,335
Labytnangi	26,936
Muravlenko	33,391
Nadym	46,611
Novy Urengoy	104,107
Noyabrsk	110,620
Municipal Districts	
Krasnoselkupsky	6,204
Nadymsky	19,919
Priuralsky	14,995
Purovsky	51,280
Tazovsky	16,537
Shuryshkarsky	9,814

[9] Against the country's total of 143,436,145 people (Source: ARPS-2010).

[10] Results of the All-Russia Population Census 2010, Population Size and Distribution, Yamal-Nenets Autonomous Okrug, Territorial Body of the Federal State Statistics Service (Yamalstat).

[11] Population of YNAO in 2002 was 507,006 people.

Yamalsky	*16,310*
Yar-Sale settlement (District centre)	6,486
Other rural settlements	9,824

Source: All-Russia Population Census of 2010[12]

Subsequent to the 2010 ARPC, the YNAO Department of Health reported that the population of the Okrug amounted to 536,558 as of 01.01.2012. The most recent data provided by the YNAO Government[13] as of 01.04.2013 show that the Okrug's population including registered migrants (temporarily resident for 9 months and more) was 544,200 persons, which demonstrates a 1.0% increase over the previous year. The YNAO Government reports that the population growth is predominantly a result of the natural increase[14], with the number of births in 2012 in YNAO (9,025) having increased by 9.3% as compared with 2011 and as against 2,877 deaths in 2012.The official results of the demographic monitoring for 2013 also acknowledge an increasing influence of migration on the population size. The male-female ratio of the Okrug population is almost equal at 50.3 (men): 49.7 (women).

The beginning of intensive industrial development of Western Siberia in the 1960s and subsequent northward progression of the industrialisation, along with the development of gas fields in YNAO, made a significant contribution to the population growth. However, the collapse of the Soviet Union in early 1990s, and consequent institutional and socio-economic transformations, had a downward effect on the local demography. From 1990 through to 1992, the emigration to other regions of Russia exceeded immigration, resulting in negative net migration.

Since the mid-1990s, the population of YNAO has been growing steadily, primarily due to the natural population increase (on average, four thousand people per year), which is the result of improved living standards and proactive social policies implemented in the region.

YNAO is characterised by a high proportion of urbanisation. As of early 2010, urban residents accounted for nearly 85% of the total resident population, (i.e. 443,043 urban residents compared to 79,861, or 15% rural residents). The Okrug reached the current level of urbanisation in the late 1980s – early 1990s. The urban population is concentrated in eight relatively large towns, while the rural population resides in 102 small settlements scattered across a vast area, of which 45 settlements have less than one hundred residents. The breakdown between the rural and urban population figures for the period of 2010-2012 is shown in Table 8.2.

[12] Federal State Service for Statistics (Rosstat)

[13] Source: The Analysis of Demographic Monitoring in Yamal-Nenets Autonomous Okrug for Q1 2013. The official web-site of the YNAO Government: http://правительство.янао.рф/region/population/

[14] Natural increase is the difference between the numbers of births and deaths in the population.

Table 8.2: Proportion of urban and rural population in YNAO between 2010-2012 (% of total population at beginning of the year)

	2010	2011	2012
Urban	84.7	84.8	85.0
Rural	15.3	15.2	15.0

Source: Yamalstat[15]

According to the 2010 ARPC data, the YNAO population includes the following ethnic groups:

- Russians: 312,019 people (about 60% of the total population),
- Ukrainians: 48,985 people (9.3%),
- Tatars: 28,509 people (5.5%).

The YNAO population also includes Indigenous Small-Numbered Peoples of the North (ISNPN, or the Indigenous Peoples of the North, IPN)[16], who number over 37,125 people in total thereby accounting for over 7% of the YNAO population and 22% of the entire IPN population in Russia. The following indigenous peoples constitute the majority of the IPN in YNAO:

- Nenets: 29,772 people (5.7% of the total population of YNAO)
- Khantys: 9,489 people (1.8% of the total population of YNAO),
- Selkups: 1,988 people (0.4%of the total population of YNAO).

Overall, the YNAO population consists of numerous ethnic groups, including other peoples that are also categorised as IPN: Evenks, Vepsians, Dolgans, Kets, Koryaks, Kumandins, Mansi, Nanais, Teleuts, Ulches, Chuckchis, and others (such as Saams, Udegeits, Shortsy, Evens, Ents, and Yukagirs).[17,18]

Table 8.3 shows the numbers of the other IPN residing in the Okrug.

Table 8.3: Other IPN residing in YNAO, APRC-2010 data

IPN	Numbers
Chuckchis	2
Dolgans	2

[15]Territorial Agency of the Federal State Statistics Service for the Yamal-Nenets Autonomous Okrug.

[16]In 2000, the Government of the Russian Federation approved “The Complete Register of Indigenous Small-Numbered Peoples of the Russian Federation” (Decree of the Russian Government No.255 of 24 March 2000). Forty peoples living in the North or in the territories with harsh climate equated to the North were included in a separate document entitled “The List of Indigenous Small-Numbered Peoples of the North, Siberia and the Far East of the Russian Federation” (approved Government Decree No.536-r of 17 April 2006). Seventeen of these number less than 1,500 people. See: O. Murashko, Modern Interpretation of Term “Peoples of the North”, Russian Association of Indigenous Peoples of the North, Siberia and Far East (RAIPON), http://www.raipon.info/

[17]International energy and environment program “Energy of the Arctic”. Scientific report “Current State and Perspectives of the Development of the Agrifood Sector of the Russian Arctic Territories (on the example of the Yamal-Nenets Autonomous Okrug)” Under the supervision of E.N. Krylatykh, Professor of the Russian Agricultural Academy, December 2011.

[18]The All-Russia Population Census of 2010, Nationalities in the Russian Federation, Yamal-Nenets Autonomous Okrug

Table 8.3: Other IPN residing in YNAO, APRC-2010 data

IPN	Numbers
Evenks	42
Evens (Lamuts)	2
Ents	2
Kets	9
Koryaks	1
Kumandins	4
Mansi	166
Nanais	3
Saams	1
Shortsy	5
Teleuts	2
Udegeits	2
Ulches	3
Vepsians	3
Yukagirs	1

Source: Rosstat

Over 14,000 of the IPN population (circa 40% of the total) residing in the Okrug are nomadic.

8.2.2 BASIC DEMOGRAPHIC CHARACTERISTICS AND PUBLIC HEALTH INDICATORS IN YNAO

8.2.2.1 BIRTH RATE

According to statistical records, the birth rate in YNAO in recent years has exceeded the national level. The 2010 ARPC (see also Figure 8.3) showed that the crude birth rate[19] in the Okrug was 15.8 against the overall Russian birth rate of 12.6. In 2011, 8,249 children were born in the region; since 2009 the number of births has always exceeded eight thousand babies per year. In comparison with 2009, the birth rate in the region grew by 4.6%, and by 8.2% compared to the year 2008. The birth rate in YNAO is 2.9 times higher than the death rate.

In 2012, the crude birth rate in YNAO was 16.7 births per 1,000 people, which is more than 7% higher than2011 (15.6). This birth rate exceeds the Russian average (13.3) by over 25%. The positive trend in the birth rate at the Okrug level and the exceedance of the average country rate has been observed in YNAO over the past 5 years, and this is also a steady positive trend over the last two decades.

The comparative dynamics of the birth rate indicators in YNAO as against the Ural Federal Okrug (a larger administrative unit of which YNAO is a part) and the country as a whole are shown in Figure 8.3 below.

[19]Crude birth rate indicates the number of live births occurring during the year, per 1,000 people estimated at midyear in per mil. Data of Rosstat and the Department of Public Health in the Yamal-Nenets Autonomous Okrug.

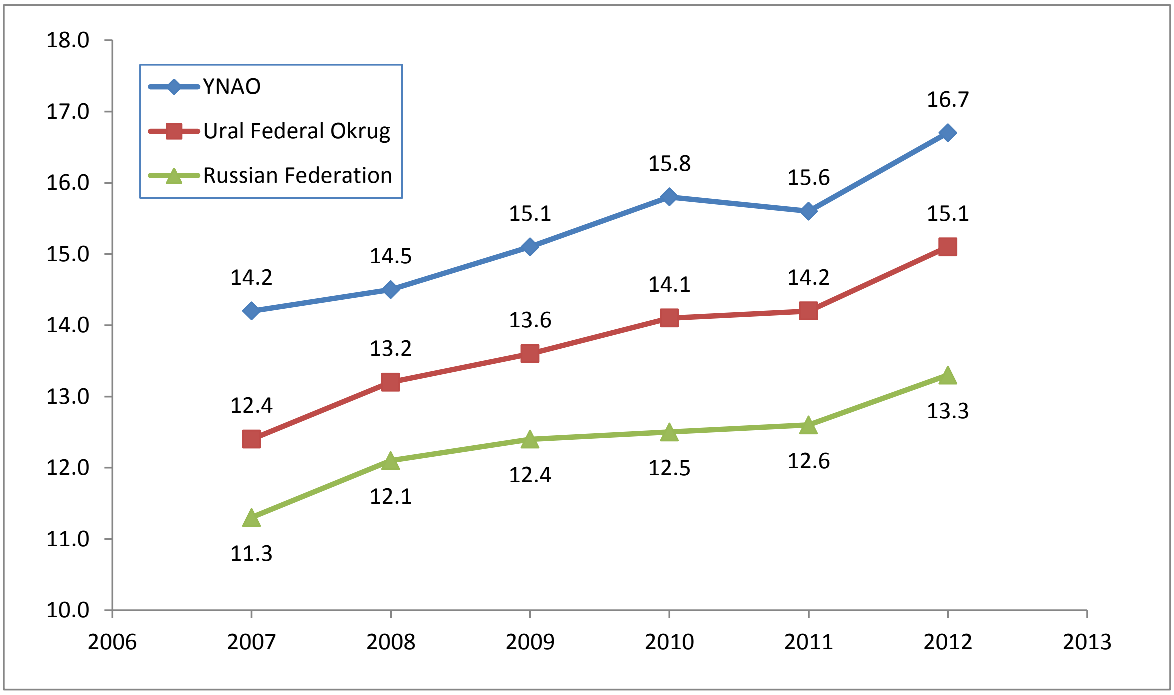

Figure 8.3: Birth rate comparison, YNAO vs. Ural Federal Okrug and Russian Federation, (2007-2012, per 1000 people)

Source: YNAO Department of Public Health, 2013 [20]

The Okrug authorities consider the natural increase to be the primary factor behind the growing population of YNAO in the first decade of the 2000s, as it contributes over 90% to the total population rise in comparison with the other potential drivers such as in-migration (see also "Migration" in section 8.2.2 below). The natural increase rate[21] in YNAO amounted to 11.4 per 1,000 people in 2012, which is in contrast with the general situation in Russia where an overall natural population decline has been the prevailing tendency over the past years[22].

The number of multi-child families in the Okrug has also been growing: in 2011 alone their number increased by almost 7%. In 2012, the YNAO Governor approved a local task programme "Development of the Social Protection System in YNAO for 2012-2020", with a funding allocation of

[20]Report on the Status of Public Health and Healthcare Organisations in YNAO in 2012. Salekhard, 2013.

[21]The rate of natural increase refers to the difference between the number of live births and the number of deaths occurring in a year, divided by the mid-year population of that year, multiplied by a factor (usually 1,000). Source: OECD Glossary of Statistical Terms, http://stats.oecd.org/glossary/

[22]"Natural population decline in Russia decreased to almost zero in 2012, whereas the population increase still mainly depends on migration". Data for the period of January-November 2012 show that the natural increase rate in Russia was -0,02‰. Source: Demoscope Weekly, Russia's demographic barometer. No. 541 – 542, 4 - 17 February 2013. http://www.demoscope.ru/weekly/2013/0541/barom02.php

over seven billion RUB. A significant part of financial resources earmarked for the programme will be used for stimulation of birth rate and support of young families[23].

The lowest birth rates are typically in the urban population. In rural areas, the birth rates exceed the Okrug's average by 50% and more. Traditionally, high birth rates are typical of the rural areas with a prevalent indigenous population. The highest birth rate of 25.8 was registered in Yamalsky District (see Figure 8.4).

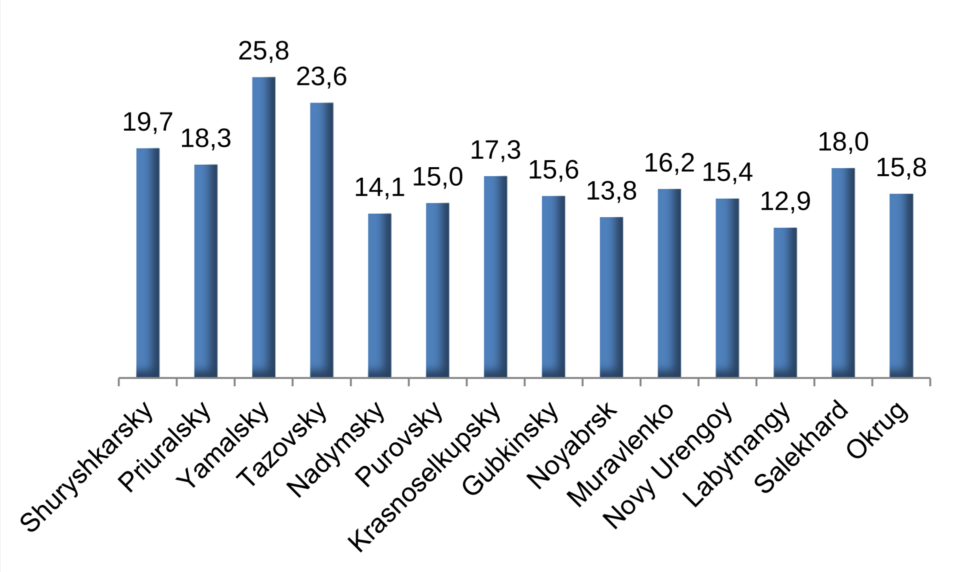

Figure 8.4: Birth rates in YNAO municipal districts in 2010 (per 1000 people)

Source: YNAO Department of Public Health, 2011.

The main factor contributing to the positive trend in the natural growth of the population is the prevalence of people at child-bearing age from 20 to 44 years in YNAO's demographic structure (232,360 persons in total were in this age group in 2010, or more than 44% of the Okrug's total population).The average age of residents in YNAO is 32-33 years.

Table 8.4 also shows a breakdown of the YNAO population based on the working age[24] which typically serves as the key indicator of population's economic activity.

[23] A. Ivanova. Baby Boom in the Permafrost Conditions: Motherhood and Childhood Are Among the Priorities on Yamal. Newspaper "Rossiyskaya Gazeta", as of 17 April 2012.

[24] Able-bodied population – persons of working age who are able to participate in the labour process. In the Russian Federation this category includes males aged 16-59 years and females of 16-54 years of age, with the exception of disabled people as well as unemployed persons of working age receiving state pensions. Source: http://www.glossary.ru/

Table 8.4: Age Distribution of the YNAO Population, as of the beginning of the year

	2007	2008	2009	2010	2011*	2012
Total population, in thousands	538.6	542.8	543.6	522.7*	524.9	536,5
Including:						
Below working age	114.7	113.7	113.5	114.6	115.7	117,0
Able bodied (working age)	388.8	389.6	387.3	383.9	367.6	376,0
Above working age	35.1	39.5	42.8	48.0	41.6	43,5

**Adjusted in accordance with the results of the All-Russia Population Census of 2010. Source: Yamalstat*

Since 2000, the correlation between the age groups changed significantly: the percentage of people above working age increased from 4.4% in 2000 to 7.9% in 2011; the percentage of people below working age decreased from 26% in 2000 to 22% in 2009. At the same time, the Okrug's Department of Public Health reports that the number of the population below working age (children and teenagers under 16 years that numbered 117,000 persons in 2012) is still considerably higher than that of people above working age (43,500 persons).

8.2.2.2 MORTALITY RATE

Due to the younger population of the region compared with Russia's national average, the overall death rate is 2.6 times lower than the national average (in 2010 it was 5.5 per 1000 people compared with the national average of 14.3).

In 2012, the mortality rate in YNAO amounted to 5.3 per 1000 people, which is more than 2 times lower than the overall mortality rates in the Ural Federal Okrug or the Russian Federation (Figure 8.5).

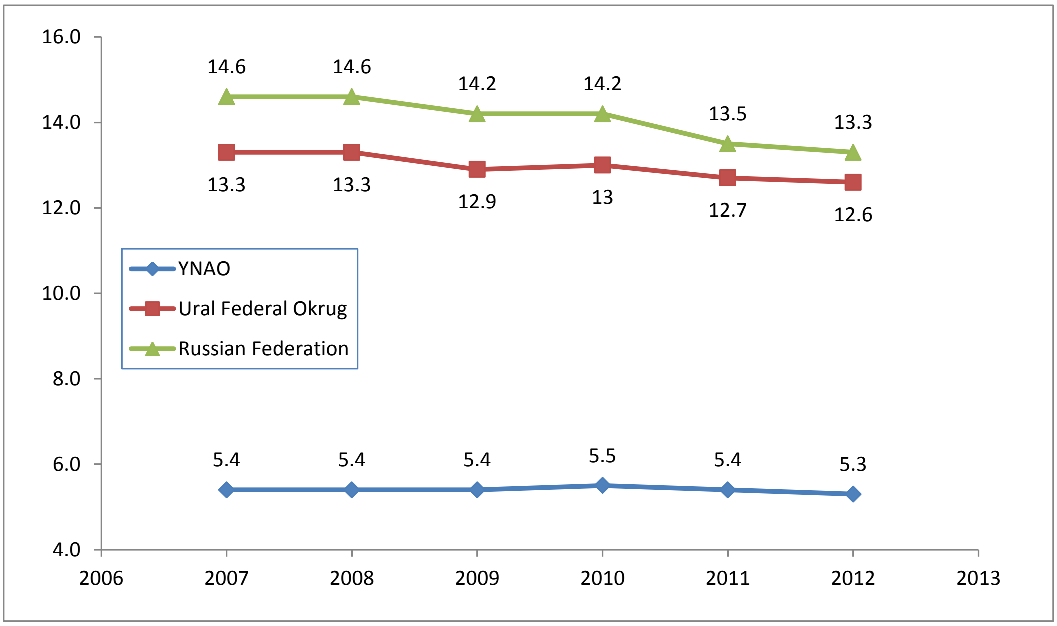

Figure 8.5: Mortality rate comparison, YNAO vs. Ural Federal Okrug and Russian Federation (2007-2012, per 1000 people)

Source: YNAO Department of Public Health, 2012

At the YNAO regional level, the mortality rate is highest in those districts with the greatest share of rural and nomadic populations. In Shuryshkarskiy, Yamalsky and Krasnoselkupskiy Districts, the death rate is twice the YNAO average (see Figure 8.6). The mortality rates are also relatively high in the towns of Salekhard and Labytnangi, mostly due to the higher average age of the population. Overall, a distinct difference is observed in the mortality rate among the urban and rural population; the mortality rate in rural areas is almost twice that in urban areas (90.7 compared to 48.5 per 10,000 people.[25])

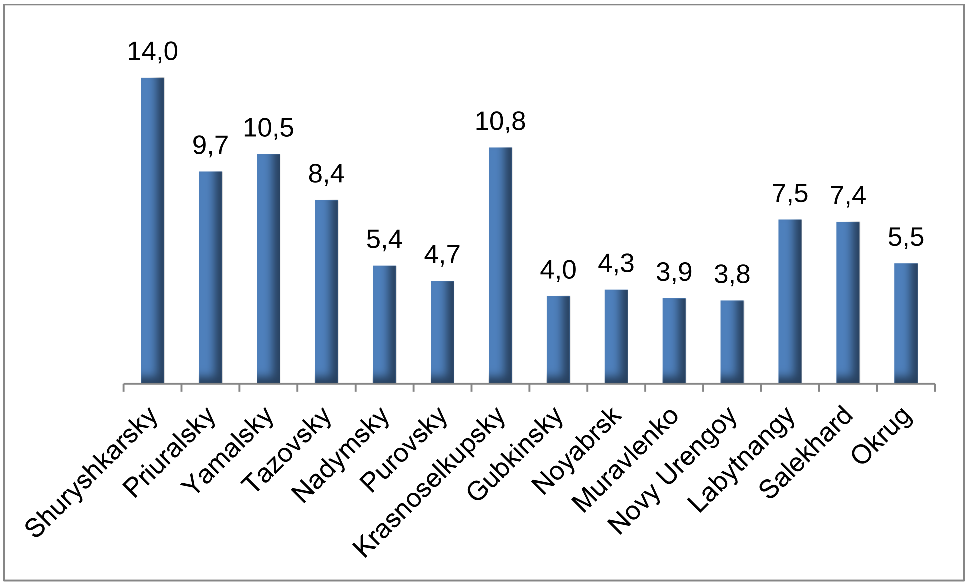

Figure 8.6: Death Rates in Municipal Districts, 2010 (per 1,000 people)

Source: YNAO Department of Public Health, 2011

The main cause of death in YNAO (40.5%) is disorders of the heart and circulatory system, mainly the coronary heart disease. In 2010, the rate of deaths caused by coronary heart disease was 22.3 per 10,000 people (compared tithe national average of 80.1 per 10,000 people). More than 48% of deaths of this category occur among the able-bodied population. Despite a significant growth of morbidity caused by pernicious habits, physical inactivity, eating habits, mental and emotional tension and stresses, the mortality level remains the same due to proper medical surveillance implemented in YNAO, prevention of complications (strokes, infarctions) and availability of high-technology medical services.[26]

The next most frequent causes of death are accidents, poisonings and injuries, which brought over 22% of deaths or 12.0 per 10,000 people in 2010 (as compared with the national average rate of 15.8). More than 85% of all accidents, injuries and poisonings occur among the able-bodied population. The decrease of this rate by 26.4% in the last five years has been observed due to:

[25]Other data available from the YNAO Department of Public Health show that the mortality rate among the rural population was 82.7 per 10,000 people in 2012.

[26]Source: YNAO Department of Public Health. Report on the Status of Public Health and Healthcare in YNAO in 2010. Salekhard, 2011.

measures taken against substance abuse, inhalant abuse, alcohol addiction, prevention of road traffic injuries; upgraded ambulance equipment and hospital facilities and enhancement of staff professional qualifications in the public health system.[27]

The third most common cause of death (16.9% of all deaths in YNAO) is cancer, which accounts for 8.0 per 10,000 people compared to the national average of 20.6. More than 50% of such deaths occur among the able-bodied population. According to the report of the YNAO Department of Public Health, main causes of the increase in malignant growth incidence (5.2 fold increase in the last five years) are general deterioration of the environmental conditions, poor quality of water and food, pernicious habits and stress. In order to improve this situation, the public healthcare system in the Okrug focuses on early preclinical diagnosis of such diseases and the provision of curative treatment as early as possible.

Table 8.5 summarises the most prevalent causes of death among the Okrug's population and also shows the comparison with the Ural Federal Okrug and the Russian Federation as a whole.

Table 8.5: Main causes of death in YNAO, per 100,000 people. Comparison with the Ural Federal Okrug and the Russian Federation

	2011	2012	% of total	2012	
	YNAO			Ural Federal Okrug	RF
Total deceased	543.5	533.1	100.0	1256.7	1327.3
including:					
Diseases of the circulatory system	212.7	215.7	40.5	658.5	729.3
Neoplasms (tumour)	80.8	90.2	16.9	200.3	201.2
Accidents, injuries and intoxication	124.4	118.8	22.3	154.9	125.1
including Traffic-related injuries	16.9	15.6	13.1	23.0	20.5
Suicides	20.7	15.8	13.3	26.7	20.2
Homicides	10.4	9.8	8.2	12.7	10.4
Diseases of the digestive system	37.3	30.2	5.7	60.7	60.9
Respiratory diseases	29.4	20.8	3.9	53.7	48.1
Infectious and parasitic diseases	15.7	16.5	3.1	33.7	21.4
including Tuberculosis	10.8	11.3	68.5	15.5	12.2

Source: YNAO Department of Public Health, 2012

[27] Source: Ibidum.

Although the infant mortality rate[28] in the Okrug has been showing a declining trend in recent years, it remains higher than the national average: 10.7 cases per 1,000 births in 2012 (a decrease by 2.7% over 2011), as compared to Russia's average of 8.7 per 1,000.

Figure 8.7 shows the comparative dynamics of infant mortality in YNAO, as against the Ural Federal Okrug and the Russian Federation as a whole.

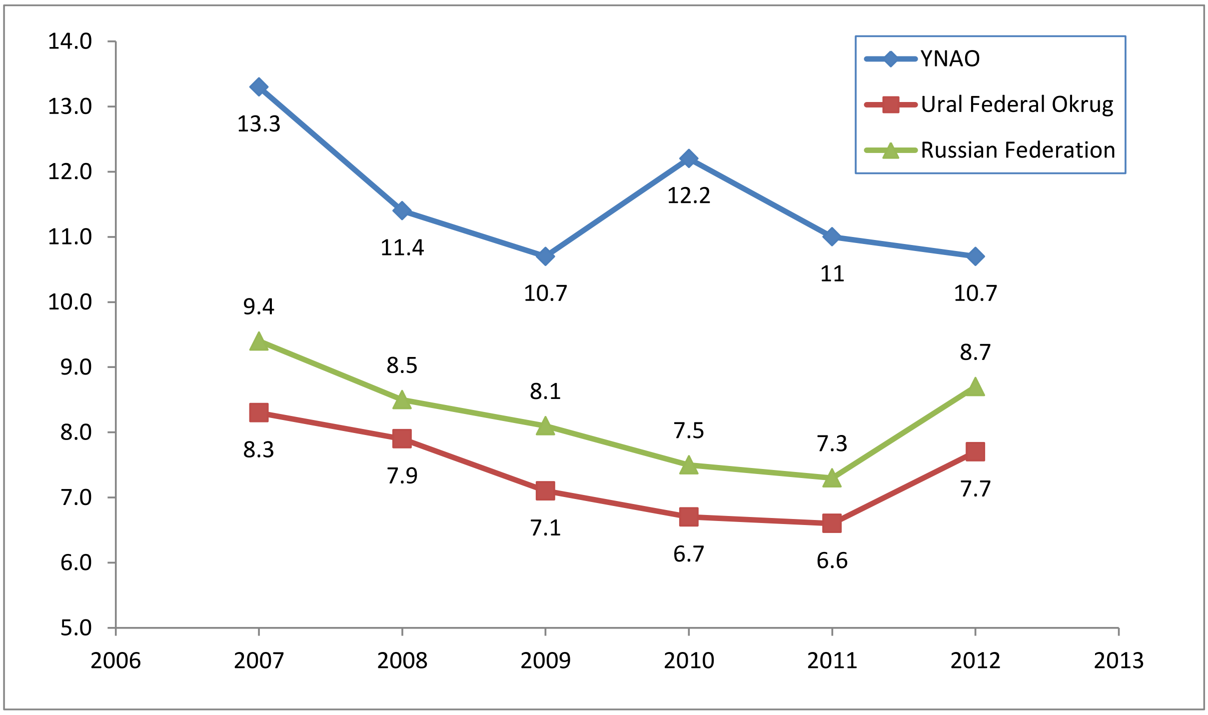

Figure 8.7: Infant mortality rate in YNAO, per 1,000 births (Comparison with the Ural Federal Okrug and RF)

Source: YNAO Department of Public Health, 2012

The YNAO Department of Public Health data emphasise the stable decrease in infant mortality that has been observed over the recent years. Unlike the other regions of the Ural Federal Okrug, where the decline in this indicator has been due to the reduced perinatal[29] mortality (infant mortality within 28 days of birth), in YNAO the reduction was mainly a result of the decreasing infant mortality among the rural and tundra population. In 2012, out of 9,015 births in the Okrug there were 8,965 live births (99%) and 50 stillborn (less than 1% of total). 88 death cases were registered within the first year of birth, including:

- 39 cases in urban areas;
- 49 cases in rural areas.

[28]Under 1 year of age.

[29]The term 'perinatal' pertains to the period immediately before and after birth. The perinatal period is defined in diverse ways and depending on the definition, it starts at the 20th to 28th week of gestation and ends 1 to 4 weeks after birth. Source: Medical dictionary, http://www.medterms.com

From the total number of mortality cases in children under the age of one, 33 cases (37.5%) were among the indigenous population. 30 cases from the total number were premature infants, including 16 with the extremely low body weight.

The higher rate of infant mortality in YNAO as compared with the national average (10.7 versus 8.7) is associated with the extreme climatic conditions of the region and difficulties related to prompt accessibility of medical aid to the remote rural and tundra areas. In 2012, almost 24% of infant mortality cases registered among the tundra population took place due to the unavailability of medical aid. The main causes of child mortality in the tundra are respiratory diseases, congenital anomalies, and external adverse factors of the surrounding environment, such as extremely low temperatures, greater exposure to accidents and harsh living conditions.[30,31].

The dynamics of infant mortality in rural and urban areas of the Okrug are shown in Figure 8.8.

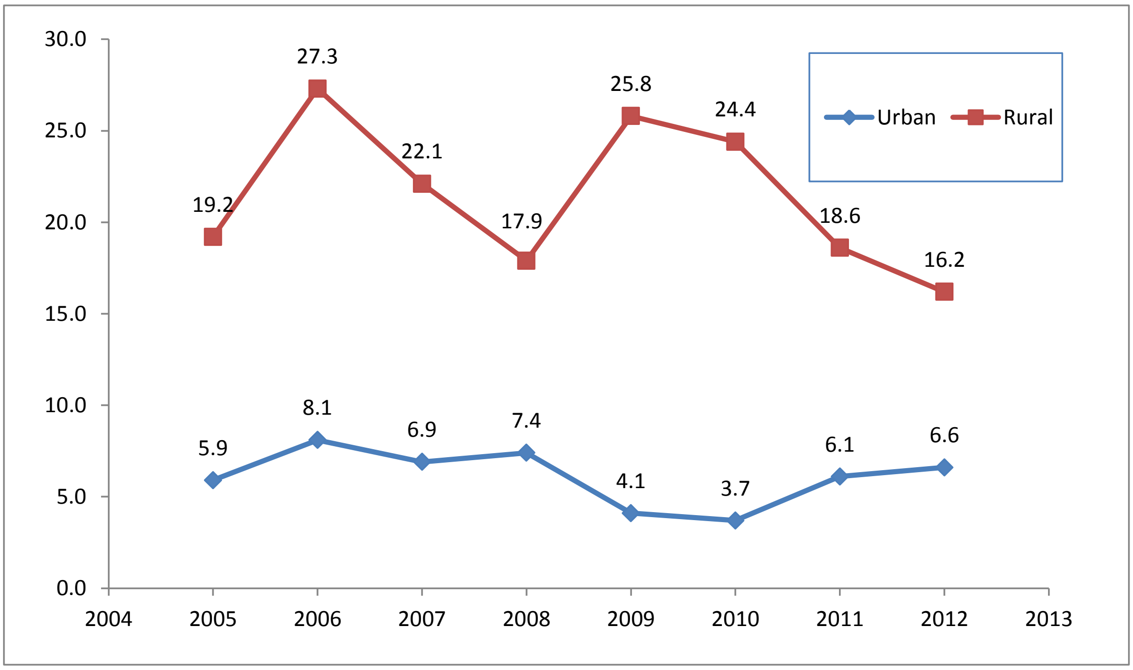

Figure 8.8: Infant mortality dynamics, urban vs. rural areas of YNAO

Source: YNAO Department of Public Health, 2012

In 2012, the YNAO Department of Public Health identified the following measures aimed at the reduction of child mortality in the region:

- For rural tundra areas:
  - development of transport schemes for nomadic women with new-born infants so that they are transferred from medical institutions to their dwellings (*chums)* in the shortest possible time and in comfortable conditions, by air, land or water means of transportation;

[30]"Medical Aid to Newborns in the YNAO". 18 April 2012. "Yamal" data portal: http://www.yamal.ru/

[31]YNAO Department of Public Health. Report on the Status of Public Health and Healthcare Organisations in YNAO in 2012. Salekhard, 2013.

  - implementation of satellite-based tracking systems for communication with tundra herders;
  - provision of all-terrain vehicles for all local hospitals;
- For urban areas:
  - continued efforts to provide medical facilities with equipment for special care nursing for premature births and the diagnosis of congenital malformations in infants;
  - expansion of psychological counselling to expecting mothers and the availability of accessible obstetric-gynaecologic assistance to teenagers in children's policlinics.

Since early 2011, the state has implemented additional measures to improve perinatal diagnosis of congenital abnormalities in newborn infants, and to introduce modern methods of treatment for premature infants and expectant mothers in need of intensive therapy during pre-labour and labour.

8.2.2.3 POPULATION MORBIDITY

Basic morbidity data for YNAO are shown in Table 8.6.

Table 8.6: Morbidity of the YNAO Population in 2008-2012, per 1,000 people

Morbidity	2008	2009	2010	2011	2012
Infections and infestations	84.4	81.6	88.7	90.0	84.1
Neoplasms (tumour)	44.5	47.3	53.3	55.9	53.8
Blood diseases	13.0	14.2	17.1	17.5	19.2
Diseases of the endocrine system	84.6	78.8	85.0	86.5	90.7
Mental disorders	65.8	65.4	67.6	70.6	68.7
Diseases of the nervous system	77.9	76.2	74.6	78.1	77.6
Diseases of the eye and appendages	151.9	135.0	142.2	144.1	133.4
Diseases of the ear and mastoid process	42.2	40.9	45.7	46.6	46.0
Diseases of the blood circulatory system	135.2	136.6	145.4	151.3	151.0
Respiratory diseases	**522.1**	**521.5**	**509.0**	**563.8**	**552.5**
Diseases of the digestive system	136.7	120.5	123.9	121.7	127.9
Diseases of the skin and subcutaneous tissue	107.9	100.5	87.3	94.4	90.5
Diseases of the musculoskeletal system	**170.9**	**169.3**	**170.0**	**170.7**	**171.2**
Diseases of the genitourinary system	**163.8**	**164.0**	**176.9**	**185.5**	**168.7**
Congenital abnormalities and malformations	7.6	9.7	5.5	11.1	10.4
Symptoms, signs and undiagnosed conditions	13.3	14.2	11.0	10.7	11.7
Injuries and poisonings	102.7	98.8	102.8	103.5	100.3

Source: The YNAO Department of Public Health 2013

As shown in the table, the respiratory diseases dominate the population morbidity profile in the Okrug. Prolonged periods of very low air temperatures exacerbated by strong winds, frequent exposure to these natural conditions both by the local nomadic population and people engaged in the industrial development whose activities necessitate being in the open air are conducive to the accelerated progression of the respiratory illnesses. This category of diseases has evidently been prevailing in the morbidity structure over the recent years.

The crude morbidity rate[32] among the YNAO population in 2012 was 2,007.2 per 1,000 people, which was 2% higher than the 2008 level. The morbidity rate among children aged between 0-14 years old decreased by 2.3% as compared with 2011 (from 3,016.7 per 1,000 children in 2011 to 2,946.0 in 2012)[33].

Figure 8.9 shows the comparative dynamics of population morbidity in YNAO, as against the Ural Federal Okrug and the Russian Federation as a whole.

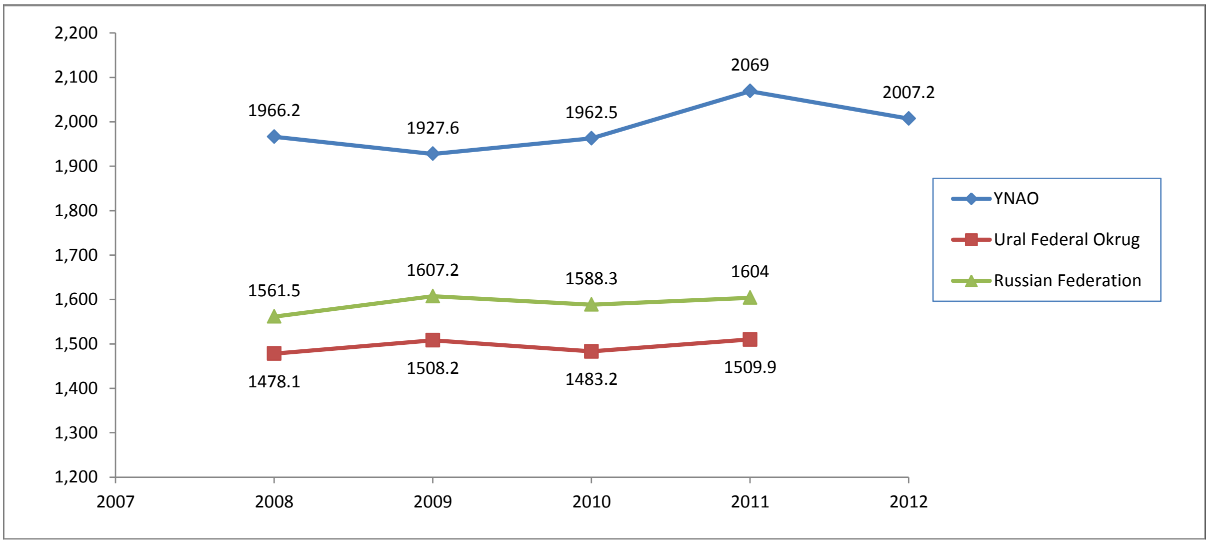

Figure 8.9: Crude morbidity in YNAO, per 1,000 people (Comparison with the Ural Federal Okrug and RF)

Source: YNAO Department of Public Health, 2013

The variation of population morbidity rates between the YNAO districts is shown in Table 8.7. Over the period of 2008-2012, the highest morbidity rates were registered in Purovsky and Priuralsky Districts, and Yamalsky District is also characterised by a higher morbidity rate than the Okrug's average.

[32] Total of illnesses (acute and chronic) among a certain group of the population per year.

[33] The YNAO Department of Public Health. Healthcare in Yamal-Nenets Autonomous Okrug in 2012. Statistical compendium. Salekhard, 2013.

Table 8.7: Crude morbidity dynamics, per 1,000 people, by YNAO Districts

Administrative units (Districts/cities)	2008	2009	2010	2011	2012	Per cent change in 2012	
						vs.2008	vs. end of 2011
Shuryshkarsky	2095.0	2090.3	2183.3	2234.9	2059.2	-1.7	-7.9
Priuralsky	1463.1	1643.0	1753.3	2246.6	2789.4	90.6	24.2
Yamalsky	*2218.9*	*2194.0*	*2050.1*	*2294.5*	*2396.8*	*8.0*	*4.5*
Tazovsky	1618.8	1699.5	1776.6	2214.5	1925.5	18.9	-13.1
Nadymsky	1682.9	1503.5	1695.3	1787.8	1675.3	-0.5	-6.3
Purovsky	2549.9	2531.4	2493.6	2493.7	2057.3	-19.3	-17.5
Krasnoselkupsky	1977.7	2044.9	2215.0	2353.4	2691.4	36.1	14.4
YNAO	**1966.2**	**1927.6**	**1962.5**	**2069.0**	**2007.2**	**2.1**	**-3.0**

Source: YNAO Department of Public Health, 2013

The YNAO Department of Public Health reports that during 2008-2012 the highest morbidity rates were registered in 2011 (2,069.0 per 1,000 people), which was mainly accounted for by the improved detection of illnesses. In 2011, the implementation of the regional Programme for Healthcare Modernisation enabled the purchase of new equipment, upgrading of medical facilities, and enhancement of healthcare standards in the Okrug. This led to the greater availability of medical aid and, consequently, to the higher detectability of diseases[34].

The harsh climate and environmental conditions also contribute significantly to the status of public health in the Okrug. According to a report by the Head of Yamalsky District Administration (2011)[35], the District is unsuitable for permanent settlement by non-locals population, and the maximum length of residence without an irreversible damage to health for people not adapted to the local conditions is claimed to be about 2-3 years.

At the same time, some researchers[36] consider that climate warming may result in the (re-) emergence of diseases new to the northern polar regions. Against the changing environmental background, modifications in the clinical course of diseases, manifestation of symptoms and the accelerated transition to chronic phases of widely-spread diseases have reportedly been observed. The incidence of dystrophic and tumour growth processes has been on the increase; new forms of infection pathology, genetic predispositions, heightened chemical sensitivity, and immune deficiency conditions have all been reported, and, as a consequence, accelerated ageing and

[34] The YNAO Department of Public Health. Healthcare in Yamal-Nenets Autonomous Okrug in 2012. Statistical compendium. Salekhard, 2013.

[35] The Report of the Head of Yamalsky District Administration "On achieved indicators for assessment of efficiency of Yamalsky District Administration activities in 2010 and projected indicators for a 3-year period", 2011.

[36] See for example: "Climatographic medical zoning of the Polar North regions. Practical Recommendations", Scientific Research Institute "Russian Academy of Medical Sciences for Medical Issues of Polar North", Nadym, 2009.

shorter life expectancy. According to some researchers, contribution of the environmental conditions to the pathogenesis of most common diseases varies from 30% to as high as 60%.[37]

The population morbidity data in Yamalsky District is shown in Table 8.8. These data have been obtained from the Report on socio-economic development of Yamalsky Municipal District[38] (2012) and appear to differ from the data reported by the YNAO Department of Public Health in Table 8.7 above, particularly in relation to crude morbidity per 1,000 people.

Table 8.8: Population Morbidity in Yamalsky District, 2011-2012

Absolute number	**2011**	**2012**
Morbidity across all age groups	26 397	27 807
Age group breakdown:		
children	12 356	14 312
teenagers	1 801	1 605
adults	12 240	11 890
Per 1000 people		
Morbidity across all age groups	1 611	1 664
Age group breakdown:		
children	2 463	2 396
teenagers	2 028	1 972
adults	1 168	1 107

The increased rate of detected morbidities can, to an extent, be explained by improved diagnostic medical coverage among the district population in the form of scheduled check-ups, including medical examinations of schoolchildren and adults. Implementation of modern methods of early disease detection (enhanced capability of immunologic laboratories, application of endoscopic and ultrasound examination methods) also contributes to the improved detection rate.

Respiratory illnesses

Respiratory diseases are the most widespread category of diseases (26%) in YNAO due to the natural and climatic characteristics of the region. Acute respiratory infections of the upper and lower respiratory tracts, acute laryngitis and tracheitis, and chronic diseases of tonsils are prevalent. In rural areas, the number of cases of respiratory disease is higher than the YNAO average, particularly in Shuryshkarsky, Purovsky, Yamalsky, Tazovsky and Priuralsky Districts, and in the towns of Labytnangi and Gubkinsky.

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[37] Agbalyan E.V., "Studies relating to assessment of the environmental conditions and health status of population in Yamal-Nenets Autonomous Okrug under conditions of increasing technogenic stresses and climate change", Government Agency of YNAO "Arctic Research Centre", Salekhard.

[38] Municipal Administration of Yamalsky District, Department of Economy, Yar-Sale:2013.

As shown in Figure 8.10 below, the level of respiratory illness among the population of YNAO is significantly higher than in the Ural Federal Okrug and Russia as a whole.

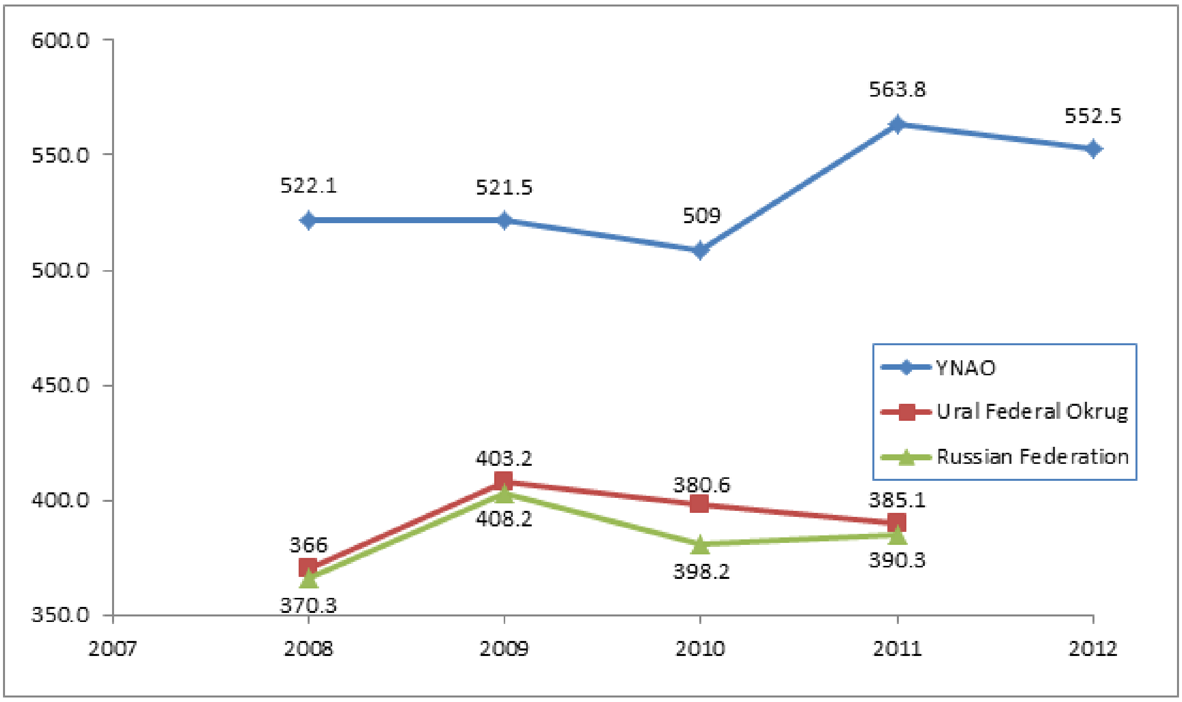

Figure 8.10: Respiratory diseases incidence, per 1,000 people (Comparison with the Ural Federal Okrug and RF)

Source: YNAO Department of Public Health, 2013

Transmissible illnesses

Tuberculosis remains among the most persistent illnesses with a high incidence rate among the population of the Okrug. The YNAO Department of Public Health reports that in 2012, the registered incidence of active tuberculosis was 64.3 cases per 100,000 people – a 3.0% decrease as compared with the 2011 levels (66.3 per100,000 people) and 10.2% decline as against the 2008 levels (71.6per 100,000 people).Greater predisposition to this disease among population of the Okrug and particularly in its remote northern areas is largely accounted for by the harsh environment and challenging living conditions, together with the limited accessibility of the nomadic indigenous communities and the associated difficulties with medical coverage for this population.

At the same time, the highest reported incidence of tuberculosis per 100,000 people is registered in Yamalsky District (159 cases per 100,000 people in 2012 as compared with 64.3 per 100,000 people for the entire YNAO). Nonetheless, the data presented in Table 8.9 indicate a general decline in the reported incidence rate of tuberculosis in Yamalsky District over the five-year period from 2008 to 2012. The largest number of reported cases of tuberculosis, including among children, occur in the districts with the territories of compact indigenous settlements[39] such as Yamalsky, Priuralsky and Shuryshkarsky Districts.

Table 8.9: Tuberculosis morbidity rates per 100,000 people, by YNAO Districts

Districts	2008	2009	2010	2011	2012
Shuryshkarsky	191.1	240.0	214.7	143.1	132.6
Priuralsky	114.3	132.7	127.1	73.4	132.3
Yamalsky	246.5	303.2	227.6	171.0	159.0
Tazovsky	91.7	119.7	90.8	150.8	98.8
Nadymsky	53.5	54.0	70.3	51.0	36.6
Purovsky	94.2	68.3	70.0	81.9	63.7
Krasnoselkupsky	143.5	142.9	80.8	96.9	84.0
YNAO	71.6	79.8	76.5	66.3	64.3

Source: YNAO Department of Public Health, 2013

Preventative measures against tuberculosis (TB prophylaxis) play an important role, especially for the population migrating in remote tundra districts due to the challenges with medical aid accessibility to this population group. Activities for tuberculosis diagnostics are based on regular photofluorographic (X-ray) examinations focused on tuberculosis high risk groups, including the tundra population. The check-ups of the migratory groups, including reindeer herders, fishermen and hunters, are undertaken through the public health system with the use of mobile X-ray screening units set up on the commonly used migration routes during the seasonal movements of these communities via factorias.

Tuberculosis vaccination for new-borns currently covers in the range of 850 infants per 1,000 live births. The preventative measures performed by the state have contributed to the decrease of tuberculosis incidence among children residing in rural areas: in 2012 this morbidity indicator amounted to 10.8 cases per 100,000 entire population as compared with 15.4 cases in 2011.The use of mobile medical units (MMU) also plays an important role in the early detection of tuberculosis in remote settlements of YNAO, which are home to the IPN who lead a nomadic way of life. As a rule, the MMU visit settlements where necessary X-ray equipment is not available or is out of service. The main task of the MMU is mass preventative examination of population for early detection of tuberculosis. The MMU visit the following districts that have a large tundra-based population on an annual basis: Shuryshkarsky, Priuralsky, Yamalsky and Nadymsky.

[39] Area (territory) of compact indigenous settlement – historically formed areas (habitat) within which the Indigenous Peoples of the North undertake their traditional natural resource use activities, cultural and day-to-day livelihoods that determine their self-identification and the way of life.

As a whole, the IPN account for a significant percentage of the detected cases of tuberculosis in rural areas of the Okrug. This is largely explained by the congested living conditions during migration and their remote location, which makes nomadic families almost inaccessible even to medical aviation services.

The reported incidence of sexually transmitted infections (STIs) has been on the decrease over the past 5 years, although the Okrug's levels still exceed the national level, as shown in Figure 8.11 (gonorrhoea as an example case).

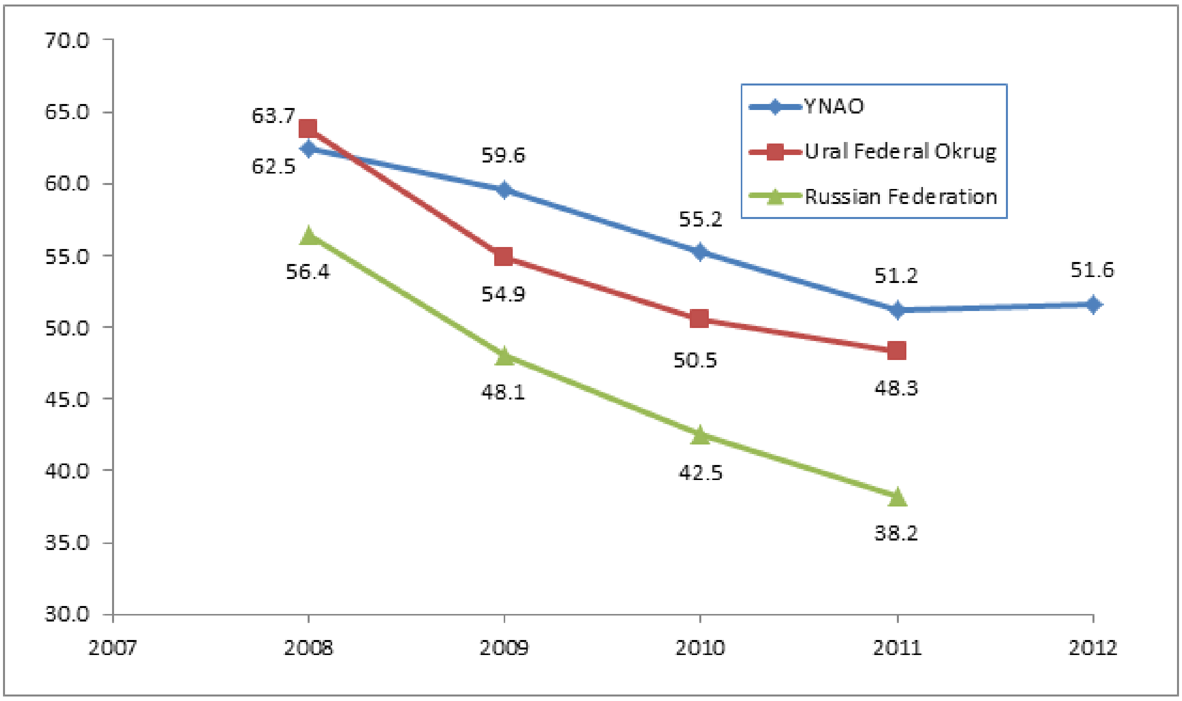

Figure 8.11: STI incidence (gonorrhoea), first-time diagnosis, per 100,000 people

Source: YNAO Department of Public Health, 2013

Of note is the predominance of urban residents among the STI patients (in the range of 85-90% of the total number of cases) as compared with rural areas.

In Yamalsky District, the STI incidence amounted to 36.7 per 100,000 people (syphilis) and 67.3 per 100,000 people (gonorrhoea) in 2012, which exceeds the YNAO average levels of 23.5 and 51.6 per 100,000 people, respectively.

HIV/AIDS

Overall, the HIV situation in the Okrug stabilised between 2003 and 2010. As of early 2011, the reported HIV incidence rate in YNAO was 319.5 per 100,000 people. By the beginning of 2012, reported HIV incidence in the Okrug reached 367.2 per 100,000 people, as against the overall national level of 455.0 per 100,000 people[40].

[40] The Yamal-Nenets Centre for Prevention and Combating AIDS and Infectious Diseases. HIV prophylaxis among the Indigenous Peoples of the North in YNAO. By Dr. L.Yu. Volova. Source: http://www.hivpolicy.ru/upload/File/RelatedFiles/publication/1430/Volova.pdf

According to data available as at May 2012, the total number of detected HIV cases in YNAO was 1,945 (including 11 children), of which 23 cases of HIV infection have advanced to AIDS[41]. By the end of December 2012, the Okrug's AIDS Centre reported that the total number of HIV cases registered in YNAO reached 2,084. Of this number, 412 cases (almost 20% of the total HIV incidence) were detected among residents that came from other regions of the Russian Federation, including 115 cases registered only in 2012. 34 cases from this particular group were among workers visiting the Okrug on a shift/rotational basis[42].

According to the YNAO Centre for Prevention and Combating AIDS and Infectious Diseases, contribution of labour migration in the increasing HIV trend has become more pronounced over the recent years. A growing number of cases detected among visiting workers from other regions of the Russian Federation and foreign countries and among rotation-based/shift workers serves as the evidence to this trend.

The HIV incidence in YNAO in comparison with the RF levels and the Ural Federal Okrug is shown in Table 8.10.

Table 8.10: Registered HIV cases in YNAO, 2012. Comparison with the Ural Federal Okrug and RF

	Number of HIV cases					Of whom have AIDS			
	Total	Children	Children infected via vertical transmission[43]	Of whom Deceased		Total	Children	Of whom Deceased	
				Total	Children			Total	Children
Russian Federation	665,590	5,939	4,195	86836	517	17928	338	15123	245
Ural Federal Okrug	116,770	1,156	908	16133	69	3957	24	3906	24
YNAO	**1,945**	**11**	**4**	**213**	**1**	**23**	**1**	**22**	**1**

**Except children with unconfirmed diagnosis. Data as of 30.05.2012.*
Source: Federal AIDS Centre, 2012

Changes in HIV incidence by districts in 2009-2011 are shown in Table 8.11.

Table 8.11: Incidence and Prevalence of HIV in the YNAO Districts, 2009-2011

Administrative units of YNAO	Number of HIV cases and HIV incidence					
	Diagnosed in 2009		Diagnosed in 2010		As of 01.01.2011	
	Absolute number	Per 100,000	Absolute number	Per 100,000	Absolute number	Per 100,000
Noviy Urengoy	33	27.8	32	26.8	730	610.2

[41]HIV-infection in the Russian Federation in 2012. Federal Centre for Prevention and Combating AIDS. Data based on statistics supplied by the territorial branches of the Federal Centre and territorial bodies of the Federal Supervision Service for Consumer Rights Protection and Human Welfare. Source: http://www.hivrussia.ru/stat/2012.shtml

[42]YNAO's AIDS Centre disseminates information on HIV infection. YamalPro Information Agency, 11/01/ 2013.Source: http://www.yamalpro.ru

[43]Vertical transmission of HIV is also known as mother-to-child transmission.

Table 8.11: Incidence and Prevalence of HIV in the YNAO Districts, 2009-2011						
Administrative units of YNAO	**Number of HIV cases and HIV incidence**					
	Diagnosed in 2009		**Diagnosed in 2010**		**As of 01.01.2011**	
	Absolute number	**Per 100,000**	**Absolute number**	**Per 100,000**	**Absolute number**	**Per 100,000**
Salekhard	10	23.4	11	25.3	193	443.2
Gubkinsky	3	13.0	8	34.0	84	357.5
Nadymsky District	21	30.6	31	45.4	201	294.2
Noyabrsk	16	14.5	17	15.3	234	210.9
Labytnangi	19	70.0	15	55.6	96	355.7
Muravlenko	9	24.2	4	10.7	74	198.4
Tazovsky District	2	11.4	4	22.7	25	142.1
Purovsky District	8	16.1	5	10.0	61	122.4
Krasnoselkupsky District	3	47.7	1	15.9	14	222.1
Yamalsky District	*1*	*6.1*	*0*	*0.0*	*7*	*42.1*
Priuralsky District	3	19.0	1	6.3	24	151.0
Shuryshkarsky District	1	10.0	1	10.0	3	29.9
Total:	129	23.6	130	23.8	1,746	319.5

Source: YNAO Department of Public Health, 2011

Other sources suggest that the number of registered HIV cases in Yamalsky District as at June 2012 was 12 in total.[44]

The most recent data on HIV prevalence in YNAO (breakdown by administrative units) as of the end of 2012 are shown in Table 8.12.

Table 8.12: HIV incidence in YNAO, 2012, by administrative units									
Administrative units of YNAO	**Number of HIV cases and HIV incidence**								
	As at 01.01.2012		**Diagnosed in 2012**		**Total by 24.12.2012**		**Registered for regular observation as at 03.12. 2012**	**HIV cases among Indigenous People**	**Receiving ART[45] as at 24.12. 2012**
	Absolute number	**Per 100,000**	**Absolute number**	**Per 100,000**	**Absolute number**	**Per 100,000**			
Noviy Urengoy	770	735,7	38	34,9	808	742,6	417		126

[44] Krasniy Sever – society and political newspaper of the Yamal-Nenets Autonomous Okrug. HIV is beyond the risk groups. By A. Chernyavskaya, 23.07.2012. Source: http://ks-yanao.ru/

[45] Standard antiretroviral therapy (ART) is the combination of at least three antiretroviral (ARV) drugs to maximally suppress the HIV virus and to stop the progression of HIV disease. Source: World Health Organisation – HIV/AIDS

Table 8.12: HIV incidence in YNAO, 2012, by administrative units

Administrative units of YNAO	Number of HIV cases and HIV incidence								
	As at 01.01.2012		Diagnosed in 2012		Total by 24.12.2012		Registered for regular observation as at 03.12. 2012	HIV cases among Indigenous People	Receiving ART[45] as at 24.12. 2012
	Absolute number	Per 100,000	Absolute number	Per 100,000	Absolute number	Per 100,000			
Salekhard	214	501,6	12	27,4	226	515,2	151	6	27
Gubkinsky	89	380,9	4	16,2	93	375,6	36		13
Nadymsky District	245	366,5	33	48,9	278	411,9	197	28	37
Noyabrsk	260	234,9	31	28,2	291	264,8	198		62
Labytnangi	112	414,5	14	52,4	126	471,4	72	4	10
Muravlenko	79	236,4	3	9,0	82	245,1	44		10
Tazovsky District	29	175,6	9	53,3	38	225,0	27	14	5
Purovsky District	71	138,1	6	11,6	77	149,4	64	2	17
Krasnoselkupsky District	14	226,4	0	0,0	14	230,6	9	4	3
Yamalsky District	*9*	*55,4*	*4*	*24,4*	*13*	*79,5*	*12*	*5*	*1*
Priuralsky District	27	180,6	7	46,5	34	225,9	28	10	3
Shuryshkarsky District	4	40,9	0	0,0	4	40,8	2	3	0
Total:	1923	367,2	161	30,3	2084	392,7	1257	76	352
Russia (01.07.2012)	650231	455,0	32561	22,8	682726	477,7			
Ural Federal Okrug (01.10.2012)	112925	922,5	9497	77,7	122381	1001,6			

Source: YNAO's AIDS Centre 2013 [46]

The detection rate of HIV cases among the IPN population of Yamalsky District shows the following dynamics:

[46] YNAO's AIDS Centre 2013 disseminates information on HIV infection. YamalPro Information Agency, 11/01/ 2013.Source: http://www.yamalpro.ru

- 2006 – 1 case:
- 2007 – 1 case;
- 2008 to 2011 – no cases among this population group; and
- 2 cases during the first six months of 2012.

The total number of HIV cases among the IPN in Yamalsky District reached 5 by December 2012.

The data provided above indicate that HIV infection has spread across the entire territory of YNAO, including the most remote areas (Yamalsky, Tazovsky, Krasnoselkupsky, Shuryshkarsky Districts). This testifies to the expanding tendency of HIV, including among the IPN.

The occurrence of HIV among the indigenous population is a signal of concern given that such a trend was not historically characteristic of the region due to its remoteness and relative isolation.

According to information of the YNAO Department of Public Health[47], HIV infection was registered among indigenous people for the first time in 2000, and in the following years it continued to spread out and concentrate in certain local areas (e.g. in the settlement of Nyda of Nadymsky District).

Generally, particular susceptibility to HIV infection is encountered among indigenous groups in many regions of the world, as the typical risk factors are common for various indigenous peoples in different countries. The most prevalent factors of risk for the indigenous communities that are also applicable in the YNAO context are considered to be as follows:

- health vulnerability as a whole,
- lower levels of transmission risk awareness,
- limited access to the formal system of healthcare and methods of protection,
- challenging social and living conditions.[48]

As of 1st January 2011, the total number of HIV cases among the indigenous population of YNAO reached 41, with 15 new cases registered by the end of that year. The most recent data quoted in Table 8.12 above show that the total number of HIV cases diagnosed among the indigenous population of YNAO has reached 76.

Sexual transmission was identified as the main channel of HIV infection among the cases registered in the indigenous population of YNAO, accounting for 86.1% of all cases in this population group. The other main transmission pathway (9.2% cases among the indigenous population) was via intravenous drug use. The share of HIV transmission pathways among the total population of YNAO exhibits a slightly different structure where the prevalent pathway is drug consumption (55.6% of all registered cases), followed by sexually transmitted HIV infection (43.5%), as shown in Figure 8.12 below.

[47] Report on the Status of Public Health and Healthcare in YNAO in 2010. Salekhard, 2011.

[48] The Yamal-Nenets Centre for Prevention and Combating AIDS and Infectious Diseases. HIV prophylaxis among the indigenous population of YNAO. By Dr. L.Yu. Volova.

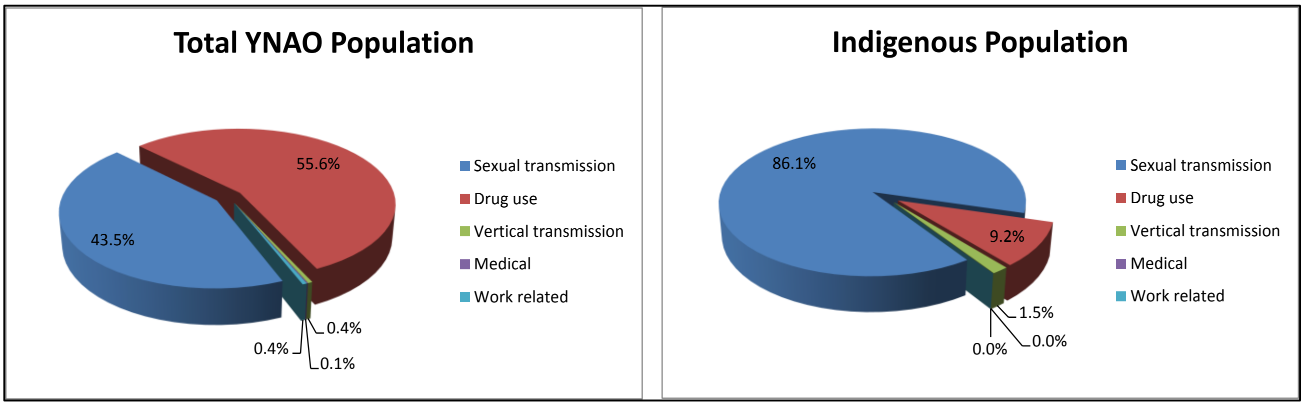

Figure 8.12: HIV Transmission Routes in YNAO, as at 01.07.2012

Source: The Yamal-Nenets Centre for Prevention and Combating AIDS and Infectious Diseases[49]

In 2012, 61.5% of HIV cases in the IPN group were among unemployed people.

HIV-positive cases detected among the IPN in YNAO show the following gender structure (based on the beginning of 2011 data): 11 men including one child and 30 women, i.e. the male-female ratio in detected cases was almost 1:3. In terms of their place of residence, inhabitants of rural settlements represent the significant majority of the HIV-positive indigenous people whereas urban residents constitute the fewer number of cases detected among the IPN group.

The specifics of the way of life and living conditions of the IPN, which includes frequent migrations, early commencement of sex life[50] (16-18 years) and a lack of safe sex practices, result in a high vulnerability of this population group to HIV and other sexually transmitted infections (STI).[51]

The age and gender distribution of HIV cases in the Okrug are shown in Table 8.13.

[49]The Yamal-Nenets Centre for Prevention and Combating AIDS and Infectious Diseases. HIV prophylaxis among the Indigenous Peoples of the North in YNAO. By Dr. L.Yu. Volova. Source: Source: http://www.hivpolicy.ru/upload/File/RelatedFiles/publication/1430/Volova.pdf

[50]A sociological survey conducted by the Yamal-Nenets Centre for Prevention and Combating AIDS and Infectious Diseases among indigenous residents of Nyda settlement, Nadymsky District in 2009 and 2011 showed that the average age of commencing sexually active life was 16-18 years (55.6% of the respondents). Only 13.4% of the respondents in 2009 and 29.7% in 2011 indicated that they resorted to the means of personal protection.

[51]Report on the Status of Public Health and Healthcare in YNAO in 2010. Salekhard, 2011.

Table 8.13: HIV prevalence by gender and age, among registered cases in YNAO

Gender/ age	Total since 1995	Diagnosed in 2011	Diagnosed in 2012	Total since 1995	Diagnosed in 2011	Diagnosed in 2012	Including YNAO residents: Diagnosed in 2011	Including YNAO residents: Diagnosed in 2012
	Absolute number			Percentage of total			Absolute number	
Men	1359	96	94	65.2	53.3	58.4	96	94
Women	725	84	67	34,8	46,7	41,6	84	67
Total cases	2084	180	161	100	100	100	180	161
Infants up to 1 year of age	5	2	0	0.2	1.1	0.0	2	0
1-14 old	4	-	0	0.2	0.0	0.0	-	-
15-19 old	153	5	4	7.3	2.8	2.5	5	4
20-24 old	631	25	18	30.3	13.9	11.2	25	18
25-29 old	570	48	39	27.4	26.7	24.2	48	39
30-39 old	524	68	66	25.1	37.8	41.0	68	66
40-49 old	157	27	31	7.5	15.0	19.3	27	31
50-59 old	34	4	1	1.6	2.2	0.6	4	1
60-69 old	6	1	2	0.3	0.6	1.2	1	2

Source: YNAO's AIDS Centre, 2013

As also shown in Figure 8.13, the greatest number of HIV cases have been registered in the 20-24age group, both among the total population of the Okrug (31.5% of all registered cases) and among the IPN communities (38.5% of HIV cases).

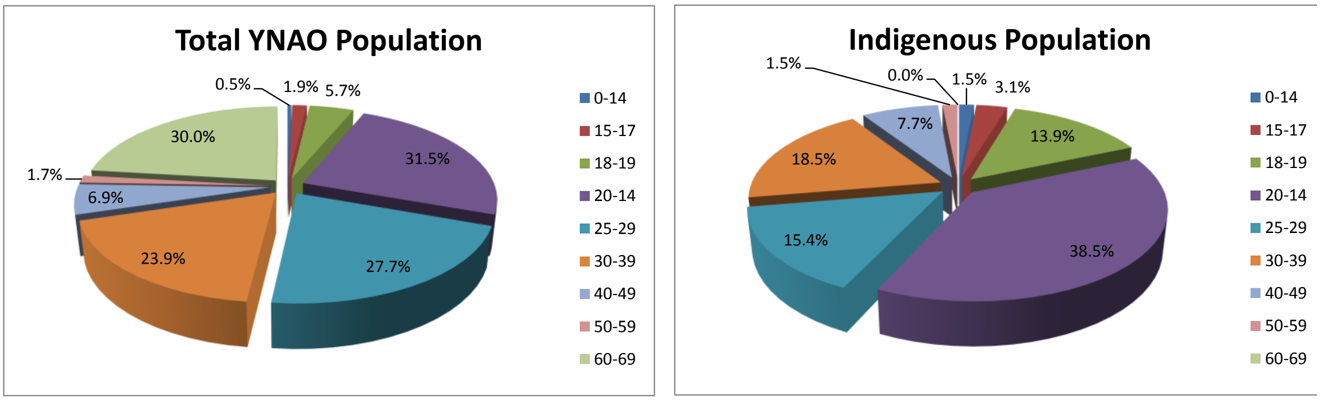

Figure 8.13: Age structure of registered HIV cases in YNAO and among indigenous population, as of 01.07.2012

Source: The Yamal-Nenets Centre for Prevention and Combating AIDS and Infectious Diseases[52]

To combat the HIV problem, a number of programmes are being implemented by the state in YNAO aimed at the prevention of HIV/AIDS infection among the population. In the context of primary preventive measures, the Yamal-Nenets Centre for the Prevention of AIDS and Infection Diseases actively cooperates with the Department of Information Policy and Public Relations of YNAO and shares with the local mass media information materials that are to be used in TV and radio programmes, in articles published in printed mass media. Educators providing social and counselling assistance to school students in the region also receive information support.

A number of programmes are being implemented in the YNAO aimed at the prevention of HIV/AIDS infection among the population. These initiatives include:

- Public educational programmes coordinated through the YNAO Centre for Prevention and Combating AIDS and Infectious Diseases;
- Educational seminars for itinerant nurses and obstetricians at local medical stations working with the indigenous population;
- An action plan for the prevention of HIV, parenteral viral hepatitis and STIs among the indigenous population jointly implemented by the YNAO Department of Public Health, Department for Indigenous Affairs and the Department of Labour and Social Protection.[53]

[52] The Yamal-Nenets Centre for Prevention and Combating AIDS and Infectious Diseases. HIV prophylaxis among the Indigenous Peoples of the North in YNAO. By Dr. L.Yu. Volova. Source: Source: http://www.hivpolicy.ru/upload/File/RelatedFiles/publication/1430/Volova.pdf

[53] YNAO Department of Public Health. Report on the Health and Public Health Status in the Yamal-Nenets Autonomous Okrug in 2010, town of Salekhard, 2011. Published at the information portal of the Department on 08 August 2012.

8.2.2.4 MIGRATION

Population migration played a significant role in demographic changes in YNAO in the 1970s and 1980s. This was largely related to the development of the oil and gas industry and associated sectors. However, in the first decade of the 2000s, despite sizeable inward and outward migration rates, the overall migration balance remained small and as a whole did not have a significant impact on the demographic growth. The growing population trend during that period was primarily attributed to the natural increase described in *"Birth rate* "section above.

Migration data from the YNAO Service of State Statistics (YamalStat) are provided in Table 8.14 below. This shows a general negative (outward) net migration trend between 2006 and 2010.

However, this trend has reversed in recent years. In 2011, a considerable surge in the number of in-migrants was registered – 35,839 persons as compared with the total of 29,590 persons that left the Okrug (i.e. a positive net migration of 6,249). Based on the data available for the first six months of 2012, the positive migration trend remained.

In-migration to YNAO has been both from foreign countries (international migration) and from other regions of the Russian Federation (inter-regional migration), whereas out-migration has been predominantly inter-regional (to other regions of the RF). International migration is the key driving factor for the overall increase in in-migration to the Okrug. The main drivers for in-migration to YNAO are personal and family circumstances as well as a search for employment opportunities. Taking into account the intensive development of oil and gas resources which has been gaining momentum over the past few years, job opportunities in YNAO primarily attract labour migrants from the former Soviet Union countries, thereby accounting for a larger part of international migration to the Okrug.

Another prevailing form of migration is intraregional migration, i.e. population movement from one settlement to another within the boundaries of the Okrug. Taking into account that the production level in some fields has been decreasing and new field developments have tended to be in more northerly locations, the intraregional migration within YNAO is significant. According to local scientists who have examined this aspect using as a case study the adaptation of the gas field workers of the Gazprom Dobycha Nadym Company[54], the intraregional shift-based commuting has a number of potential advantages, including:

- shift workers do not have to travel for considerable distances and their stay in the similar climatic conditions facilitates adaptation;
- rotation periods are normally shorter, in most cases the shift pattern is 14/14 days, which reduces the duration of social isolation and separation from the families;
- the costs associated with the transportation of workforce for longer distances are decreased;
- social situation in the Okrug is improved (lower unemployment rates, lower in-migration from other regions).

[54]See A.I. Popov, S.V. Andronov, A.A. Lobanov "Adaption of Workers of Intraregional Commuting Workforce Crews of Gas Fields", In: Scientific Research Transactions of Yamal-Nenets Autonomous Okrug. Arctic Medicine, Biology and Ecology", Issue 3 (76), Salekhard, 2012.

Another advantage of this type of intra-migration is the potential difference in outlook and behavioural patterns, as workers may take a more long-term, responsible attitude to the local environment.

Migration data are typically collected from the statistical records of the migration agencies, which register incomers at their place of residence and cancel the outgoers' registration. The terms "incomers" and "outgoers" do not describe migration accurately because in practice the same person can change the place of permanent residence several times a year.

In order to account for all persons entering the territory of YNAO and Yamalsky District by any type of transport, i.e. by air, road (including temporary winter roads) and water (during navigation season), the internal affairs and migration authorities conduct comprehensive checks of all in-comers. This is due to the border zone regulations being in force in the Okrug and in the District, which only allows registered residents and visitors with authorised passes to enter the area.

As of September 2012, 71,310 foreigners had been registered by the migration services. It exceeds the amount of foreigners registered during the same period in the previous year by 19.1%. 61,533 foreigners out of this number came to YNAO to work[55].

Table 8.14: Migration in YNAO in 2006-2011 (number of persons)

	2006	2007	2008	2009	2010	2011	2012[56]
In-migration							
Total	**15,383**	**15,422**	**13,685**	**12,282**	**12,921**	**35,839**	**21,607**
From Russia	13,190	13,060	11,450	10,422	11,398	26,228	
From foreign countries							
Total	2,193	2,362	2,235	1,860	1,523	9,611	
CIS[57] states	2,180	2,353	2,228	1,835	1,506	9,388	
Non-CIS countries	13	9	7	25	17	223	
Urban population	13,599	13,646	12,203	11,007	11,576	31,907	
Rural population	1,784	1,776	1,482	1,275	1,345	3,932	
Out-migration							
Total	**15,441**	**16,028**	**17,699**	**14,699**	**17,874**	**29,590**	**20,022**
To other regions of Russia	14,672	15,269	17,048	14,242	17,406	28,849	

[55] Administration of the Federal Migration Service for the Yamal-Nenets Autonomous Okrug. Data taken from the monitoring of migration concerning the employment of the foreign labour power.

[56] Based on first 6 months of year only.

[57] The Commonwealth of Independent States.

Table 8.14: Migration in YNAO in 2006-2011 (number of persons)							
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012[56]**
To foreign countries							
Total	769	759	651	457	468	741	
CIS states	729	734	636	444	444	728	
Non-CIS states	40	25	15	13	24	13	
Urban population	13,597	14,040	15,548	12,875	15,572	25,578	
Rural population	1,844	1,988	2,151	1,824	2,302	4,012	
Net migration, positive or negative (-)							
Total	**-58**	**-606**	**-4,014**	**-2,417**	**-4,953**	**6,249**	**1,585**
Urban population	2	-394	-3,345	-1,868	-3,996	6,329	
Rural population	-60	-212	-669	-549	-957	-80	

Source: Yamalstat

The demographic monitoring data recently reported by the YNAO Government[58] show the gradually growing migration trend. At the same time, although the in-migration to the Okrug was on an increase during January-August 2012, the end-of-year data indicated the overall negative net migration of (-) 1,127 persons.

The Q1 2013 (January-March) data show this being reversed to the migration gain of (+) 1,214 persons, as a result of the following migration structure during this period:

- 12,109 incoming persons;
- 10,895 outgoing persons.

Cross-border labour migration from the former Soviet Union countries is reported to be one of the key driving factors.

The working-age population is the most mobile group (men aged between 16 and 59, and women aged between 16 and 54). As of 2009, the share of the work-age incomers in YNAO was 80.0%, while the share of the work-age outgoers was about 75%.

Despite the extremely challenging living conditions in YNAO, the proportion of the incoming population above the working age is still relatively high, which results in an additional load on the budget of YNAO.

Most migrants come to the region from former Soviet republics, mainly due to the state programme of resettlement of compatriots. Use of rotational working practices (such as shift based work assignments in the oil and gas industry) in YNAO also influences the population structure with the growing numbers of mobile non-resident population as a result. At the same time, the share of

[58] The Analysis of Demographic Monitoring in Yamal-Nenets Autonomous Okrug for Q1 2013. The official web-site of the YNAO Government: http://правительство.янао.рф/region/population/

settled population[59] also slightly increased: from 17% in 2006 to 22% in 2011[60]. However, it should be noted that increasing immigration from the CIS and non-CIS countries and other regions of Russia leads to problems of mutual adaptation, affecting both migrants and the host population.

According to a 2011 survey (see Table 8.15) conducted in the entire Tyumen Oblast[61] (which includes YNAO), about 5% of respondents said that locals and migrants barely communicate with each other. Almost a quarter of respondents (19%) said that their relations are varying, characterised by frequent tensions and occasional conflicts escalating to fights. At the same time, more than half of the respondents (53%) noted that relations between incomers and the local residents are stable and good, or at least normal. In YNAO, migrants and the local inhabitants have consistent views on these relations, and statistically, their opinions do not differ significantly from those of the overall Tyumen Oblast.

Table 8.15: Assessment of Relations Between Local Residents and the Incomers in YNAO (in% from the total amount of respondents[62], 2011)

	Local residents	Migrants*
Relations are stable and good	16	16
In general, relations are normal but sometimes there are misunderstandings	30	35
Relations are unstable, tensions are frequent	15	9
Relations are bad, fights are frequent, police has to interfere	12	8
Local residents and migrants almost never communicate	6	6
Hard to answer, refuse to answer	21	25

**In this research, the group of migrants comprised all incomers who came to the region voluntarily from another region of the RF or a CIS state, forced migrants from another region of the RF or a CIS state, and people who came temporarily from another country and had been living in the settlement for less than 5 years.*[63]

[59] In this particular case, the share of settled population is interpreted as a proportion of people of local origin (born in the Okrug) in the overall population.

[60] A.N. Tarasova, I.F. Pecherkina. Specificity of the Economic Behaviour of Migrants and Their Involvement in the Economy of the Region. Tyumen State University. The surveys were conducted by the Laboratory of Regional Development Monitoring (Tyumen State University) in 2006, 2009 and 2011 using a standard methodology «Socio-cultural profile of the region». In total, 4000 persons were interviewed as part of the survey in 2006, 4510 persons in 2009, and 5567 people in 2011.

[61] Tyumen Region is the larger administrative unit that comprises Yamal-Nenets Autonomous Okrug (YNAO) and Khanty-Mansi Autonomous Region.

[62] The total amount of respondents 5,567 people in the whole Tyumen Region.

[63] A.N. Tarasova, I.F. Pecherkina. Specificity of the Economic Behaviour of Migrants and Their Involvement in the Economy of the Region. Tyumen State University. Published in: Taxes. Investments. Capital No.4-6 of 25.12.2012 page 053. See also: http://law.admtyumen.ru/

It is reported that at present the YNAO government officials lobby for more rigorous regulations on visits to the Okrug which is the controlled border area. In particular, it is proposed to introduce further amendments to the Federal Law «On State Border of the Russian Federation" and to the country's Code of Administrative Offences. The YNAO parliament officials propose that any persons found to be in breach of the strict rules for entry and temporary stay within the Okrug's controlled border zone be expelled at the expense of the violators. Another proposal in circulation suggests that no travel tickets should be sold on any type of Yamal-bound transport without the supporting documents granting a visitor the right to enter the border area. These proposals appear to have been drafted in response to the increased appeals from YNAO residents for stricter regulations to this effect.[64]

8.2.3 KEY DEMOGRAPHICS AND PUBLIC HEALTH INDICATORS IN YAMALSKY DISTRICT

Yamalsky District comprises 148,727 km² (over 19% of the Okrug's entire area), including the Yamal Peninsula, the islands of Bely, Litke, Sharapovy Koshki, and the small islands in the Ob' River floodplain. It stretches for 780 km in the north-south direction and 220 km from west to east. The District is one of the largest by area size among the other municipalities of YNAO, second only to the neighbouring Tazovsky District. The settlements in the District are located at a considerable distance from each other.

Yar-Sale village[65] is the administrative centre of Yamalsky District. It is located at the bank of the Malaya Yumba River, about 189 km away from Salekhard and 460 km to the south of the Yamal LNG Project licence area (see Figure 8.1).

The data on the total population of Yamalsky District differ in various sources:

- ARPC-2010 data reports that the population in 2010 was 16,310.
- Yamalstat data reports that the population in January 2012 was 16,352(see also Table 8.16).
- District Administration data [66] reports that the population in January 2011 was 17,235.

[64]"Yamal government officials lobby for stricter regulations on visiting and staying in the strategic region". 21/02/2013 Source: http://yanao.vks-express.ru/novosti/yamalskie-deputaty-xotyat-uzhestochit-pravila-prebyvaniya-v-strategicheskom-regione/

[65]In the Nenets language, "Yar-Sale" means "sandy cape". Yar-Sale was founded in 1927, initially as a factoria (trading post) and gradually grew to become a district centre. At present, Yar-Sale has the status of a rural settlement (municipality) with the total area of about 460 ha. See also: Official website of the Administration of Yar-Sale Municipality: http://yar-sale.ru/

[66]Yamalsky District Municipal Administration. Report on Socio-Economic Situation in Yamalsky District. Yar-Sale, 2011.

Table 8.16: Population size of Yamalsky District in 2011-2012, compared with YNAO

	As at 01/01/2011			As at 01/01/2012		
	Total	*Including*		Total	*Including*	
		urban	rural		urban	rural
YNAO	524,925	445,122	79,803	536,558	455,887	80,671
Yamalsky District	16,365	-	16,365	16,352		16,352

Source: YNAO Department of Public Health, 2012

The differences in the available statistical information may be accounted for by the fact that a significant proportion of the District's population is represented by the nomadic indigenous communities in migration, which may affect the aggregate data. 11,383 people out of the total population (about 70%) belong to the Indigenous Peoples of the North (IPN); of whom circa 5,600-6,000 people (over 50% of the indigenous population of Yamalsky District) lead a nomadic way of life. The total size of the nomadic population has shown a tendency for growth in recent decades:

- 1966 3,885 nomadic people
- 1997 5,057 nomadic people
- 2009 5,605 nomadic people

Overall, the total population of the IPN in Yamalsky District increased more than two-fold during the period of 1959-2008[67]. Approximately 51-53% of the indigenous population of Yamalsky District are nomadic; this is the second highest proportion in Russia. The highest proportion is registered in the neighbouring Tazovsky District, where over 80% of the indigenous population are nomadic[68].

At present, out of the total population of 6,486 in Yar-Sale more than 4,000 people (62%) belong to the IPN.

Yamalsky District is subdivided into six rural settlements (municipalities), which include 14 rural communities. The District comprises the following main rural populated areas[69]:

- Yar Sale Rural Settlement (6,928 people) including the district centre of Yar-Sale village and Synay-Sale settlement (442 people);
- Mys-Kamenny Rural Settlement (1,716 people) including Mys Kamenny village (1,653) and Yaptik-Sale settlement (63 people),
- Novy Port village (1,780 people),

[67]Source: The RF Ministry for Regional Development, minregion.ru/upload/10_dsp/dosr/proj-yanao.doc

[68]T.N. Vasilkova, A.V. Evay, E.P. Martynova, N.I. Novikova. The Indigenous Small-Numbered Peoples and Industrial Development of the Arctic. Ethnological Monitoring in the Yamal-Nenets Autonomous Okrug. Federal State Institution Scientific Centre of Prophylactic and Clinical Nutrition. Tyumen Scientific Centre, Siberian Branch of the Russian Academy of Medical Sciences. Ethnology and Anthropology Institute of the Russian Academy of Sciences, OOO "Ethnoconsulting", Moscow–Shadrinsk 2011.

[69]Rural populated area is a type of settlement (e.g. a village), the population of which is primarily employed in the agricultural sector, agro-industry, or engaged in traditional economic activities of indigenous peoples. Source: Law No.42-ZAO "On the Administrative-Territorial Division of the Yamal-Nenets Autonomous Okrug".

- Panaevsk village (2,265 people)
- Salemal village (970 people),
- Seyakha village (2,605 people),
- Tambey village (34 people),
- Ports-Yakha village (12 people).[70]

The villages of Tambey and Ports-Yakha are part of the so-called *inter-settlement territory* which is located outside the formal boundaries of established settlements. Typically, these inter-settlement territories are used by the indigenous nomadic population of the tundra on their traditional migration paths (in Russian – "*kaslaniye"*[71]). Inter-settlement territories fall within the jurisdiction of a municipal district.

According to currently available information, the inter-settlement territory in the area of Tambey village is used on a seasonal basis by 630 nomadic people (118 households) migrating in the tundra. According to ARPC-2010, the permanent population of Tambey consists of 34 people, including 20 men and 14 women[72].Yamalsky District does not have any population centres that could be categorised by the official statistics as "urban"[73]and hence the whole population living in the District is considered to be rural (as also shown in Table 8.16 above).

Of special note is the role of "*factorias*" (or trading posts) in the specific living conditions of the North. Historically, factorias were known among the Nenets as "wise shops". Inhabitants of remote areas of the tundra used them to procure the foodstuffs and other staple necessities in exchange for fur and meat. Such places were called "wise shops" primarily because there people could obtain information about the events taking place in the district, in the region or in the country.

"Factoria" is now used as the name for the local procurement and supply points/stations, which are usually located in the remote districts of northern Russia. They represent locally important hubs that enable the indigenous population to meet, exchange goods and receive credits. Factorias are still an important source of interaction and communication, distribution of printed mass media, some types of medical aid; it is also a place for meetings of the indigenous people who migrate in the remote areas of the tundra.

In Yamalsky District, Yar-Sale factoria was first opened approximately in 1926, and by the 1930's-40's a whole chain of other factorias had been established: Seyakha, Drovyanaya, Tambey, Yada, Ports-Yakha, Tarko-Sale, Ust-Yuribey, Mordy-Yakha and others.

Nevertheless, according to the information obtained from the questionnaires completed by representatives of the IPN in December 2012 within the Project licence area (see Section 8.1), trading stations are not visited frequently. Respondents reported that they visit a trading station on

[70] Based on the results of the All-Russia Population Census 2010, Yamalstat.

[71] In the Russian language, "kaslaniye" denotes the process of transhumance involving the movement of reindeer herds and the associated migration of herders together with their camps.

[72] Yamalstat. Results of the All-Russia Population Census 2010: amount of population and location of population in the Yamal-Nenets Autonomous Okrug.

[73] According to the Law "On the Administrative-Territorial Division of the Yamal-Nenets Autonomous Okrug", the settlement may be classified as "urban" if its population is occupied primarily in the industry, commerce and other economic sectors, which are characteristic for urban settlements. Settlements with the population of at least 12 thousand people may be categorised as "towns".

average from one to ten times per year mainly to purchase food and essential goods. The trading stations mentioned among those visited by the respondents included Tambey (12 respondents), Yakhady-Yakha (5 respondents), Sabetta (3 respondents), and 'Ilebts' (1 respondent). In relation to the latter, it is understood that this is one of the factorias owned and operated by the Ilebts commune, most likely either the Yakhady-Yakha trading station or the former Sabetta factoria which has now been relocated (see also section 8.2.4.1 below).

The answers given by the respondents suggest that the relative infrequency of visits to trading stations is due to the self-reliance of their traditional lifestyle (predominantly nomadic reindeer breeding, hunting and fishing), which reduces the need for frequent visits at trading stations and permanent settlements.

The total population of Yamalsky District has increased over four-fold in the last 80 years; however this figure is six times lower than the population growth in YNAO as a whole for the same period, which reflects the remoteness of Yamalsky District from the main centres of transportation and industry of the region. The population statistics for Yamalsky District are summarised in Table 8.17. These show an overall minor net reduction in the population during 2011, primarily on account of out-migration.

Table 8.17: Yamalsky District Population Statistics, 2010-2011

	As at 01/01/2010	As at 01/01/2011
Births	425	436
Birth rate (per 1,000 people)	24.7	25.9
Deaths	170	178
Including infants under 1 year	15	29
Death rate (per 1,000 people)	10.3	10.5
Natural population increase	+255	+258
Inward migration	232	228
Outward migration	214	257
Mechanical growth of population (in-migration vs. out-migration)	(+)18	(-)29

Source: Report on Socio-Economic Situation in Yamalsky District, 2011.

As shown in Table 8.17, a small out-migration from the District was evident in 2011.The total number of foreign citizens registered in Yamalsky District as at 31/12/2010 was 1,328 persons, as compared with 1,807 foreigners in 2009 (i.e. a 26.5% decrease).

The rural Yamalsky District, with a high share of the indigenous peoples, has the highest child mortality rate[74] in YNAO– more than 35‰ in 2003-2007. Between 1986-1992, the average child mortality rate was 26.3‰, and the number of newborns was higher than in 2003-2007.The main reasons of infant mortality among the indigenous peoples of Yamalsky District in 2004 were

[74]Per 1,000 live births.

respiratory diseases (42% of all death cases), congenital anomalies (33%), accidents and poisonings (25%); infections, congenital development defects had the same share of 10% of all deaths.

The official current data on infant mortality is publicly available mainly at the Okrug level (see section 8.2.2), whereas the breakdown of this indicator by District is not available. However, Yamal regional television reports that the largest number of cases is registered in Yamalsky and Tazovsky Districts, and in particular in tundra areas, with acute pneumonia being the primary cause of infant deaths.[75]

The high infant mortality rate in Yamalsky District has been also confirmed by the findings of the Arctic Research Centre[76]. According to data they obtain for 2011-2012, the rate was as high as 60.2 per 1,000 live births, i.e. five times higher than the average rate in the Okrug.

Key issues affecting infant mortality rates include difficulties with accessing medical aid in remote locations of the tundra and with reaching nomadic families that are constantly on the move. Reducing child mortality rates, especially among IPN, therefore remains an important social and medical challenge. The Okrug's public healthcare authorities consider a number of measures to improve the situation, including the development and implementation of satellite tracking system allowing ready location of nomadic families, providing the latter with the means of communication and the local hospitals with all-terrain vehicles[77].

Yamalsky District is among the few districts in YNAO where the birth rate of the indigenous population is higher (two-fold) than the death rate. The highest birth rate (over 20 per 1000 people) is typically registered in the rural areas. Overall, the birth rate in Yamalsky District is more than twice the national average[78].

According to the Administration of Yamalsky District, a substantial modernisation of the public health services in the District is planned during 2013.In particular, this will involve the provision of satellite communications to nomadic families and the establishment of new medical and obstetrics units in the Tambey and Ports-Yakha Factorias. Setting up mobile medical units based on all-terrain vehicles is also under consideration. It is anticipated that these measures will contribute to the improved accessibility and availability of medical aid for nomadic population and a reduction in infant mortality[79].

According to the questionnaire survey conducted in December 2012 (section 8.1), representatives of the indigenous peoples migrating on a regular basis in the Seyakha tundra currently have limited

[75] Infant mortality indicators in Yamal exceed the overall Russia's levels by 1.5 times. News – 18 April 2012. YNAO's State Television Radio Broadcasting Company "Yamal Region". Source: http://yamal-region.tv/news/2229/

[76] See E.V. Agbalyan, E.V. Shinkaruk, N.V. Kasatskaya "Some Approaches to Assessment of Medico-environmental Situation in Yamal-Nenets Autonomous Okrug", GKU YaNAO "Arctic Research Centre", Nadym

[77] Infant mortality indicators in Yamal exceed the overall Russia's levels by 1.5 times. News – 18 April 2012. YNAO's State Television Radio Broadcasting Company "Yamal Region". Source: http://yamal-region.tv/news/2229/

[78] Report on activities of the Head of Yamalsky Municipal District in 2012. Source: http://ямальскийрайон.рф/index.php?option=com_content&view=article&id=1016&Itemid=94

[79] Source: http://www.yamal.org/

or no access to medical services except for hospitals located in settlements (e.g. Seyakha) and the medical and obstetric stations available only at some of the trading stations (e.g. the Yakhady-Yakha factoria).

In general, the natural population dynamics in Yamalsky District are largely determined by the following factors:

- Absence of urban population;
- High proportion of the IPN in the total population;
- Higher birth rate among the indigenous peoples;
- High child mortality and mortality rates among indigenous people.

8.2.4 YAMAL LNG LICENCE AREA AND AREA OF INFLUENCE

The following settlements are included in the Yamal LNG direct Area of Influence[80] (see also Figure 8.1):

- Within the licence area:
    - The Sabetta worker accommodation camp for shift-based personnel, located circa 6 km to the south of the main LNG site (the camp is a Project facility and will be used both during the construction and operational phases);
    - The Project's accommodation facility (camp) for the LNG operations personnel, to be situated in close proximity and westward of the main LNG site, about 1200m from the boundary of the LNG site;
    - A number of temporary mobile camps set up by some of the construction contractors accommodating up to 1,800 workers in total; and
    - Tambey village/factoria, located at 30-km distance to the north of the main LNG site facilities.

- Outside the Project licence area:
    - Village Seyakha, some 90 km to the south of the licence area boundary and around 120km from the main LNG site. The potentially impacted receptors are mainly nomadic reindeer herders that use the licence area periodically as part of their traditional migrations but who are formally registered in Seyakha for their domicile.

In the past and before the Project realisation, another small village named Drovyanoy existed within the administrative borders of Yamalsky District, approximately 100 km to the north of the Project licence area. Since the local population stopped visiting the village on a regular basis, it was officially abolished by the corresponding legal act of YNAO in 2006.

Detailed descriptions of the above settlements are given below.

8.2.4.1 SABETTA WORKERS ACCOMMODATION CAMP

The Sabetta workers' accommodation camp is located within the Yamal LNG licence area, 6 km to the south of the LNG Plant site. The workers' camp is part of the vital infrastructure of the South

[80] More detailed description of the Project direct and indirect AoI can be found in Chapter 4.

Tambey gas condensate field and has been set up to accommodate rotational personnel engaged in the field development, including construction workers involved in the Project's preparatory works.

At present, the Sabetta camp accommodates approximately 1,200 rotation-based personnel; there are no permanent or non-workforce residents in the camp. Chartered helicopters are the only means of personnel transport to the camp, which ensures all-year-round connection with the administrative centre at Salekhard and also with the city of Novy Urengoy, which is an important regional transportation hub. During the shipping period from late May- early June through mid-October, navigation is possible via the Gulf of Ob'. Road transport can be used during the cold season (November-April), which allows construction of temporary winter roads [81] by snow compaction and levelling. The use of ice crossings is also possible on rivers and other water bodies that freeze during the winter, with the ice thickness allowing temporary routes of up to 3-4 km in length to be laid. Yamal LNG Project does not utilise the shipping and ice-roads for personnel transport to the site.

The location of the present Sabetta camp was previously occupied by a factoria[82] used by reindeer herders, mostly the local communities and families migrating in the Seyakha tundra (about 20-30 families). Yamal LNG has carried out negotiations with representatives of the local "Ilebts" commune that was using the Sabetta Factoria in the past in order to establish the most suitable option for relocation of this trading station. Based on the agreement reached with the "Ilebts" commune and consent from the commune leadership obtained in December 2011, the relocation of the Sabetta Factoria has been arranged to two separate sites: at the distances of 20 km south and 35 km north-west from the original site, respectively. The factoria was relocated in February 2012. The sites are still within the Project licence area. The southern site of the relocated factoria is situated in proximity to the coast, in the area rich with fish, and is presently manned by one person located there on a permanent basis. The north-western site operates as a seasonal factoria and does not include permanent residential areas. The Ilebts commune is free to access the relocated factoria facilities as there are no Project assets or related activities in the vicinity of the sites that may prevent the operations of both factoria sites.

Out of 38 representatives of the indigenous population interviewed in December 2012 (see Section 8.1), only three people mentioned that they used the trading station of Sabetta to purchase goods and they do so at a frequency of 2 to 3 times per year. One of the 38 respondents reported that the Sabetta factoria was used as a possible place to receive medical services.

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[81] In general, winter roads and crossings of the regional importance in Yamal Peninsula allow the use of heavy-load vehicles (up to 30 tonnes) and tracked transport (up to 45 tonnes). The ice crossings via the main rivers withstand similar load – up to 30 tonnes. Winter roads of the Okrug's and district's importance allow the movement of all types of vehicles with the tonnage of up to 25 t. The length of winter roads can vary from tens to hundreds of kilometres. As a rule, the winter roads are equipped with check points to ensure traffic safety and to enable the count of vehicles on these seasonal routes. The use of four-wheel drive vehicles is recommended for winter roads, as well as the availability of survival reserves – extra fuel, food and water – in case of an emergency. With the seasonal change of weather conditions (typically by the end of April – beginning of May, with the air temperature reaching above zero C), winter roads are closed. Source: http://www.yamal.org

[82] According to the available information, Sabetta trading station (factoria) was set up in the early 1990's in place of a former geological exploration camp (now replaced by Sabetta shift workers' camp), which used to provide all the necessary infrastructure (utilities and services). Unlike Tambey trading station, Sabetta was not a traditional "factoria" (trading outpost).

8.2.4.2 TAMBEY FACTORIA

The Tambey Factoria (71°28'31"N 71°48'43"E) is the nearest settlement to the Project facilities that is not related to the accommodation of Project personnel. It is a permanent settlement located on the coast of the Gulf of Ob, inside the northern boundary of Yamal LNG licence area, some 30 km to the north from the main Project facilities. Tambey Factoria has the status of a village[83] and is primarily a transitory transfer point for nomadic herders.

Tambey Factoria is a local hub for the nomadic population of the tundra and it mainly serves brigades of reindeer herders, as well as individual herders and hunters who visit it on a seasonal basis to procure foodstuffs and staple commodities. The factoria provides facilities for the primary treatment and processing of reindeer products (meat, velvet antlers[84], antlers, hides) as well as enabling access to communications and local printed media. The facilities available at the Tambey Factoria include:

- a post office,
- a boiler plant (not currently operational);
- a convenience shop;
- a corral (a stock pen) for reindeer and a slaughter house (which is not properly equipped at present and does not comply with the veterinary-sanitary standards);
- an obsolete diesel power generator;
- an obsolete sauna currently not in use;
- a dismantled camp facility;
- some snowmobiles;
- a paramedical unit; and
- a radio station.

The Factoria is also a common place for seasonal gatherings of the nomadic population of the tundra and medical check-ups.

According to current data (the results of the ARPC-2010), the permanent population of Tambey consists of 34 people, including 20 men and 14 women[85].

Inter-settlement territories around the Factoria are widely used by nomadic indigenous reindeer herders, hunters and fishermen (this information was also confirmed by the results of questionnaire interviews with indigenous people in December, 2012).

The total nomadic population using Tambey Factoria and its surroundings numbers about 600 people (approximately 118 households); 99.5% of whom are Nenets reindeer herders. At present, Yamal LNG confirms the data on the nomadic population using Tambey Factoria on a seasonal basis, i.e. mostly twice a year (during the spring and late autumn migrations). According to information obtained in December 2012, Tambey Factoria is used by six local communities, four of

[83] Typically, the word “village” is used for a rural settlement with several (or several dozens) of individual houses.

[84] Velvet antlers are traditionally derived from male deer antlers during the early stage when the antlers are covered in soft delicate fur of velvety texture. Velvet antler is a well-known medicinal extract that has been traditionally used for a variety of different applications, including as a performance and endurance enhancer and immunity booster.

[85] Yamalstat. Results of the All-Russia Population Census 2010: amount of population and location of population in the Yamal-Nenets Autonomous Okrug.

which are based in the area north of the Sabetta camp, and the two other communities migrate west of Sabetta. The composition of these communities is as follows:

- *Tusyada* community – three nomadic families, 12 members of which are part of the community, 1200 reindeer;
- *Maretya* community – four nomadic families with a total of 16 people, six of whom are the community members, 800 reindeer;
- *Khabey-Yakha* community – three families with a total of 10 people, six of whom are the community members, 850 reindeer;
- *Ilebts* community – more than 200 families of which over 100 are reindeer herders.
- *Tetta* community - two families with a total of 11 people, four of whom are community members, 1000 reindeer;
- *Okotetto* community – three families with a total of 20 people, five of whom are community members, 700 reindeer.

A visit undertaken to Tambey Factoria in December 2012 as part of Yamal LNG's local engagement showed that there are currently five families occupying eight functional flats in the houses (mainly wooden) at this factoria. There are 14 obsolete (also wooden) houses which are not in use due to their poor condition.

However, different information was provided verbally by a researcher/representative of the YNAO "Arctic Research Centre" (Salekhard) in the course of an oral discussion as part of the baseline preparation.[86] According to the researcher, only one family presently resides in Tambey Factoria on a permanent basis, and another 5 to 7 families use it as a trading hub during the summer season. The researcher also indicated that due to overgrazing of the pastures surrounding this trading station, reindeer herders typically limit their stay to short intervals in summer; and they also visit this area for summer fishing.

The major land user in the area is the Municipal Reindeer Breeding Enterprise "Yamalskoye" (MOP Yamalskoye) which employs circa 100 staff and has a 7,300-strong herd. In addition to its main specialisation in reindeer breeding and related products, the enterprise also produces bread, makes clothing and fur items, provides services in veterinary aid, machinery repair and maintenance and is engaged in fisheries and gathering activities (nuts, wild berries).

8.2.4.3 SEYAKHA VILLAGE

The rural settlement (village) of Seyakha (70°10'00''N 72°30'30''E) is located approximately 90km to the south of the Yamal LNG licence area and 120km from the Sabetta worker accommodation camp. Seyakha[87] village (known variations of the name include '*Syoakha*' or '*Se-Yakha*') is part of the administrative structure of Yamalsky District. Seyakha village was founded in the 1930's in the central part of Yamal Peninsula, on the bank of the Seyakha River near its confluence with the Gulf of Ob. Nenets represent a large part of the village population. They are traditionally engaged in reindeer herding, hunting and fishing. Permanent settlements appeared within the Seyakha Rural

[86] An oral discussion with the expert was held in February 2013.

[87] Name "*Seyakha*" (based on the name of the local river) can be translated from the Nenets language as "river throat", most likely due to the settlement's distinct location at the river confluence with the Gulf of Ob.

Administration only in the 1930's, when reindeer breeding cooperatives began to appear and merge with factorias.

According to the official data, the total population of Seyakha village in 2010 was 2,605, including 2,000 indigenous people (i.e. about 77% of the total population of the village). The vast majority of the indigenous population (99.6%) are Nenets and 0.4% are Khantys. Similar to the rest of Yamalsky District, the size of the Seyakha population stabilised in late 1990's and even began to grow.

The survey conducted among the IPN representatives in December 2012 (see Section 8.1) indicates that Seyakha is a key settlement in the area with regard to medical services, educational and cultural facilities, services, and other infrastructure amenities. Most of the respondents are registered as residents in Seyakha, some of them own private accommodation (rooms/flats/houses) used during their occasional stays in the settlement in rest periods between migrations. The frequency of stays in Seyakha is similar to the periodicity of their visits to factorias, i.e. one to ten times per year.

8.2.4.4 TAZOVSKY DISTRICT

The neighbouring Tazovsky District is situated on the eastern side of the Gulf of Ob (see Figure 8.2), and is therefore in a relatively close proximity to Project activities in the Gulf of Ob conducted as part of developing the seaport and shipping channel (see also Chapter 4). Tazovsky village is the administrative centre of the Tazovsky District and is located in the south of the District, some 200 km to the north of the Arctic Circle (see Figure 8.2). As of 2010, the population of Tazovsky District was 7,544 including 7,300 IPN. A significant proportion of the indigenous peoples' communities is involved in reindeer herding and migrate all year round.

8.2.5 VULNERABLE GROUPS

Indigenous peoples represent almost 70% of the total population of Yamalsky District. In addition, over 50% of the indigenous population of the District are involved in traditional activities linked with a nomadic way of life. This population therefore constitutes the most vulnerable group due to the dependence of their livelihoods on the specific natural habitat and natural resources.

8.2.5.1 THE INDIGENOUS SMALL-NUMBERED PEOPLES OF THE NORTH

According to available estimates, 40 to 60 small-numbered ethnic groups live in the harsh climatic conditions of northern Russia. The official status of the "indigenous small-numbered peoples of the North, Siberia and the Far East" is defined in the law of the Russian Federation which guarantees to the native inhabitants of the region protection of their collective rights, traditional way of life, culture and traditional habitats[88]. For the purposes of this chapter, this category of the indigenous population is abbreviated as the Indigenous Peoples of the North (IPN).

[88]Federal Law No.82-FZ of 30 April 1999 "On Guarantees of Rights of the Indigenous Small-Numbered Peoples of the Russian Federation" (amended and revised).
Federal Law No.104-FZ of 20 July 2000 "On the General Principles for the Organisation of Obshchiny (communities) of the Indigenous Small-Numbered Peoples of the North, Siberia and the Far East of the Russian Federation" (amended and revised).

The Russian law defines these ethnic groups as "indigenous small-numbered peoples" who live in areas traditionally inhabited by their ancestors, adhere to their traditional way of life, identify themselves as distinct ethnic communities, and are less than 50,000 in number in Russia. The key characteristics of the IPN are their preservation and sustenance of traditional livelihoods and forms of economic activity, such as reindeer herding, hunting, fishing and gathering. The fact that these peoples have not established class industrial societies influences all aspects of their social and cultural life, including a kin-based structure of the society and ancient forms of religion[89].

YNAO is the historical homeland to the several IPN, primarily to the Nenets, the Khantys and the Selkups. An introductory description of these peoples is provided below.

Nenets

The Nenets are one of the largest Samoyedic peoples. It is the most numerous peoples among the IPN. According to their economic activity and culture, the modern Nenets can be divided into two main groups. The first, main group (90%) includes the Tundra Nenets whose main occupation and source of livelihood is reindeer breeding and herding. The Tundra Nenets have spread to the northernmost regions of Yamal Peninsula, and now constitute the majority of the native population of YNAO. Prolonged seasonal migrations are characteristic of the Tundra Nenets' way of life. This group is also predominant in the Project Area of Influence.

The second group, the Forest Nenets, reside in the taiga areas to the south of Yamal Peninsula in the Ob-Yenisei watershed, mainly along the Pur and Taz Rivers. Being small-numbered, the Forest Nenets population mainly resides in Purovsky District in the southern part of YNAO. Their main occupation is migratory reindeer herding, hunting and fishing[90]. The size of reindeer herds kept by the Forest Nenets tends to be smaller as compared with those bred by the Tundra Nenets (from a few dozen to a few hundred head as compared with some thousand head of reindeer typically owned by the Tundra Nenets), with semi-free ranging that implies the use of wooden corrals and smoky fires to protect animals from mosquitoes and other insects[91].

Historically, reindeer herding has always been the major occupation of the Nenets people. Long seasonal migrations, all-year-round grazing of animals under the supervision of herders and their herding dogs, and the usage of reindeer-drawn sledges (*narty*) are the typical features of this activity, especially for the Tundra Nenets.

In the winter, reindeer herders stay at the border of the forest zone, and they spend summer in the vicinity of the sea coast. The main triggering factor for migration (*kaslaniye*) between the pastures is the depletion of lichen which is the main forage source for reindeer. Herders and their families migrate together with the reindeer carrying their portable dwellings (*chums*) and household items.

[89] R.V. Sulyandziga, D.A. Kudryashova, P.V. Sulyandziga. "Indigenous Small-Numbered Peoples of the North, Siberia and the Far East of the Russian Federation. Overview of the Current Status", Moscow, 2003.

[90] R.V. Sulyandziga, D.A. Kudryashova, P.V. Sulyandziga. "Indigenous Small-Numbered Peoples of the North, Siberia and the Far East of the Russian Federation. Overview of the Current Status", Moscow, 2003..

[91] To create a protective smoke curtain herders make fires from four sides of the herd, gradually covering the fires with earth and turf. See also: "The Nenets Reindeer Breeding in XX – beginning of XXI century". By Yu.N. Kvashnin. YNAO Department for the Indigenous Peoples of the North. Tyumen-Salekhard:2009.

The migrations entail short camping stays on the route (with an average duration of 4 to 6 days) which require assembly and subsequent dismantling of portable dwellings (chums) as well as temporary corralling of the reindeer. Typically, the locations for such short stays (camping sites) are selected in habitual places traditionally used by a certain family or a kin. Migration routes also follow the traditionally established patterns and known paths. Largely, the only aspect that may be subject to variation is duration and a timeframe of the migration depending on the weather conditions and the state of pastures.[92]

Nenets are also involved in fishing and hunting of fur animals and ungulates. Along with the traditional occupations, cage-based fur farming and domestic cattle breeding have also become wide-spread. Traditionally, women process skins of reindeer and fur animals, make clothes, bags and covers for the *chum*.

Religious beliefs of the Nenets people are based on shamanistic and animistic[93] concepts. They used to erect idols in the form of anthropomorphic figures in sacred places, such as stones, rocks, groves.

Khanty

The Khanty are an indigenous people of Western Siberia. In the territory of YNAO, most Khantys live in the Shuryshkarskiy and Priuralskiy districts (see Figure 8.2). The Khanty are also known in scientific literature as *Ob Ugrians*. The Khanty people emerged from the culture of ancient indigenous Uralic tribes, whose main occupations were hunting and fishing. Traditionally, Khantys have been semi-nomadic hunters and fishermen. In addition, the northern Khanty practise reindeer herding, whereas cattle breeding is popular in the south. Hunters and fishermen use season-specific settlements/camps and dwellings, which are different for the winter and summer periods.

From the17th to 19th centuries, the Khanty population increased almost threefold. Today, they represent one of the largest populations among the IPN.

Selkup

The Selkup are an indigenous people of the Samoyedic language group in Western Siberia. Some Selkups live in the Krasnoselkupskiy District of YNAO (see Figure 8.2), and also in the Tomsk Oblast. Today, the total Selkup population in Russia is approximately 4,000 people. Historically, the Selkups are subdivided into two isolated territorial groups (northern and southern).

For all Selkups, the main social units are neighbourhood-based communities, which include representatives of different ethnic territorial groups without kin relationships.

Selkups practise different traditional economic activities, with hunting and fishing being their main occupations. The Northern Selkups also practise reindeer herding in the taiga areas. They have relatively small reindeer herds and relatively short migration routes.

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[92] "Reindeer breeders in Yamal: social inequality amid the active industrial development of the region". By E.P. Martynova. Ethnopanorama Journal, No. 3-4 (29), 2011. pp. 96-100.

[93] Animism - belief in innumerable spiritual beings concerned with human affairs and capable of helping or harming human interests. Animism attributes importance to categories of supernatural beings whose individual members are attached to particular places and persons or resident in particular creatures and are autonomous in their dealings. Source: Encyclopaedia Britannica

8.2.5.2 MAIN DEMOGRAPHIC CHARACTERISTICS OF THE INDIGENOUS PEOPLES IN YNAO

YNAO is the homeland for 22% of the total number of the IPN in the Russian Federation. As of 1st January 2011, the indigenous population of YNAO totalled 37,125 (against 36,800 on 1st January 2010).This represents approximately 7% of the total population of YNAO and outnumbers the level of 1959 by more than 78%.The proportion of IPN in the overall population is relatively high in YNAO compared to other arctic and subarctic regions of Russia.

An overview of the main social indicators for the YNAO IPN population is provided in Table 8.18 (based on the available statistical data as of the beginning of 2010).

Table 8.18: Key indicators of social and economic development of the indigenous small-numbered peoples of the North in YNAO

Indicators	2010
Rural population of IPN living in YNAO, thousand persons	36.2*
Population of IPN living in YNAO leading nomadic way of life, thousands persons	14.9
Population of YNAO systematically practising traditional national sports[94], persons (including women)	1,050 (100)
Average life expectancy, years	51.5(estimated data)
Average monthly salary of people occupied in traditional types of economic activity, thousands of RUR	13.5
Share of the IPN living in YNAO with the income below the subsistence level, %	53 (estimated data)
Level of primary disease incidence[95] among the IPN living in YNAO, per 1,000 of people	1 100 (estimated data)
Proportion of the IPN living in YNAO speaking their native language, %	83%
Number of the IPN communities living in YNAO	67

**Note: According to the verified data of 2011, the total population is 37,125 people.*
Source: M.Sh. Adbrakhmanov, 2011[96].

The indigenous peoples living in YNAO speak their native languages along with Russian, which is spoken by most of the native inhabitants. According to the data of Rosstat/All-Russia Population

[94] Races on reindeer-led sledges, lasso throwing and axe throwing, jumps over sledges, rope pulling etc.

[95] Primary disease incidence (morbidity) – a number of diseases diagnosed and registered for the first time in person's life in the course of one year. The statistics takes into account all acute diseases and chronic diseases (diagnosed for the first time) based on a person's first admission to a medical facility, except for relapses of chronic pathology manifested during a year.

[96] Formation of Labour Potential among the Youth of the Northern Region. By M.Sh. Adbrakhmanov, Salekhard:2011. pp.70-71.

Census of 2010, 26,022 people out of 29,772 of the total Nenets population[97] living in YNAO indicated the Nenets language as their mother tongue (3,360 people indicated the Russian language as their native tongue). 3,438 Khanty people[98] named Russian to be their native language, and 93 chose the Nenets language. 5,361 Khantys indicated the Khanty language. 642 Selkups[99] named Russian as their mother tongue, and 89 people named the Nenets language. The total number of people speaking the Selkup language as a mother tongue is 825.

In YNAO, the state places a great emphasis on the preservation of the indigenous peoples' native languages. In 2011, 5,023 students were studying native languages at school, i.e. circa 53% of the total number of IPN school students in YNAO as follows:

Nenets language	3,303 students
Khanty language	1,591 students
Selkup language	129 students

Children of the nomadic population are guaranteed full provision by the state during their studying for the elementary and secondary vocational education in YNAO[100].

8.2.5.3 NOMADIC POPULATION AMONG THE INDIGENOUS PEOPLES OF YNAO

About 95% of YNAO's indigenous population live in rural areas and are engaged in traditional economic activities[101]. The largest number of IPN in YNAO is found in Yamalsky District, where 70% of the total population are IPN; Tazovsky District with almost 45% has the next highest proportion. Within Yamalsky District, the proportion of IPN in each of the rural administrations is as follows:

- Panaevsk Rural Administration 89%
- Seyakha Rural Administration 83%
- Novy Port Rural Administration 79%
- Yar-Sale Rural Administration 70%

[97] Out of 29,701 people who indicated their native language. The total number of the Nenets population speaking Russian is 26,425 people.

[98] Out of 9,476 people who indicated their native language. The total number of the Khanty population in the region is 9,489 people. The total number of the Khanty population speaking Russian is 9,267 people.

[99] Out of 1,985 people who indicated their native language, with 1,988 people of the total number of the Selkups living in the region. The total number of Selkups speaking Russian is 1,955 people.

[100] O. Alferova, O. Ermakova. "Experience of the Yamal – a Worthy Example of Protection of the Indigenous People". Municipal public affairs newspaper "Severniy Lutch", 23.04.2011. http://prgsl.info/

[101] International energy and environment program "Energy of the Arctic". Scientific report "Current State and Perspectives of the Development of the Agrifood Sector of the Russian Arctic Territories (on the example of the Yamal-Nenets Autonomous Okrug)" Under the supervision of E.N. Krylatykh, Professor of the Russian Agricultural Academy, December 2011.

In Tazovsky District, the indigenous population is prevalent in all rural administrations except for Gaz-Sale, where the share of the indigenous population is less than 1%.[102]

Nomadic herders make up about 40% of the total IPN population in YNAO. As of early 2011, almost 14,700 people (3,166 households) were leading a nomadic way of life, 75% of which were in Yamalsky and Tazovsky Districts. More than 4,000 children live with their parents in tundra, of whom over 500are under one year of age[103].

The total nomadic population in YNAO in 2011 was almost 11% higher than in early 2003. This trend testifies to the social stability in the region and suggests that the native population is interested in preserving their traditional way of life. It is anticipated that the rural population of YNAO, including the indigenous population, will continue to grow and will exceed 41,000 people by 2020[104].

At present, nomadic herders represent more than half (approximately 52%) of the total IPN population in Yamalsky District, whereas in Tazovsky District the number of nomadic people ranges, according to the different sources, between 70-80% of the total indigenous population (see also Table 8.19 for details).

Table 8.19: Dynamics in YNAO's Indigenous Population in 2010-2011 (people)

District	Total IPN in YNAO			Nomadic IPN in YNAO		
	January 2010	January 2011	% increase	January 2010	January 2011	% increase
Krasnoselkupsky	1,588	1,604	1.0%	216	200	-7.4%
Nadymsky	2,105	2,129	1.1%	576	567	-1.6%
Priuralsky	5,731	5,847	2.0%	1,773	1,885	6.3%
Purovsky	2,983	3,080	3.3%	988	977	-1.1%
Tazovsky	7,576	7,629	0.7%	5,276	5,308	0.6%
Shuryshkarsky	5,310	5,244	-1.2%	69	71	2.9%

[102] T.N. Vasilkova, A.V. Evay, E.P. Martynova, N.I. Novikova. The Indigenous Small-Numbered Peoples and Industrial Development of the Arctic. Ethnological Monitoring in the Yamal-Nenets Autonomous Okrug. Federal State Institution Scientific Centre of Prophylactic and Clinical Nutrition. Tyumen Scientific Centre, Siberian Branch of the Russian Academy of Medical Sciences. Ethnology and Anthropology Institute of the Russian Academy of Sciences, OOO "Ethnoconsulting", Moscow–Shadrinsk 2011.

[103] Department of Agro-Industrial Complex of the YNAO. Presentation "Main Results of the Year 2011 and Growth Prospects of the Agro-Industrial Complex of Yamal" – report of V.S. Kucherenko, Director of the Department of Agro-Industrial Complex Development of the Yamal-Nenets Autonomous Okrug. Salekhard. 28.12.2011. Source: http://www.yamalagro.ru/prezentacia.htm.

[104] Department of Agro-Industrial Complex of the YNAO. On the Implementation of the Priority National Project "Development of Agro-Industrial Complex" in the Yamal-Nenets Autonomous Okrug. http://www.yamalagro.ru/apk.itogi.htm

Table 8.19: Dynamics in YNAO's Indigenous Population in 2010-2011 (people)

District	Total IPN in YNAO			Nomadic IPN in YNAO		
	January 2010	January 2011	% increase	January 2010	January 2011	% increase
Yamalsky	*11,265*	*11,383*	1.0%	*5,747*	*5,600*	-2.6%
City of Salekhard	207	209	1.0%	59	59	0.0%
YNAO TOTAL:	**36,765**	**37,125**	**1.0%**	**14,704**	**14,667**	**-0.3%**

Source: Rosstat[105]

According to the information provided by representatives of the IPN during the survey conducted in December 2012 (see Section 8.1), the main types of traditional activities their families, parents and ancestors were involved in are, as follows:

- Reindeer breeding, fishing and hunting;
- Hides tanning;
- Clothes and footwear making;
- Bartering and trade in traditional produce.

Fur farming and marine fauna hunting were not mentioned among the activities that the representatives of indigenous people of Seyakha tundra are engaged in on a regular basis.

Recognising that more than 40% of the indigenous population of YNAO lead a traditional way of life, the YNAO Government prioritises the preservation and development of the traditional sectors and lifestyle practised by the indigenous peoples, to stimulate their economic activity. To this end, the YNAO Government has adopted a long-term target programme "Preservation of Traditional Lifestyle, Culture and Language of the Indigenous Small-Numbered Peoples of the North Living in Yamal-Nenets Autonomous Okrug for 2012-2015"[106]. The main goals of the Programme are the promotion of sustainable development of the IPN living in YNAO, preservation of their cultural heritage and traditional way of life, and improvement of education and employment levels. The programme uses the following key performance indicators in relation to the nomadic population of the tundra:

- The proportion of nomadic families who have received monetary benefits (for the acquisition of fuel and lubricants for mini power stations);
- The proportion of nomadic families equipped with the means of communication.

[105] Source: International energy and environment program "Energy of the Arctic". Scientific report "Current State and Perspectives of the Development of the Agriood Sector of the Russian Arctic Territories (on the example of the YNAO)" Under the supervision of E.N. Krylatykh, Professor of the Russian Agricultural Academy, December 2011.

[106] Approved by the Decree of the YNAO Government No.1007-P of 23 December 2011. Source: "Collection of Regulatory Legal Acts of the Yamal-Nenets Autonomous Okrug Concerning Guarantees and Rights of the Indigenous Small-Numbered Peoples of the North: Under the editorship of S.N. Kharyutchi, A.V. Evay and A.V. Vinokur. Salekhard, 2011.

8.3 NATIONAL AND REGIONAL ECONOMY

8.3.1 NATIONAL ECONOMIC PROFILE

Russia is the sixth largest world economy in terms of GDP[107] at PPP[108] (as of 2012). It ranks ninth in terms of the nominal GDP for 2011.The GDP (nominal) in 2011 was 54,600 billion RUB; GDP at PPP was $ 2,380 billion. However, according to the GDP (nominal) per capita in 2011, Russia was only 52nd on the list of world countries. In 2012, Russia's share of the world economy was equivalent to 4.1%.

The breakdown of Russia's GDP by sector is provided in Table 8.20.

Table 8.20: Distribution of Russia's GDP per sectors

GDP breakdown (2011)	Forestry, agriculture, fishing	3.6 %
	Mining	9.1 %
	Processing and manufacturing	13.6 %
	Energy	3.2 %
	Construction	5.5 %
	Trade	16.2 %
	Transport and communications	7.5 %
	Education	2.5 %
	Health care	3.2 %
	Finances and services	14.0 %
	Government administration and defence	5.0 %
	Taxes on products	15.1 %

107 Gross Domestic Product
108 Purchasing Power Parity

8.3.2 REGIONAL ECONOMY

8.3.2.1 OVERVIEW

The backbone of the YNAO economy is oil and gas production which accounts for over 88% of industrial production.

At present, YNAO is the “gas heart” of Russia accounting for 90% of Russian gas production and 22% of the world production of natural gas.[109] The proven hydrocarbon reserves in the Okrug amount to 34 trillion[110] m^3 of natural gas, 2.3 billion tonnes of oil and 1.1 billion tonnes of gas condensate.[111] Total potential reserves in the Yamal Peninsula (including gas deposits in the Kara Sea shelf) are estimated at 50.5 trillion $m^3$of gas and over 5 billion tonnes of liquid hydrocarbons.[112]

The local hydrocarbon resources in the Okrug are extremely large and important both nationwide and on a global scale. YNAO is designated as the main gas producing province of Russia in energy strategies adopted by the RF Government for the period till 2020[113] and 2030[114].

To date, more than 200 hydrocarbon deposits have been discovered in the YNAO territory, of which one quarter are in commercial production and the rest are in exploration.

The largest gas and gas condensate fields and promising development areas on Yamal Peninsula and neighbouring areas are located in the elevated areas between the Seyakha-Mordyyakha and Naduy-Yakha river valleys and in the Nadym-Pur-Tazovsky region. They include (see also Figure 8.14):

- Urengoyskoye gas field with estimated reserves of 10 trillion m^3;
- Medvezhye gas field with proven reserves of up to 2 trillion m^3;
- Yamburg field with initial discovered reserves of 6.9 trillion m^3 of gas and 133 million tonnes of gas condensate;
- Bovanenkovo industrial zone, including Bovanenkovskoye, Kharasaveyskoye and Kruzenshternskoye fields, with estimated annual production of 220 billion m^3 of gas and 4 million tonnes of condensate;
- Tambey industrial zone comprising six fields: North Tambey (Severno-Tambeyskoye), West Tambey (Zapando-Tambeyskoye), Tasiyskoye, Malyginskoye (licences for these are held by Gazprom Group), South-Tambey (Yuzhno-Tambeyskoye) and Syadorskoye, with the total

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109 Source: http://region-yamal.ru/

110 In the Russian metric system the unit of trillion equals to 1000 x billion, or 10^{12}.

111 Problems and prospects of geological exploration in Yamal-Nenets Autonomous Okrug. By A. Ostryagin. Official web-site of the National Institute for System Research in Business and Enterprise, 2006. Source: http://www.smb.ru/analitics.html?id=gas-IV-ostryagin

112 Source: http://region-yamal.ru/

113 Approved by RF Government Decree #1234-r of 28 August 2003. See: Institute of Energy Strategy at http://www.energystrategy.ru/projects/ES-28_08_2003.pdf

114 Approved by RF Government Decree #1715-r of 13 November 2009 (http://www.energystrategy.ru/projects/es-2030.htm)

estimated annual production of up to 65 billion m^3 of gas and 2.8 million tonnes of condensate; and

- Zapolyarnoye oil/gas and condensate field in Tazovsky district of YNAO, with proven reserves of circa 3 trillion m^3 of gas.[115]

Figure 8.14: Gas Deposits in the Yamal Peninsula Vicinity

Source: Gazprom[116]

[115]See: Gazprom, Projects and Fields at http://www.gazprom.ru/about/production/projects/deposits/

Longer-term development opportunities are associated with the Kara Sea shelf, where ca. 2 trillion m^3 of gas were already produced from the Leningradskoye and Rusanovskoye fields, as well as with prospective deposits in the Gulf of Ob and Tazovsky Bay. Taking into account the Kara Sea shelf reserves, gas production in the Yamal Peninsula is expected to reach 360 billion m^3 per annum. [117]

8.3.2.2 AGRO-INDUSTRY

The YNAO agro-industry is the main sector of the local economy, providing jobs and livelihood for the local indigenous people. Due to the climate and environmental conditions, the agro-industry is primarily oriented towards traditional uses, such as reindeer-herding, fur animal breeding, fisheries, commercial hunting, processing of meat, fish, and furs/skins. The total land area of YNAO is 76,925,000 ha, including 200,800 ha of agricultural lands with 900 ha of arable land and 199,900 ha of forage lands.[118] The total area of lands suitable for reindeer grazing is 49 million ha.

8.3.3 LIVELIHOODS AND TRADITIONAL ECONOMY IN YNAO

8.3.3.1 LIVELIHOODS

As defined in the IFC Performance Standards (PS), “livelihood” refers to the full range of means that individuals, families, and communities utilize to make a living, such as wage-based income, agriculture, fishing, foraging, other natural resource based livelihoods, petty trade, and bartering.

Limited historical information is available on the economic contribution of hunting, fishing, trade, salaried work, and other sources to nomadic livelihoods of YNAO were available (presumably, such investigations had not been carried out in the area). In view of this, in December 2012, the Project initiated a programme of interviews with representatives of nomadic population in order to obtain a better understanding of their lifestyle. In addition, Yamal LNG commissioned dedicated research (performed by FRECOM in 2013 and EthnoExpert in 2013-2014) into traditional land use and the ethnic and cultural environment. Research results demonstrate that the principal means of IPs’ subsistence in the Yamal Peninsula is reindeer herding. Fishing, hunting and gathering are also performed by locals, but mainly for diversification of their diet rather than for subsistence. This conclusion is also confirmed by the results of the interview survey. Indigenous respondees mentioned that they undertook reindeer herding all year round, whereas fishing was practiced only during 1-3 months every year. A detailed description of these livelihood activities is given below; potential Project impacts on these practices within the direct AoI are assessed in Chapter 10.

The livelihoods of the local population are closely connected with the concept of Ecosystem Services (ES). ES are the goods and services provided by ecosystems upon which human wealth and individual well-being depend. The ES methodological framework is particularly relevant where the livelihoods of indigenous groups are dependent upon natural resources. A description of the

[116] Source: Gazprom, Megaproject “Yamal”: reserves and resources in Yamal, http://www.gazprom.ru/about/production/projects/mega-yamal/

[117] Source: http://www.arctic-info.ru/Encyclopedia/Article/mestorojdenia-amala

[118] Strategy of Social and Economic Development of the YNAO until 2020.

ES within the Area of Influence is provided in Chapter 7. Impacts on these ecosystem services are described in chapter 10, including:

- Provisioning services, including:
    - Livestock (i.e. reindeer – see Chapter 10, section 10.6)
    - Capture fisheries (including informal fishing – see 'land use for fishing and gathering' in Chapter 10, section 10.6)
    - Wild foods (including gathering of berries - see 'land use for fishing and gathering' in Chapter 10, section 10.6)
    - Hunting (see 'land use for fishing and gathering' in Chapter 10, section 10.6)
- Regulating services:
    - Water regulation - see Chapter 10, section **Error! Reference source not found.**
- Cultural services – these are assessed in Chapter 10, section **Error! Reference source not found.**.

8.3.3.2 REINDEER HUSBANDRY

The principal traditional sector in Yamal Peninsula is reindeer herding. At present, an area of 47 million hectares[119] is used in YNAO for grazing of the largest domesticated reindeer herd in the country: about 660,000 head in total, or 53% of total reindeer stock in the Russian Federation, and approximately one third or 35% of total reindeer stock in the world.

The agro-industrial sector in YNAO employs about 13,000 people, 90% of whom are IPN. Over 7,000 indigenous people work in the reindeer husbandry sector.

Agricultural products are produced by 96 entities of various forms of ownership, including more than 80 indigenous communities, over 50 individual entrepreneurs, and 3,000 private reindeer breeding farms. Over 143,000 reindeer in YNAO are herded by the indigenous communities. Since 1995, private reindeer herding has become the prevailing form of reindeer ownership in the region. The main feature of the region's reindeer husbandry is the prevalence of private household businesses (in possession of 63.1% of the reindeer population) over agricultural enterprises (only 36.9%). Over the past decades, YNAO has demonstrated an intensive growth of the reindeer stock in the private sector. The statistics show a considerable growth of the reindeer population, especially in the Yamalsky and Tazovsky districts, both of which are characterised by a relatively high percentage of privately owned reindeer (43.3% and 81.1% respectively).

In accordance with the "Strategy of Social and Economic Development of YNAO until 2020," traditional reindeer husbandry is regarded as a promising sector for further development provided that advanced technology for deep processing of produce is used[120] (i.e. not only the production of meat and hides, but also the utilisation of other subproducts such as blood and internal organs). Reindeer husbandry is a priority right of the indigenous peoples and ethnic communities of the

[119] The total area of the Yamal-Nenets Autonomous Okrug is about 77 million ha. The total area of the tundra suitable for reindeer grazing is ca 49 million ha.

[120] The strategy provides for processing of 95% of primary products of reindeer husbandry using advanced technology.

North, and creation of conditions for sustainable development of the reindeer herding, regardless of the form of ownership, is guaranteed by law[121].

In 2012, the production of reindeer meat in YNAO exceeded 2,250 tonnes, which represented an increase of 10% on 2011 levels and of 47% on 2008 levels. More than 970 tonnes of meat in the region were produced by communities and individual reindeer herders in 2011 (see Figure 8.15). More than 500 tonnes of meat produced in YNAO were sold for export.

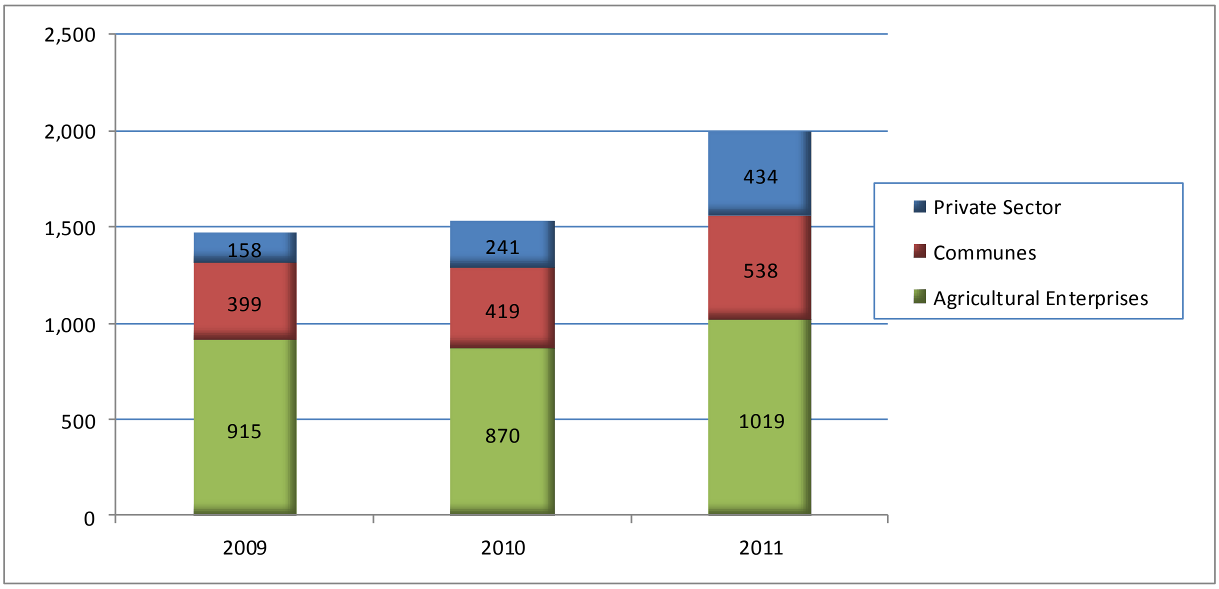

Figure 8.15: Production of reindeer meat in YNAO in 2009-2011

Source: YNAO Department of Agro-Industry[122]

The main characteristic of reindeer husbandry in YNAO is the prevalence of privately owned and commune owned reindeer stock (56% of the entire reindeer population) compared to agricultural enterprises (44%) (see Figure 8.16 below). Another characteristic feature of YNAO is a specific symbiosis between the collective and private reindeer husbandry sectors, based on the interdependence of these ownership forms in a shared use of pastures, supply of consumer goods, as well as the production and sale of produce. This model has emerged as a result of the long-standing coexistence of these husbandry forms. This phenomenon of merging of collective and private reindeer breeding activities is also evident from the findings of the IPN questionnaire survey conducted in December 2012 (see Section 8.1). Most of the respondents are both employees of an enterprise / members of communities and private reindeer owners, taking care of herds owned by an enterprise/commune and of their own private herd.

Before the market reforms, the reindeer population in the area was concentrated in large agricultural enterprises with well-developed husbandry technologies, stable reindeer population structure, and highly organised labour management. This system enabled good production and

[121] YNAO Law #46 of 02.11.1998 "On Reindeer Herding".

[122] The agro-industrial department of Yamal-Nenets Autonomous Okrug. Presentation "The main 2011 results and development prospects of Yamal agro-industrial sector". Report made by director of the agro-industrial department of the Yamal-Nenets Autonomous Okrug V.S. Kucherenko. Salekhard, 28.12.2011. Source: http://www.yamalagro.ru/prezentacia.htm

economic results. The reforms gave rise to the development of small commercial farms, joint stock companies, agricultural cooperatives, family and community reindeer husbandry. All this helped preserve the reindeer population but increased difference in prices for agricultural products has resulted in some enterprises facing economic difficulties.[123]

To date, all types of agricultural production on Yamal are subsidised from the Okrug budget. The state supports delivery of goods to trading outposts and fuel supply, including provision of the nomadic population with food and commodities. All these measures are aimed at supporting the reindeer husbandry sector.

Moreover, YNAO is the only northern reindeer breeding area of Russia where the reindeer population increased in the course of the market economy formation (by 140,000).The committed policy of local authorities, preservation of collective farms and gradual conversion of reindeer herding to private ownership made a considerable contribution to the growth of the reindeer population.[124]

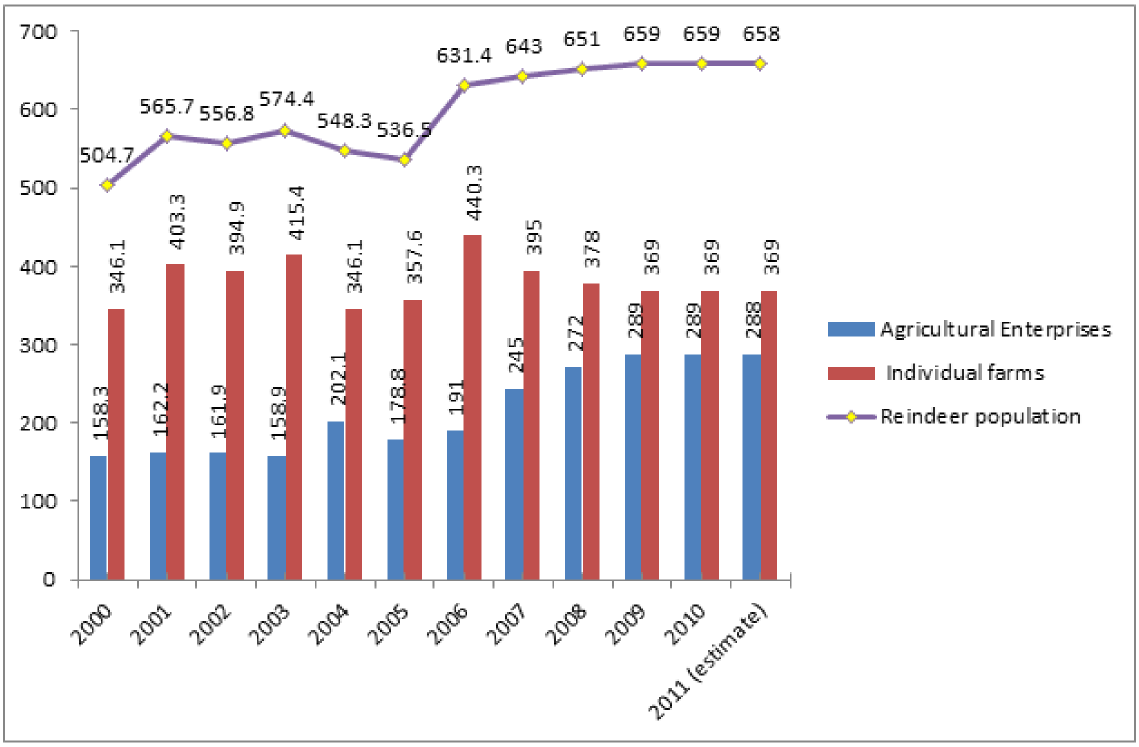

Figure 8.16: YNAO reindeer population by farming categories, thousands

Source: Department of Agro-Industry of Yamal-Nenets Autonomous Okrug [125]

[123]See "Myasnoy Ryad" magazine, "Yamal-Nenets Autonomous Okrug: Reindeer breeding problems to be discussed in Salekhard" at http://www.m-ryad.ru/jornal.php

[124] International Energy and Environment Programme "Energy of the Arctic". Scientific report "Current State and Perspectives of the Development of the Agrifood Sector of the Russian Arctic Territories (on the example of the Yamal-Nenets Autonomous Okrug)" under the supervision of E.N. Krylatykh, Professor of the Russian Agricultural Academy, December 2011.

[125]YNAO Department of Agro-Industry. "Performance in 2011 and development prospects of the Yamal agro-industrial sector". Report by Director of the agro-industrial department of the Yamal-Nenets Autonomous Okrug V.S. Kucherenko. Salekhard, 28.12.2011.Source:http://www.yamalagro.ru/prezentacia.htm

The size of reindeer population in YNAO is, however, constrained by the shortage of suitable grazing areas and pasture capacity, i.e. the amount of available foraging resources. The surplus of reindeer herds (reindeer overpopulation) creates problems for private breeders, primarily due to a deficit of pasture areas. This is a critical issue as legal titles for grazing land are granted to reindeer-breeding enterprises only. In this way, private herders in the Okrug who typically own three times as many animals as the enterprises have to graze their herds in a quasi-legal manner.

Yamalsky District remains the leader in the production of reindeer husbandry products in YNAO (see Figure8.17).

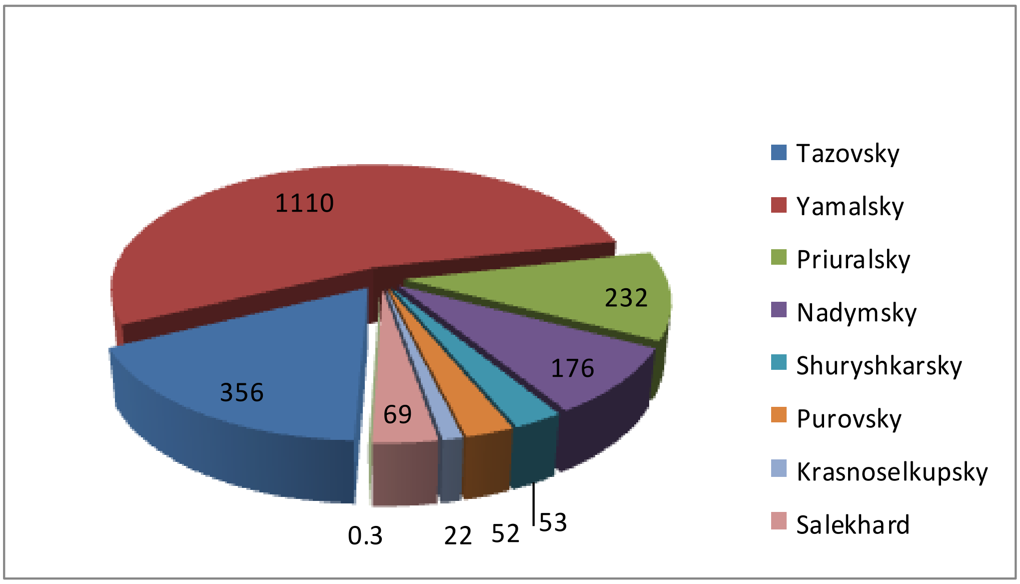

Figure 8.17: Production of reindeer meat by the YNAO districts in 2011, tonnes

Source: YNAO Department of Agro-Industry[126]

Slaughtering and product processing are carried out during migration by reindeer herding teams. When the air temperature is -15°C or lower (usually in November), animals are slaughtered in the open air. Major processing operations are carried out at a modern facility of the “Yamalskiye Oleni” municipal enterprise located in the Yar-Sale village in Yamalsky District. The capacity of this facility is 360 reindeer/day; the facility accounts for 50% of the workload during the slaughter and meat preparation period. Additional slaughtering and meat processing stations operate in Seyakha (Yamalsky District) and Antipayuta (Tazovskiy district).In 2013, another reindeer slaughtering facility is expected to go into operation in Payuta village (Priuralsky district). Similar facilities will be set up in future in Tazovsky and Gyda villages (Tazovskiy district) and Nyda (Nadym district)[127].

In the recent years reindeer hide and *kamas*[128] processing workshops were reopened, thereby providing additional employment opportunities in rural areas.

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[126]YNAO Department of Agro-Industry. “Performance in 2011 and development prospects of the Yamal agro-industrial sector”. Report by Director of the agro-industrial department of the Yamal-Nenets Autonomous Okrug V.S. Kucherenko. Salekhard, 28.12.2011.Source: http://www.yamalagro.ru/prezentacia.htm.

[127]YNAO Department of Agro-Industry.

[128]*Kamas* (derived from Saami) are pieces of reindeer hide from reindeer leg used as ski pads, fur footwear, gloves or clothing decorations by peoples of the North and Siberia.

Reindeer blood derived from the antlers and of vascular origin is thought by some to have active biological properties and is used to make various medicinal treatments. Preparations containing reindeer blood are also considered psychoactive agents (stimulants) and can equally be used for the treatment of anaemia and various infectious diseases. Reindeer antlers are also thought to possess exceptional therapeutic properties.

Currently, the reindeer population in some areas considerably exceeds the capacity of pastures[129]: by 50% in Yamalsky District, 13% in Tazovsky district, and by 10% in Priuralsky district. It is reported that many enterprises operating in the region are not allowed to increase the size of their herds due to the deficit of pastures and the risk of overgrazing of existing pasture grounds. As the optimal capacity of the reindeer pastures has already been exceeded, the growth of reindeer population is not considered in the agrisector development plans.[130] Moreover, 1.15 million ha of pastures had to be withdrawn from the agricultural use as a result of fires and industrial development[131].

At the same time, there is a different view expressed by a researcher studying the region and interviewed as a part of baseline data collection that it is not the industrial development that creates problems for reindeer breeding but the overgrazing of pasture lands in the Seyakha tundra by reindeer herds. Overgrazing of pastures is the determining factor in the shifting of reindeer herders towards more fertile lands in the surrounding areas.

Detailed information on the extent of pastures that have been affected by overgrazing is not available at the regional scale, although the area of lichen tundra in the Yamal has reportedly reduced dramatically over the last few decades. Over-grazing of upland areas within the Licence Area has been identified (see Chapter 7).

However, an advantage associated with the industrial development of the district is additional opportunities for reindeer meat sales to industrial workforces in the region. This offers the opportunity for additional sales and increased locations where meat can be sold. In addition, industrial workers are more likely to pay for meat in monetary form rather than bartering and the herders can, in turn, use the money to buy goods at factorias and in the settlements[132].

Reindeer husbandry in Yamalsky District

Yamalsky District is the leader in YNAO in domesticated reindeer herding; the reindeer herd totals 284,157 head[133], which is equivalent to 44% of YNAO total, and accounts for 19% of Russia's reindeer population. This is an increase of over 7,000 head compared with the reference data as of

[129] Capacity of pastures: capability of a natural system being a pasture to provide an annual (or seasonal) biological cycle of a certain reindeer population without violating the rules of regional zoocultural standards of feeding, keeping or protection of reindeer.

[130] "Reindeer breeders in Yamal: social inequality amid the active industrial development of the region". By E.P. Martynova. Ethnopanorama Journal, No. 3-4 (29), 2011. pp. 96-100.

[131] Decree of the YNAO Governor as of 24.09.2002 No. 267 "On the Concept of Task Programme for Socio-Economic Development of the Indigenous Peoples of the North in Yamal-Nenets Autonomous Okrug for 2003-2005". Reindeer breeding.

[132] This observation was provided by the researcher of the government agency of the YNAO "Arctic Research Centre" (City of Salekhard) interviewed as part of the baseline preparation.

[133] According to the data by the Department of Agro-Industry as at 01.01.2013. On the whole, the data on the total number of reindeer in Yamalsky District varies from 276,000 to more than 290,000 based on the different reference sources.

early 2012 which showed the total reindeer population of 277,129 head. These official statistics indicate the following breakdown in the reindeer stock ownership in the District:

- agricultural enterprises – 168,758 head (largest share of the total size of the reindeer herd in the District);
- in private ownership by population – 113,619 head;
- individual farm holdings/households– 1,780 head.

The percentage distribution between the types of reindeer stock ownership is shown in Figure 8.18.

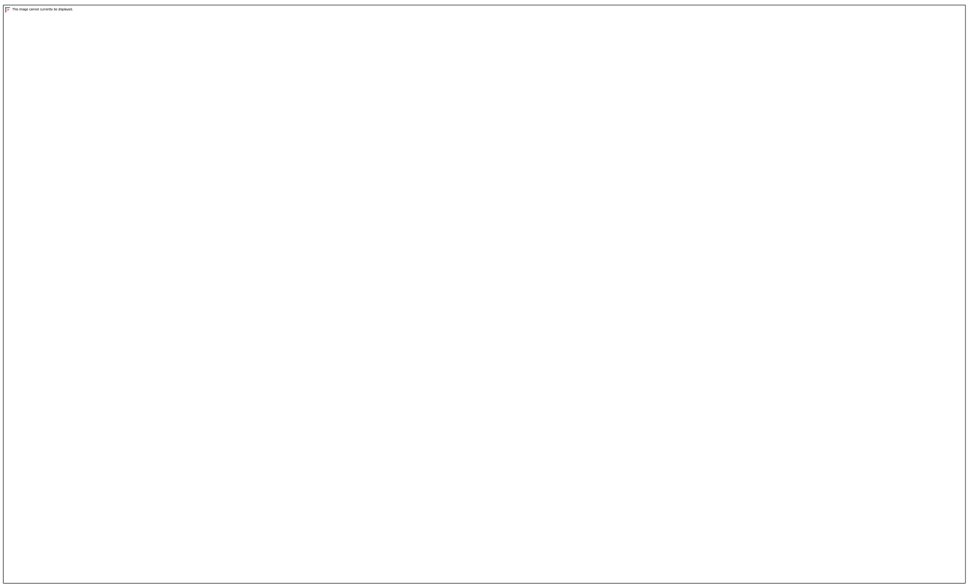

Figure 8.18: Reindeer stock ownership in Yamalsky District, 2013 data

The district accounts for 50% of the total reindeer meat production of YNAO. Observations from the researcher of the YNAO "Arctic Research Centre" who performs regular surveys in the area and who was interviewed in the process of baseline data collection indicate that reindeer breeding in the Seyakha - Tambey locality is currently of extremely intensive type, with the size of reindeer herds increasing annually.

Several reindeer husbandry enterprises operate in the District: MOP[134] Yamalskoye, MOP “Yarsalinsky”, Northern Reindeer-Breeding Enterprise of Yamal Peninsula (SOH Yamal), MOP “Panayevskoye”.[135]

The reindeer stock in the ownership by the agricultural entities, private owners and individual farm holdings/households of Yamalsky District in 2012 and 2013 is given in the Table 8.21 below. The stock owned by the agricultural enterprises and small-scale enterprises had increased by 2013, whereas the reindeer population in the ownership of indigenous communities and individual farm holdings/households has decreased.

[134]Municipal reindeer breeding enterprise

[135]Based on the data of YNAO Department of Agroindustry. http://www.yamalagro.ru/

Table 8.21: Reindeer Stock in Yamalsky District by Agricultural Entities, Private Owners and Individual Farm Holdings/Households, head

Agricultural Entity	Total Reindeer Population (01.01.2012)	Total Reindeer Population (01.01.2013)
Total owned by agricultural establishments	164,515	168,758
○ *Agricultural Enterprises*	46,698	48,343
- MOP Yarsalinsky	27,045	27,818
- MOP Yamalskoye	7,213	7,525
- MOP Panaevskoe	12,440	13,000
○ *Small-Scale Enterprises*	9,790	22,670
- OOO Northern Reindeer-Breeding Enterprise of Yamal Peninsula (SOH Yamal)	6,290	5,635
- OOO Valama	3,500	3,500
- APC[136] Ladukai	0	0
- OOO Ilne	0	13,535
○ *Indigenous Communities*	108,027	97,745
Edey-Il	7,340	120
Okotetto	4,180	4,131
Sevry	2,261	2,663
Ya Erv	1,340	1,769
Kharp	52,032	58,322
Panayevskaya	14,598	17,610
Ser Lapta	3,090	2,750
Nyanduk Khanavey	5,384	6,085
Khabey-Yakha	1,002	1,000
Maretya	1,100	1,020
Tusyada	1,300	1,220
Ilebts[137]	14,400	0
Ilir	0	1,055
Total in private ownership by population	110,578	113,619

[136] Agricultural production co-operative.

[137] Normally, an indigenous community is entitled to state subsidies for their reindeer stock. However, in reality these subsidies are almost entirely reverted back to the state in the form of mandatory tax payments. As a result, having a reindeer herd in communal ownership does not bring tangible advantages for a community. In 2012, the members of the Ilebts community took back their reindeer from the communal ownership, which is reflected in the figures presented in this table (0 communal reindeer reported in 2013). The reindeer population belonging to the individual members of the community is presently about 21,000 head.

Table 8.21: Reindeer Stock in Yamalsky District by Agricultural Entities, Private Owners and Individual Farm Holdings/Households, head

Agricultural Entity	Total Reindeer Population (01.01.2012)	Total Reindeer Population (01.01.2013)
Total owned by individual farm holdings/households	2,036	1,780

Source: YNAO Department of Agro-Industry, 2013

The size of reindeer stock maintained by the population (private ownership) in the different village administrations of Yamalsky District in 2012-2013 is shown in Table 8.22 below. In general, the yearly variation in the stock size is not very significant in most of the individual administrations, although the increase by over 2,900 reindeer head is registered in Seyakha village administration in 2013.

Table 8.22: Reindeer Stock in Private Ownership in Yamalsky District, by Village Administrations[138], head

Village administration	2012	2013
Panayevsk	25,904	24,883
Salemal	2,387	2,387
Yar-Sale	41,512	42,863
Novy Port	11,527	11,629
Mys Kamenny	9,787	9,466
Seyakha	19,461	22,391
Total, District	*110,578*	*113,619*

Source: YNAO Department of Agro-Industry, 2013

The data on reindeer stock maintained by the individual farm holdings/households in the District in 2012-2013 is shown in Table 8.23 below.

Table 8.23: Reindeer Stock Owned by Individual Farm Holdings/Households in Yamalsky District, head

Individual Farm Holding	2012	2013
Individual entrepreneur 1	500	500
Individual entrepreneur 2	256	0
Individual entrepreneur 3	1,280	1,280
Total, District	*2,036*	*1,780*

Source: YNAO Department of Agro-Industry, 2013

[138] Named by the administrative centre of each village administration. Such rural administrations typically comprise settlements and inter-settlement areas.

At present, there are three main types of nomadic reindeer breeding:

- workers of the municipal reindeer enterprises (often referred to as “state farm workers” as in the Soviet times);
- individual (private) reindeer herders; and
- commune-based reindeer herders;

Each group represents a certain husbandry management system (municipal entity, commune, family) and has a specific social status.

Reindeer herders employed by *municipal enterprises* are assigned to crews or brigades. Team supervisors decide on work and life management/personal issues during migration. Each reindeer-husbandry enterprise consists of several reindeer herding teams according to the number of reindeer herds.

Only Nenets people are employed as herdsmen or camp-workers (those taking care of the mobile dwellings also known as *chums*) at reindeer husbandry enterprises in Yamalsky District. Russians are predominantly employed as managers or veterinarians, livestock experts, accountants, etc. The size of individual reindeer herds varies from 1,000 to 2,000head, increasing to 2,000-2,700 after the fawning season. In addition, each herd includes a certain number of reindeer owned privately by herdsmen’s families or their relatives. Reindeer herds typically include some 800 to 1,500 privately owned animals that graze together with other jointly and collectively owned animals. The size of herds men’ teams varies from five to 12 people according to herd size. The standard workload is 270 animals per herdsman. According to the information provided by the reindeer breeders during the survey conducted in December 2012, a private herd is commonly estimated to 200-600 head, while herds owned by communities or enterprises can be as large as several thousands of animals (up to 6,000 per herd).

The Municipal Reindeer Breeding Enterprise (MOP) Yarsalinskoye, which is the largest both in YNAO and in Russia, has 18 reindeer-herding teams with 272 workers. These teams are conventionally subdivided into:

- “southern” teams (pasturing south of the Yuribey River);
- “central” teams (pasturing in areas beyond the Yuribey in summer);
- “northern” teams (moving further north beyond the Seyakha River towards the Kara Seacoast in summer).

Reindeer-herding enterprises have legal rights to use reindeer pastures. They are supported by and operate under the continuous supervision of government authorities in accordance with approved plans for the reindeer population and delivery of reindeer-herding products.

Individual reindeer herders live and work in accordance with traditional customs and have limited accountability to the authorities. The families of individual reindeer herders, who own three times as many animals compared with enterprises, typically do not have regulatory rights to pastures, and select grazing areas predominantly on the basis of traditions and personal agreements. Individual reindeer herders are often not recognised as officially employed individuals. They are not paid wages and live off the commercial sale of reindeer and fish products. Reduction of the pasture areas as a consequence of the on-going industrial development in the region can affect all groups of reindeer-breeding population. Individual reindeer herders are rendered most vulnerable as they do not have registered titles to the grazing lands.

The third group, *reindeer herders community*, is the group that has emerged most recently. Reindeer herding communities were first organised in YNAO in the late 1990s, with the assistance of local authorities. In recent years, the number of communities and their members, as well as the size of commune-owned reindeer herds, have been growing steadily.

Families of reindeer herders join communities as it is easier and more profitable to sell meat and other products through the commune-based networks. In addition, the communities are subsidised by the state to support the reindeer breeding sector. Similar to municipal enterprises, communities have target plans for maintaining the reindeer herd size and for the volumes of meat production. Commune members have officially recognised labour experience records. Migration distances of commune-owned herds may reach hundreds of kilometres, although these distances are still shorter than those in the “state farming” days. Families of reindeer herders that are members of the communities often join their herds for a summer period, whereas in other seasons they operate individually.

As mentioned above, collective and private reindeer breeding activities are often carried out simultaneously. According to the results of the survey conducted in December 2012 (see Section 8.1), 29 out of 38 respondents belonged to one or another form of a registered entity (commune or enterprise)[139], which potentially implied availability of officially allocated land.

However, 18 of those 29 respondents indicated that the land they used for traditional activities was not formally registered and was exploited solely on the basis of informal historical agreements.

Based on the answers provided during the survey, it may be assumed that local land users are not always aware of the legal aspects of traditional land use practices and specific procedures for legalization of the land ownership.

All reindeer pastures of the northern part of YNAO are now officially assigned to MOP Yamalskoye. However, this area is also being used by several other reindeer-herding entities. They comprise communities (Yarokhoy and Tusyada), commercial enterprises (Northern Reindeer-Breeding Enterprise (SOH) Yamal’, OOO Valama, and agricultural production cooperative Ilebts) and individual family reindeer-breeding farms (private reindeer herders).

The communities contribute significantly to the increase of reindeer meat production in Yamalsky District. Their proportion in the total meat production in the District was almost 44% in 2010 (see also Table 8.24).

Table 8.24: Volume of reindeer meat production in Yamalsky District by private sector, 2008-2010

	2008		2009		2010	
	Reindeer stock as at 01.01.	**Meat produced, tonnes**	**Reindeer stock as at 01.01.**	**Meat produced, tonnes**	**Reindeer stock as at 01.01.**	**Meat produced, tonnes**
Panayevskaya	14,301	18.9	13,682	15.0	13346	11.3
Kharp	29,793	42.7	38673	110.0	43,354	130.0

[139]It should be also taken into account that 8 out of 38 respondents didn’t’ give any answer to this question.

Table 8.24: Volume of reindeer meat production in Yamalsky District by private sector, 2008-2010

	2008		2009		2010	
	Reindeer stock as at 01.01.	Meat produced, tonnes	Reindeer stock as at 01.01.	Meat produced, tonnes	Reindeer stock as at 01.01.	Meat produced, tonnes
Ilebts	21,010	72.0	21,100	80.0	21,100	49.3
Yedey il	5,039	5.1	13,329	30.4	13,687	20.0
Northern Reindeer-Breeding Enterprise 'Yamal'	7,545	20.0	8,543	20.0	8,600	25.6
OOO «Valama»	1,600	13.4	3,079	28.0	3,592	47.1
Tusyada	800	13.4	932	18.0	1,208	19.8
Maretya	900	18.3	960	17.0	1,155	17.5
Yarokhoy		1.6		0.9		
Ser Lapta	945	3.3	945	3.0	1,911	0.2
Ebtsota	517	1.7	771	2.4		
Ladukai	420	1.1	420			
Nyanduk Khanavey	3,900		5,659	6.7	5,700	12.2
Khabey-Yakha			630	2.0	715	2.0
Total, small-scale husbandries	86,770	211.5	108,723	333.5	114,368	335.0
Private breeders	139,630	58.1	130,881	8.4	125,867	25.9
TOTAL, Private sector	226,400	269.6	239,604	341.9	240,235	360.9

Source: Report on Socio-Economic Situation in Yamalsky District, 2011.

The major producer or reindeer meat and subproducts is MUP[140] "Yamalskiye Oleni", based in Yar-Sale. The enterprise includes the modern multi-unit slaughtering and processing complex with the capacity of 360 head per day or up to 20,000 head per season. Apart from meat produce, the complex output comprises a range of semi-processed foods and other subproduce such as bone flour. The total production output of the enterprise is over 500 tonnes of high-quality reindeer produce a year.[141]

8.3.3.3 FISHING

Fishing is the second important agricultural industry of YNAO. Over two thousand people catch fish on Yamal peninsula. Most of them are indigenous people. Fishing is predominantly carried out in areas of traditional use in the lower reaches of big rivers and adjacent lake systems.

Commercial fishing in the Gulf of Ob below the Nyda – Yamsale line is prohibited. In inland waters of the region (rivers and lakes), fishing activities are undertaken in the summer, autumn and winter periods (from onset of ice formation to April)[142]. Since 1964, commercial fishing in YNAO has been limited. Fishing quotas are adjusted according to available reserves of given fish species to a limited number of fishing companies/enterprises. They are awarded annual quotas that serve as a basis for planning production and fishing activities. Currently State permits for commercial fishing are not issued for communities in Yamal'skiy District.

About 90% of the catch is taken in the summer season. Most fishing activities, regardless of specific fish species, are carried out in areas of traditional use by indigenous peoples where fishing rights areas signed to agro-industrial enterprises (provided they have a fishing licence stating fish quotas and designated fishing areas). The fisheries output produced by indigenous people accounts for 78% of the total volume of fish production in YNAO.

The fishing industry encompasses a variety of labour organisation forms, including fishing cooperatives, collective enterprises, agricultural enterprises, fish processing plants, communities and rural farm enterprises. 12 fishing enterprises, 11 reindeer and fishing husbandries and over 60 enterprises of different forms of ownership operate in the whole YNAO[143]. The development of the fishing sector aimed to form an integrated system of fisheries that would combine the entire process from harvesting to processing and selling of fishery products in the form of raw (frozen), canned or smoked fish.

The period 2009 to 2011 was characterised by a stable annual fish production of 9,400 tonnes in YNAO, including valuable whitefish species. This was the best performance in the last 20 years. However, 2012 was not as successful, with the total fish production having amounted to ca. 8,000 tonnes by the end of the year. The reduction of fish production in 2012 was attributed to extremely

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[140] Municipal reindeer slaughtering and processing enterprise.

[141] Source: http://yamaloleni.com/

[142] Most of the respondents of the survey performed in December 2012 indicated that they were involved in fishing activities during very limited period of time, i.e. one to three months per year only.

[143] According to the data provided by the agro-industrial department of the Yamal-Nenets Autonomous Okrug/ Performance of regional fisheries in 2012. Source: “Krasny Sever”, a socio-political newspaper of the Yamal-Nenets Autonomous Okrug, issue of 14.12.2012.

low water level in rivers of the Ob-Irtysh river basin.[144] In order to prevent adverse economic effects on industry workers, in 2012, the YNAO government decided to increase subsidies to support fishermen's wages.

Fish production in 2007 was also relatively low due to the reduced level of catch along the Ob River and a mass fish kill in the Gulf of Ob during that year[145]. Some local people blamed the fish kill on either:

- suffocation of fish due to lack of oxygen as the freezing period in the Gulf lasted longer than usual
- the presence of gas industry in the Gulf of Ob.[146]

There are two major groups of fishing enterprises in Yamalsky District:

- municipal and state-owned enterprises;
- non-government enterprises: cooperatives, communities, and small businesses.

The main fish producers in YNAO are:

- Novoportovsky and Salemalsky fish factories;
- State Farm Panayevsky;
- MOP Yamalskoye;
- OOO Altair;
- Integrated agricultural production company "The Nare Commune";
- Indigenous communities Edey-II, II, Nyanduk Hanavey, and others.

Fishing enterprises receive subsidies from the YNAO budget for shared financing of operating expenses associated with fish production. The majority of fishermen belong to the indigenous population. All fishing team workers in the Okrug are Nenets, who also comprise approximately 80% of workforce engaged in fish-processing, net-setting and fur-sewing operations.

The fishing grounds of YNAO are assigned to enterprises only; the indigenous people continue to fish without formally designated fishing grounds or special fishing permits. Reportedly, there are no official/legal fishing areas assigned to enterprises within the Project AoI.

It should be noted here, that reliable baseline information on informal fishing practices is difficult to ascertain. According to the results of ethnological field studies conducted during the period from May through August 2013, traditional non-commercial fishing within the Project licence area is focused on the estuaries of the Sabettayakha and Vanuymueyakha rivers. Reportedly, local people (exact numbers are unknown but roughly assessed as a few tens of individuals) come to these areas for autumn fishing. The research revealed that this type of fishing is not a subsistence activity (whereas reindeer herding is), but performed by locals mainly for diversification of their diet.

[144] The most probable reason for the low-water level in the Irtysh River must be intensive use of two-thirds of the river water in China and Kazakhstan. Moreover, the previous dry winter also had its impact on the fill rate of Yamal rivers. Source: The Federal Agency for Fisheries. Press Centre, "Yamal is calculating landings". 17/12/2012. РИА Fishnews.ru, http://www.fish.gov.ru/presscentre/news/Pages/news015330.aspx

[145] Source: Agroindustry in 2007. http://region-yamal.ru/content/view/8104/

[146] Source: «Mass Fish Deaths in the Gulf of Ob», By V. Sotnik, 06.08.2007 http://www.fishkamchatka.ru/?cont=long&id=5433&year=2007&today=06&month=08

8.3.3.4 HUNTING

The main objects of hunting in YNAO have traditionally been fox, rabbit, squirrel, grouse and waterfowl.

Because of the lack of a market, fur animal hunting is currently in decline. However, there are a few organisations buying furs, including some trading posts or communities which are subsidised for this activity.

A 91-strong hunting team was recreated in 2008 by MOP Yarsalinskoye. The reason for this was a large increase in the tundra arctic fox population. The Arctic fox is a carrier of cysticercosis, a serious and almost incurable disease affecting reindeer herds. Larvae get into the stomach of reindeer through the fox's urine that remains on the tundra surface. In 2008, the YNAO budget allocated subsidies for skins of Arctic foxes so the enterprise was able to arrange their sales. Purchase prices depend on the type of fur, but the minimum price is 400 roubles. The main purpose of this initiative was not only to regulate the fox population but also to solve, at least partially, employment problems of independent reindeer herders[147]. At present, processing of down and fur constitutes one of the main specialisations of MOP Yarsalinskoye.

Sport/subsistence hunting has always been, and continues to be, part of the traditional means of sustenance of the Yamal Nenets. In winter, they actively hunt for partridges, and in spring for ducks and geese. Use of traps to catch foxes, whose skin is used to decorate traditional clothes, is less frequent. Unlike fishing, most of the indigenous population practice hunting occasionally to diversify the family diet. Nenets say that hunting brings in no income so the priority is given to more profitable fishing and reindeer husbandry. The respondents of the survey conducted in December 2012 also indicated that the scale of commercial hunting had been substantially decreased, which in their opinion was attributed to a couple of factors – the first one is industrial development of the region, and as a consequence, a change in migration routes of animals and birds. The second reason for decrease in scale of commercial hunting is unfavourable changes in climatic conditions without indication of any specific aspects of such changes. Nevertheless, according to the studies conducted by the members of the Arctic Research Centre, the region is prone to climate warming. E.V. Agbalyan[148] points out that this trend entailed changes in the ecosystems and occurrence of extreme weather phenomena (although no specific examples are given)[149].

In some families, reindeer herders gave up hunting for lack of weapons and expensive ammunition.

[147] T.N. Vasilkova, A.V. Evay, E.P. Martynova, N.I. Novikova. The Indigenous Small-Numbered Peoples and Industrial Development of the Arctic. Ethnological Monitoring in the Yamal-Nenets Autonomous Okrug. Federal State Institution Scientific Centre of Prophylactic and Clinical Nutrition. Tyumen Scientific Centre, Siberian Branch of the Russian Academy of Medical Sciences. Ethnology and Anthropology Institute of the Russian Academy of Sciences, OOO "Ethnoconsulting", Moscow–Shadrinsk 2011.

[148] E.V. Agbalyan, "Studies relating to assessment of the environmental conditions and health status of population in Yamal-Nenets Autonomous Area under conditions of increasing technogenic stresses and climate change", Government Agency of YaNAO "Arctic Research Centre", Salekhard

[149] See also: "Scientific Research Transactions of YaNAO Arctic Medicine, Biology and Ecology", Issue 3 (76), Salekhard, 2012

8.3.3.5 FUR FARMING

Agricultural enterprises in YNAO also specialise in fur animal breeding. The fur breeding farms in YNAO focus on blue fox, silver-black fox, silver fox, mink, and sable. Animal breeding in YNAO provides jobs for a substantial portion of the sedentary local population. According to the survey results in December 2012 (see Section 8.1), only 7 out of 38 respondents indicated that fur animal breeding was regularly practiced by their families.

8.3.3.6 CATTLE BREEDING

Cattle breeding is also part of the YNAO economy. As reported by the YNAO Department of Agroindustry at the end of 2012, the total bovine livestock in the Okrug exceeds 1,000 head, including some 600 cows providing dairy products for social institutions (day nurseries, schools, hospitals, etc.). The plans outlined by the Okrug's Department of Agroindustry for 2013 include purchase of equipment and animals in Noyabrsk, and later in Gubkinsky[150].

Production and other technical equipment, communication facilities and reindeer were purchased as part of the YNAO task programme "Development of Agro-Industry in YNAO in 2006-2010", which also provided livestock maintenance and preventive veterinary measures.

Another dedicated task programme "Development of agriculture in YNAO"[151] is being implemented for the period of 2011-2013, which provides for a range of measures implemented by the state with the aim of enhancing performance of the Okrug's agricultural sector. These include purchase of breed animals to improve livestock productivity, transportation and equipment assistance, adoption of innovative technologies etc.

In Yamalsky District, local dairy farming does not constitute a major portion of the agricultural production. In 2010, the total production volume of cow milk by local farms was lower than in the two preceding years:

- 2010 - 71 tonnes,
- 2009 - 79.2 tonnes,
- 2008 - 81.6 tonnes.

The decrease in milk production by the local farms was accounted for by the high level of competition on this market. The lack of modern equipment does not allow local milk husbandries in the District to achieve an appropriate standard of quality and to successfully compete with the larger dedicated commercial entities.

Reported issues facing agro-industry in YNAO can be summarised as follows:[152]

- lack of transportation and logistics infrastructure for recording collection, export and sales of agricultural products;

[150] Department of Agro-Industry of the Yamal-Nenets Autonomous Okrug. Results of the sector activity in 2012. Source: http://www.yamalagro.ru/novosti_apk.htm

[151] The Task Programme was approved by the YNAO Government's Decree as at 27/12/2010.

[152] Strategy of Social and Economic Development of the Yamal-Nenets Okrug till 2020.

- reduction of land carrying capacity for reindeer grazing as a result of industrial development in YNAO;
- lack of a legislative framework for legal assignment of grazing lands to reindeer herding communities and individual private herders;
- reduction of valuable fish species population in the Ob basin due to illegal fishing of whitefish;
- considerable depreciation of fixed assets (70-75%), shortage of circulating assets, lack of financial resources for implementation of innovations and investment projects;
- low energy efficiency and insufficient depth of product processing in the agro-industry and fishing sectors;
- significant decline in demand for animal breeding and commercial hunting products;
- inadequate level of research and development and poor organisation of stock breeding work;
- difficulties in staffing the agricultural industry with suitably qualified personnel;
- seasonal employment of rural population;
- lack of comfortable and affordable housing in rural areas (there is a significant difference between urban and rural living conditions), poor development of communication and telecommunication facilities;
- limited land reinstatement conducted on disturbed or contaminated reindeer pastures.

8.3.4 LABOUR MARKET AND EMPLOYMENT

According to the YNAO Department of Employment, 6,698 people were registered as unemployed in YNAO in 2012, which is 26% less than in 2011. The “registered unemployment” rate[153] in YNAO between 2011 and 2012 is shown in Figure 8.18. This is based on the number of *registered* unemployed job seekers and shows that:

- as of December 2012, the registered unemployment rate was 0.72%
- month-on-month registered unemployment rate was slightly lower in 2012 than in 2011.

Total unemployment (as opposed to registered unemployment) is reported by Rosstat using ILO methods[154]. The latest Rosstat data for October 2012 report a total unemployment rate of 3.4% in YNAO. The unemployment levels in YNAO during 2011-2012 are shown in Figure 8.19.

[153] “Registered Unemployment” is the number of unemployed job seekers who are registered in government agencies. This statistical information does not reflect the so-called "hidden unemployment", i.e. the number of unemployed among all able-bodied citizens. Source: http://trudobzor.ru/

[154] “Total Unemployment” is registered in special quarterly population surveys on employment issues; it is estimated using statistical methods of the International Labour Organisation (ILO). The ILO defines an unemployed as an individual who: 1) has no job; 2) takes concrete and active steps to find a job; 3) is ready to start working immediately, either as a hired labour or as a private business owner.

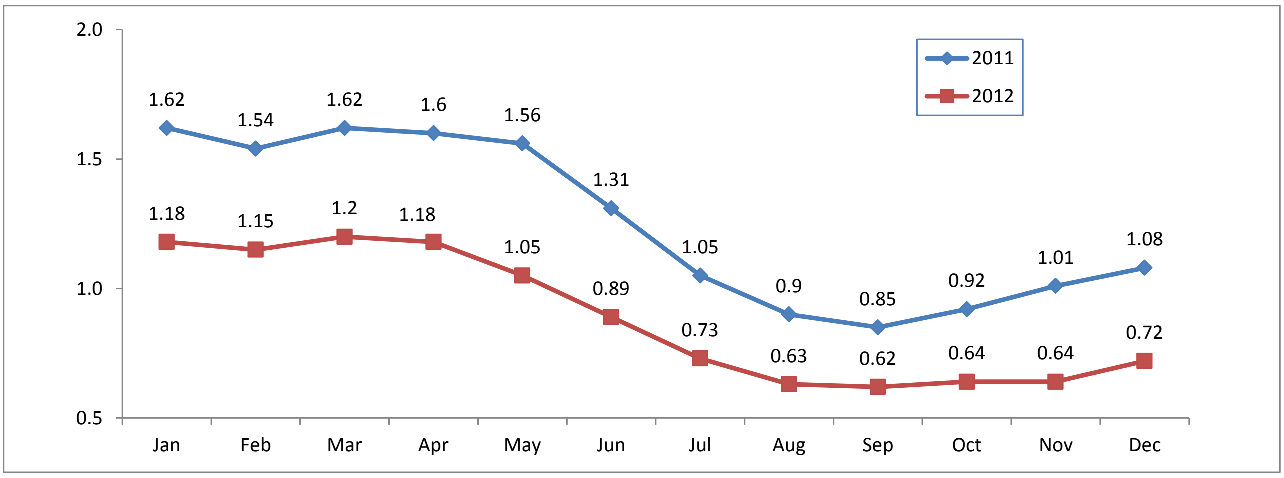

Figure 8.19: Registered unemployment in YNAO, 2011-2012

Source: YNAO Department of Employment, 2012

A breakdown of unemployment levels at the district level within YNAO is provided in Figure 8.20. This shows that the number of unemployed in Yamalsky District in 2012 totalled 133 people, which is one of the lowest unemployment rates in YNAO (although this is, at least in part, a reflection of the relative population size in the district).

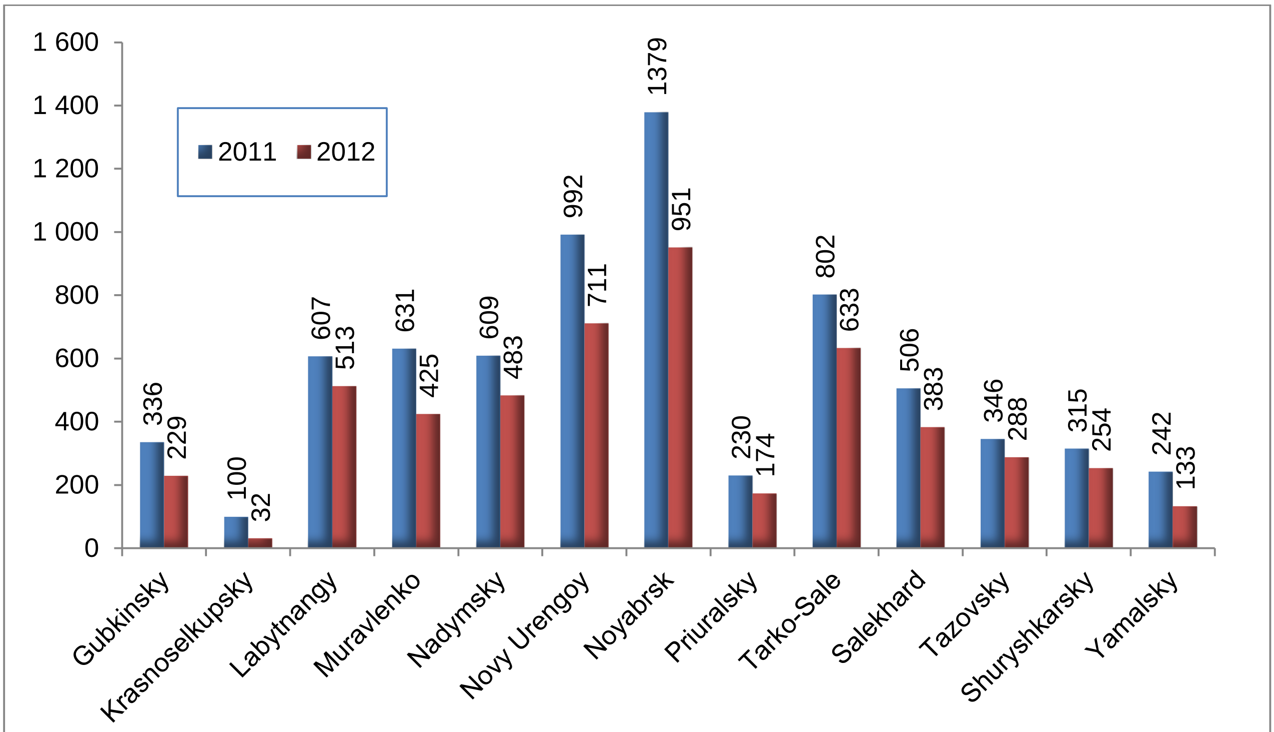

Figure 8.20: Regional breakdown of unemployed in YNAO, 2011-2012

Source: YNAO Department of Employment, 2012

A breakdown of registered unemployment in YNAO by women, young adults (16-29 years), rural population and disabled persons provided in Figure 8.20 below, and shows that the highest rates of unemployment are among women and young adults. There is a similar picture at the Yamalsky

District level where women and young adults account for the following proportion of total unemployed numbers:

- Women: 45%
- Young adults (16 to 29 years old): 46%

In addition, indigenous people constitute 73.7% of the total number of the unemployed in Yamalsky District. This relatively high percentage is explained by the fact that individual private reindeer herders are not officially recognised as employed/working citizens as they are not salaried or waged workers (instead they live off sales of reindeer-breeding and fishing products). The main categories of unemployed are shown in Figure 8.21.

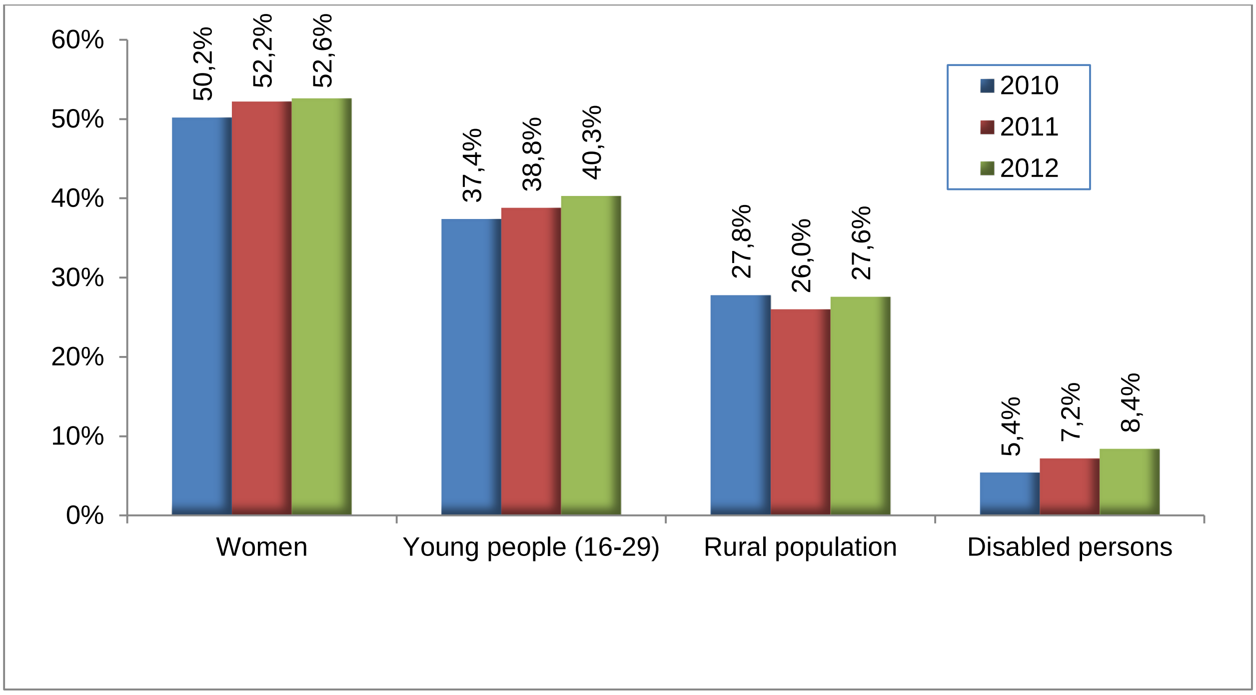

Figure 8.21: Breakdown of registered unemployment numbers in YNAO, 2010-2012 (%)

Source: YNAO Department of Employment, 2012

As shown in Figure 8.22, most job vacancies in YNAO are provided by construction sector (over 50% of all vacancies). Vacancies are also available in the extractive industry (9.1%), transport and communications (8.5%), and real estate (8%) sectors.

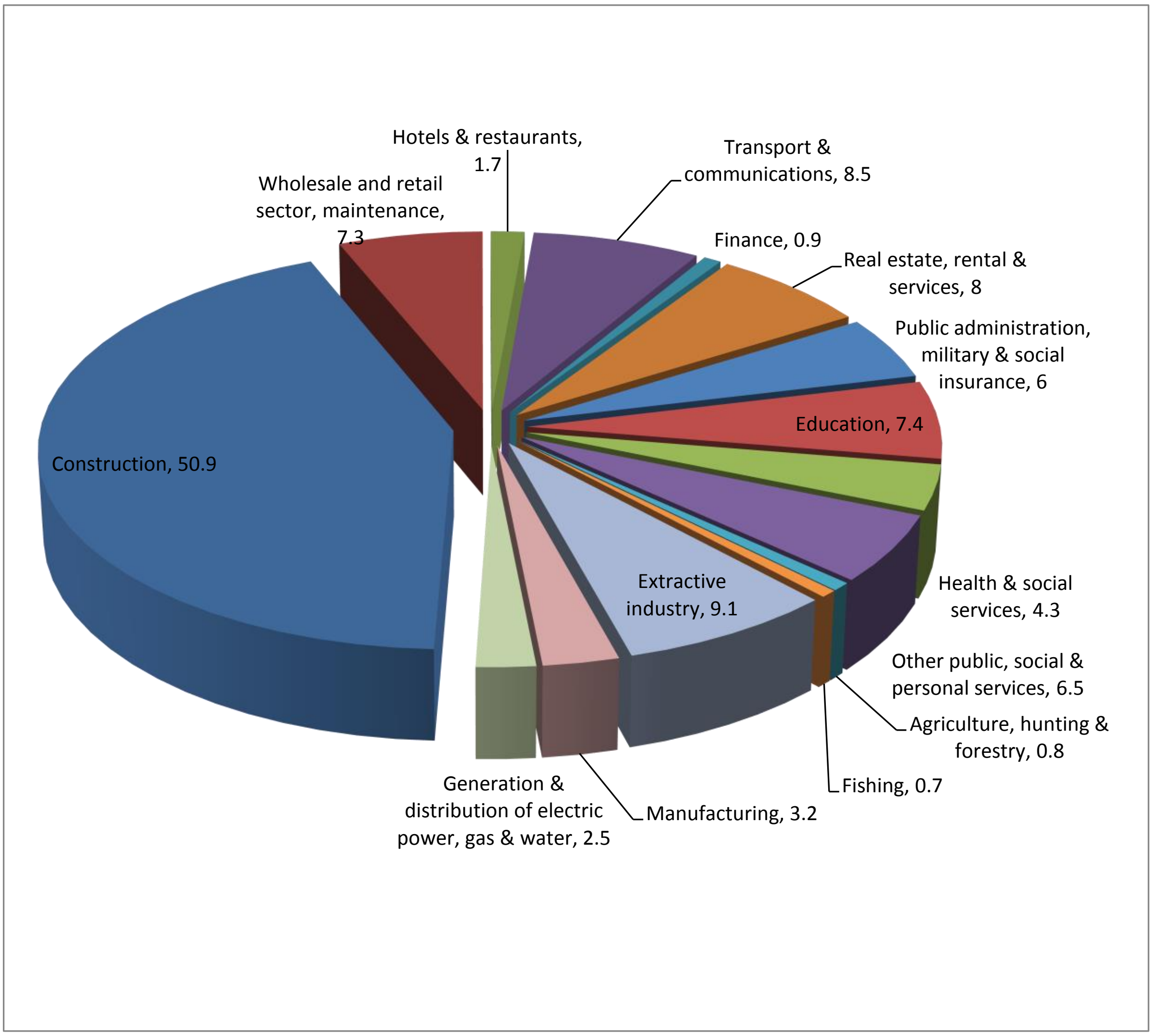

Figure 8.22: Vacancies by sectors in YNAO, 2012

Source: YNAO Department of Employment, 2012

The YNAO labour market is characterised by a great number of people who work on a rotational basis and reside outside the region (over 15% of workers engaged in the economy).

As of December 2012, the demand for labour exceeded supply in twelve districts in YNAO, the only exception is the Shuryshkasky district (Figure 8.23).

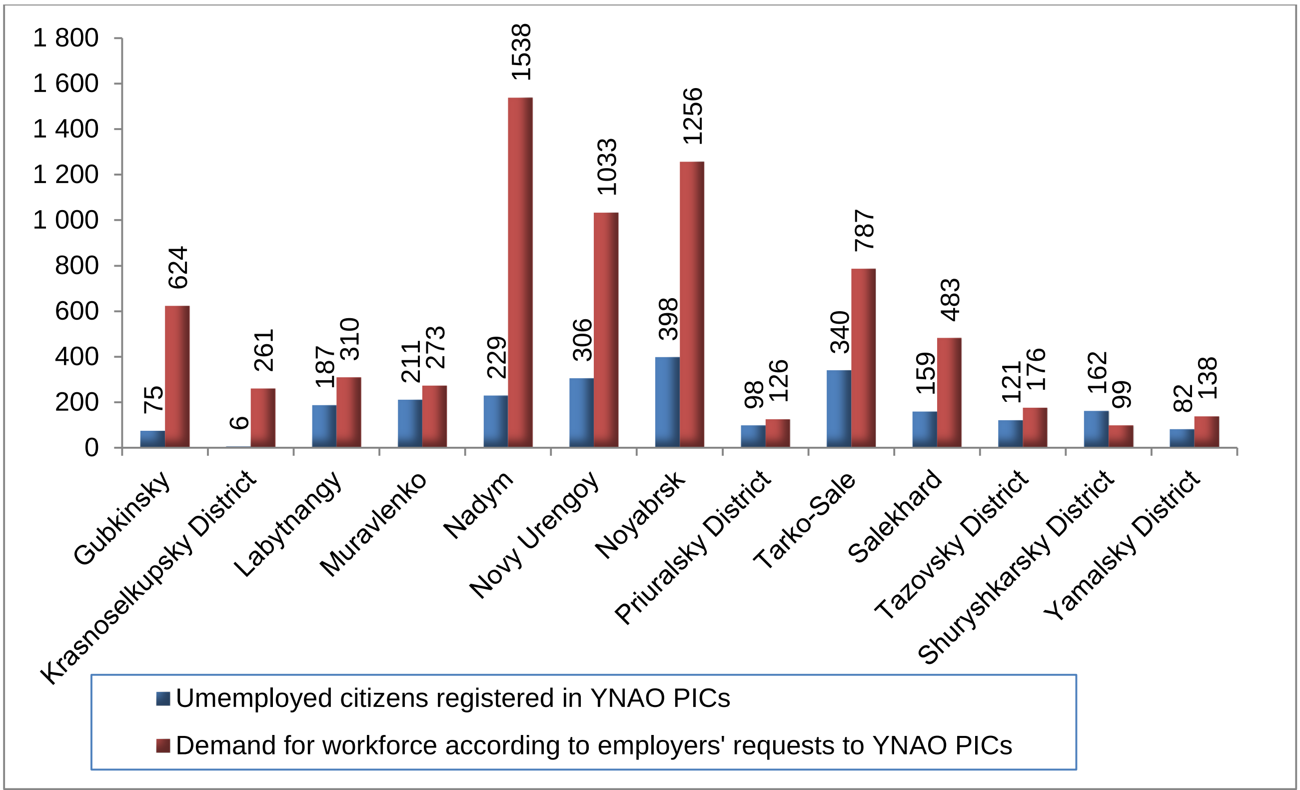

Figure 8.23: Labour market in YNAO in 2012. Administrative division (based on information from population employment centres – PIC)

Source: YNAO Department of Employment, 2012

In October 2012, five disabled persons were registered as unemployed in Yamalsky District (Table 8.25).

Table 8.25: Details of the registered unemployment in YNAO in 2012

	Disabled people				Rural Population			
	2011		2012		2011		2012	
	Number of people	% from the total number of unemployed (as of October)	Number of people	% from the total number of unemployed (as on October)	Number of people	% from the total number of unemployed (as on October)	Number of people	% from the total number of unemployed (as on October)
YNAO	**216**	**7.2**	**179**	**8.4**	**782**	**26.0**	**589**	**27.6**
Gubkinsky	12	10.8	13	16.0	-	-	-	-
Krasnoselkupsky	-	-	1	14.3	20	100.0	7	100.0
Labytnangy	21	8.0	15	8.2	-	-	-	-
Muravlenko	24	8.4	12	7.1	-	-	-	-
Nadym	11	4.3	16	9.5	90	35.6	50	29.6
Novy Urengoy	40	10.0	33	12.0	-	-	-	-

Table 8.25: Details of the registered unemployment in YNAO in 2012

	Disabled people				Rural Population			
	2011		2012		2011		2012	
Noyabrsk	48	8.7	39	10.2	-	-	-	-
Priuralsky	3	3.2	3	4.5	65	69.1	66	100.0
Tarko-Sale	13	3.6	15	5.3	162	44.3	105	37.2
Salekhard	25	11.4	15	9.1	2	0.9	4	2.4
Tazovsky	8	6.2	6	5.2	129	100.0	115	100.0
Shuryshkarsky	9	4.2	6	3.9	212	100.0	154	100.0
Yamalsky	2	2.0	5	5.7	102	100.0	88	100.0

Source: YNAO Department of Employment, 2012

The majority of the unemployed among graduates of educational institutions registered in Yamalsky District are graduates of secondary vocational schools (Table 8.26).

Table 8.26: Graduates of educational institutions registered as unemployed in YNAO municipalities in 2012

	% From the Total Number of Unemployed Graduates (as of October 1)						Proportion Of Vocational Educational Institutions' Graduates In Total Number Of Unemployed	
	Graduates of Higher Vocational Educational Institutions		Graduates of Secondary Vocational Educational Institutions		Graduates of Primary Vocational Educational Institutions			
	2011	2012	2011	2012	2011	2012	2011	2012
YNAO	46.4	48.2	33.8	35.7	19.8	16.1	6.9	7.9
Gubkinsky	66.7	50.0	22.2	-	11.1	50.0	8.1	2.5
Krasnoselkupsky	-	-	-	-	-	-	-	-
Labytnangy	40.0	18.2	20.0	45.5	40.0	36.4	3.8	6.0
Muravlenko	15.4	26.1	61.5	69.6	23.1	4.3	4.5	13.7
Nadym	43.8	47.4	12.5	26.3	43.8	26.3	6.3	11.2
Novy Urengoy	60.0	67.7	27.5	19.4	12.5	12.9	10.0	11.3
Noyabrsk	52.4	60.7	39.3	30.4	8.3	8.9	15.2	14.7
Priuralsky	50.0	50.0	50.0	50.0	-	-	2.1	3.0
Tarko-Sale	33.3	27.3	26.7	45.5	40.0	27.3	4.1	3.9
Salekhard	-	50.0	100.0	25.0	-	25.0	1.4	2.4
Tazovsky	40.0	20.0	-	20.0	60.0	60.0	3.9	4.3
Shuryshkarsky	16.7	50.0	16.7	50.0	66.7	-	2.8	1.3

Table 8.26: Graduates of educational institutions registered as unemployed in YNAO municipalities in 2012

	% From the Total Number of Unemployed Graduates (as of October 1)						Proportion Of Vocational Educational Institutions' Graduates In Total Number Of Unemployed	
	Graduates of Higher Vocational Educational Institutions		Graduates of Secondary Vocational Educational Institutions		Graduates of Primary Vocational Educational Institutions			
Yamalsky	-	-	75.0	100.0	25.0	-	3.9	2.3

Source: YNAO Department of Employment, 2012

The population with only general secondary education have the highest unemployment rates in Yamalsky District at over 39% (see Table 8.27).

Table 8.27: Structure of unemployed population by education level

	% From the Total Number of Registered Unemployed											
	Higher Vocational Education		Secondary Vocational Education		Primary Vocational Education		Comprehensive Secondary Education		General Secondary Education		No General Secondary Education	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
YNAO	19.7	22.4	18.3	18.5	15.2	15.4	28.9	25.6	14.9	15.1	3.0	2.9
Gubkinsky	33.3	39.5	21.6	17.3	15.3	12.3	21.6	23.5	8.1	6.2	-	1.2
Krasnoselkupsky	10.0	-	15.0	28.6	10.0	14.3	35.0	57.1	30.0	-	-	-
Labytnangy	17.5	17.4	11.8	11.4	29.3	33.2	31.6	23.9	8.7	13.6	1.1	0.5
Muravlenko	19.2	18.5	22.6	29.8	13.6	18.5	32.8	29.2	7.7	4.2	4.2	-
Nadym	22.5	27.8	7.5	10.1	16.6	17.8	20.6	19.5	26.5	19.5	6.3	5.3
Novy Urengoy	27.1	37.2	14.5	11.3	10.5	5.8	40.1	39.8	7.5	5.5	0.3	0.4
Noyabrsk	30.4	33.5	27.5	23.8	13.0	14.4	21.5	18.8	6.5	7.9	1.1	1.6
Priuralsky	4.3	13.6	16.0	10.6	20.2	10.6	30.9	30.3	20.2	25.8	8.5	9.1
Tarko-Sale	14.8	14.5	16.9	20.9	15.0	17.4	36.6	32.3	15.6	13.5	1.1	1.4
Salekhard	18.6	24.8	31.4	32.7	9.5	8.5	21.8	14.5	17.3	15.2	1.4	4.2
Tazovsky	7.8	8.7	10.1	13.9	11.6	8.7	32.6	27.0	33.3	36.5	4.7	5.2
Shuryshkarsky	4.7	3.2	13.2	13.0	23.6	20.8	24.5	24.7	26.9	33.1	7.1	5.2
Yamalsky	1.0	1.1	12.7	15.9	5.9	13.6	24.5	14.8	39.2	39.8	16.7	14.8

Source: YNAO Department of Employment, 2012

Monthly variations in the number of people who are recognised as unemployed every month are often of a seasonal character. The largest unemployment numbers were recorded in February 2011: 69 people, including 23 fishermen formerly employed by the Salemalsky Fish Processing Factory (a municipal enterprise). The registered unemployment was at its lowest in September (12 people).

8.3.4.1 SMALL BUSINESSES

Despite the specific “northern "character and predominantly single-industry nature of the YNAO economy, the small and medium business sector is well developed, in part due to support provided by the authorities.

Over 19,000 small and medium businesses of various types of ownership currently exist in YNAO. According to rough estimates, small and medium businesses employ about 70,000 people, which is equivalent to 19% of the able-bodied population of YNAO. The most developed sectors are construction (28.5%), commerce (21%), real estate operations (16%), and transport (10%).

8.4 LAND USE

8.4.1 LAND USE IN YNAO

8.4.1.1 OVERVIEW

This Section has been prepared on the basis of "Report on the land status and land use in the Yamal-Nenets Autonomous Okrug"[155], taking into account the changes related to re-categorisation of land undertaken by the state in 2012 in accordance with the relevant legal regulations.

Land fund is the collective term which denotes the total area of land vested in different land owners or users or the territory belonging to the administrative division, i.e. the YNAO. According to the state registry of land, the total land area in YNAO is 76,925,000 ha (Figure 8.24).

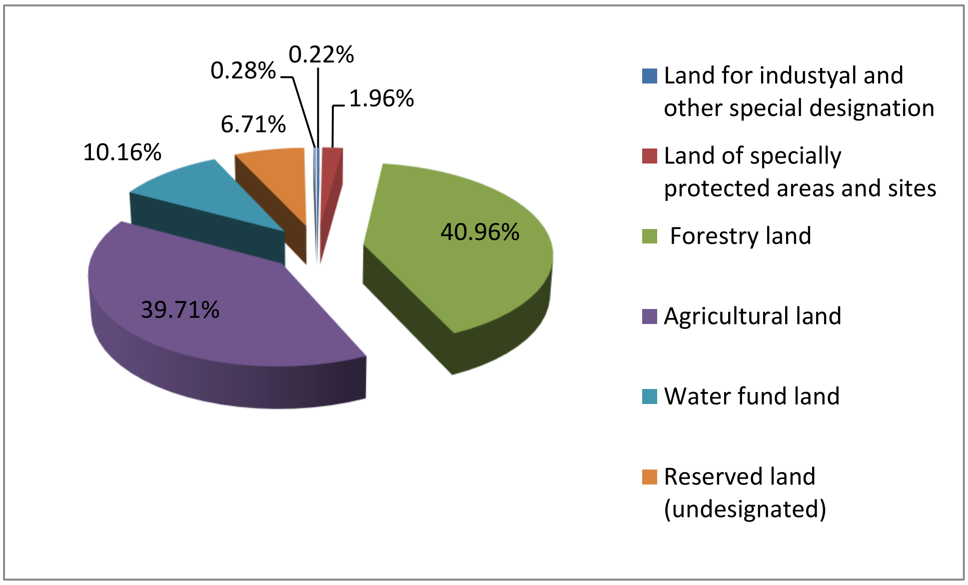

Figure 8.24: Composition of YNAO Land Fund, by Land Use Category

A land use category denotes the land designated for a particular purpose or use. The categorisation of land and re-categorisation[156] of land is performed in conformity with legal procedures.

As shown in Figure 8.23, forestry land and agricultural land are the main land use types in the YNAO land fund.

Annual changes in the land fund structure in YNAO are mainly associated with the on-going industrial development of the region. In 2012, 1,598 land plots with a total area of 9,126 ha were re-categorised as industry lands, including lands previously categorised as:

- agricultural land (7,092.2 ha)
- reserved lands (1,998.6 ha)

[155] The YNAO Department of the Federal State Registration, Cadastre and Cartography Service. Salekhard: 2012.

[156] The process of re-designation of land into another category. Land re-categorisation is a statutory procedure that requires an authorisation and approval by a competent state body/agency.

- forestry land (35.7 ha).

At the same time, 169.6 ha of land in YNAO were re-categorised in 2012 from the industrial land category to the agricultural land after the completion of industrial use on those lands and their subsequent reinstatement.

Table 8.28 provides an overview of changes in the YNAO land fund composition, with a breakdown by land use categories during 2008-2013.

Table 8.28: Dynamics in the YNAO land fund structure, by land use categories (thousand ha)

Land use category	01.01.2008	01.01.2009	01.01.2010	01.01.2011	01.01.2012	01.01.2013
Agricultural land	30,575.8	30,566.7	30,560.2	30,557.2	30,554.2	30,547.2
Land of populated areas	212.6	212.6	212.6	212.6	212.6	212.6
Land for industry and other special designation	131.4	141.9	149.4	152.6	163.4	172.4
Land of specially protected areas and sites	1,509.5	1,509.5	1,509.5	1,509.5	1,509.5	1,509.5
Forestry land	31,506.8	31,506.8	31,506.8	31,506.8	31,506.8	31,506.8
Water fund land	7,814.3	7,814.3	7,814.3	7,814.3	7,814.3	7,814.3
Reserved land	5,174.6	5,173.2	5,172.3	5,172.0	5,164.2	5,162.2
Total land area in YNAO	76,925.0	76,925.0	76,925.0	76,925.0	76,925.0	76,925.0

8.4.1.2 SUMMARY OF LAND TYPES

Agricultural land. Agricultural land is defined as land located outside of residential settlements and allocated for the needs of the agricultural sector and associated activities. The lands of this category represent the main asset for agricultural production; they have a special legal status and are subject to special protection aimed at the preservation of the land area, prevention of any adverse processes and the improvement of soil fertility.

Agricultural land in YNAO includes predominantly land plots allocated to various types of agribusiness enterprises and entities (partnerships, communities, cooperatives, state-owned and municipal unitary enterprises, scientific research institutions) for traditional economic activities. Furthermore, this category also includes land plots located outside of residential settlements and allocated to individuals for their private agricultural husbandry activities, household/subsistence needs, gardening, horticulture, animal ranging, hay harvesting and livestock grazing.

As of January 2013, the agricultural land area in YNAO is 30,547,200 ha, of which 160,700 ha belong to the land re-distribution fund157. In comparison with 2008 data, the agricultural land area has decreased by 28,600 ha.

Land of populated areas. This land use category includes lands used and designated for residential development. The boundaries of urban and rural residential areas separate them from other land categories. Demarcation or modification of boundaries of the populated areas is based on the approval or alteration of the master plan of an urban area, municipality, settlement or inter-settlement territories.

In total, lands of populated areas in YNAO make up 212,600 ha (as of January 2013), of which 83,300 ha consist of the urban residential areas and 129,300 ha comprise rural settlements.

Lands for industry, energy sector, transport, communications, radio and TV broadcasting, information technologies, as well as those associated with space exploration facilities, defence, security and other special purposes. This land use category includes lands that are located outside of the boundaries of a residential area and are used or designated for activities and/or facilities related to the sectors and remits listed above.

As of January 2013, the total area of this land use category in YNAO is 172,400 ha. Figure 8.25 shows the dynamics of an increase in this land category during the past decade, indicating the total increase in the area by 57,600 ha.

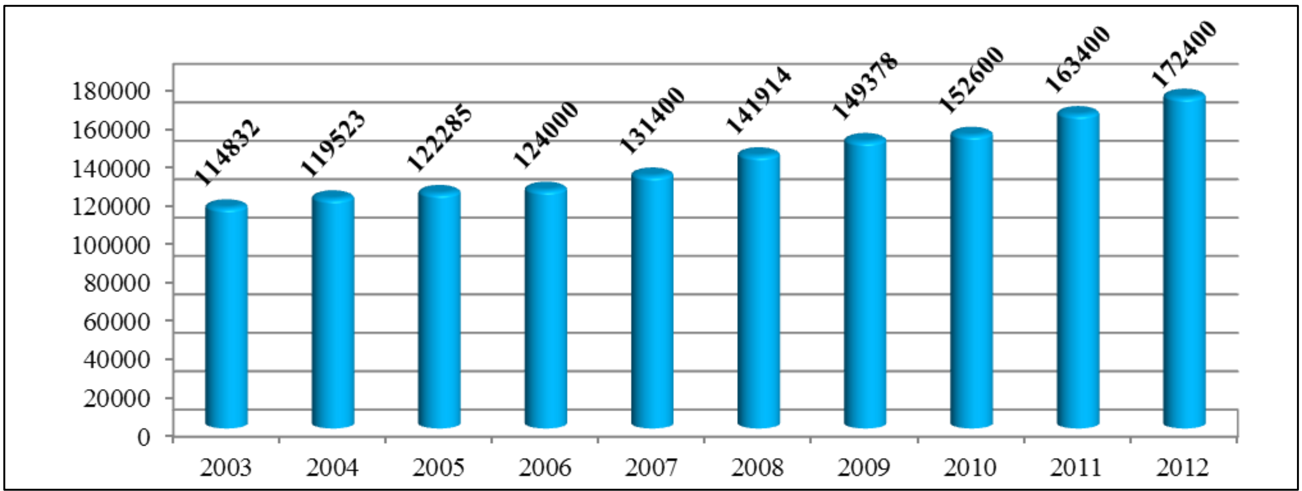

Figure 8.25: Dynamics of lands for industry, energy, transport, communications, radio and TV broadcasting, IT, space exploration facilities, defence, security and other special purposes in YNAO, by area (ha)

In YNAO, the following lands belong to this particular category:

[157] The land re-distribution fund is comprised of agricultural land plots in the following circumstances: voluntarily waived lands; in the absence of heirs/inheritance beneficiaries; in cases of waiving land inheritance to the state; or as a result of compulsory expropriation of land triggered by law (e.g. in case of an inappropriate use of land). Lands from the re-distribution fund are used for the establishment or expansion of agricultural entities, individual husbandries, and other designated agricultural purposes. Source: http://www.nice-land.ru/faq/102/quest121.html

- Industrial land: 135,500 ha – land plots allocated for office and industrial buildings, structures and installations and associated auxiliary facilities, as well as land plots allocated to the mining and oil and gas enterprises for exploitation of mineral resources.
- Land of transport facilities: 35,800 ha – land plots allocated to enterprises, entities and organisations providing transport services (railway, motor transport, civil aviation, pipelines, maritime transport, inland water transport) for special services associated with the maintenance, construction, upgrade, repairs and development of transport facilities and services.
- Land for special purposes: 1,100 ha – land of any other special purpose includes land plots allocated for various purposes not indicated for the other land use categories.
- Land of specially protected territories and objects. In accordance with the applicable legislation, this land use category includes legally protected territories and features of particular value related to nature conservation, scientific, historic, cultural, aesthetic, health and recreational significance, or other valuable properties. Pursuant to the relevant regulations, these types of land are exempt in their entirety or in part from commercial exploitation and economic turnover; and have a designated legal status. In YNAO this land use category comprises the two state nature reserves with the total area of 1,509,500 ha:
  - Gydansky nature reserve (878,200 ha) in Tazovsky District; and
  - Verkhnetazovsky nature reserve (631,300 ha) in Krasnonselkupsky District.

There are also five areas of recreational designation that have protected status (recreational facilities, skiing resort, a touristic and recreational facility, etc.), with the total area of 41 ha.

In addition to the abovementioned specially protected territories, there are also 10 state nature reserves in YNAO with the total area of 4,030,600 ha, as well as the nature park "Yuribei" (509,500 ha) and the geological nature memorial "Kharbeisky" (650 ha). See Chapter 7 for further details.

Forestry land comprises forest land, including:

- areas covered with the forest-type vegetation;
- those not covered with forests, but designated for re-forestation purposes, such as cutover areas; areas affected by forest fires; sparsely vegetated forest sections, glades; etc.,
- non-forest land plots designated for purposes associated with the forestry husbandry (clearings, roads, marshlands, etc.).

As of January 2013, the total area of forestry land in YNAO is 31,506,800 ha. About 59% of this land is comprised of the areas actually covered with forest.

<u>Water fund land.</u> The RF Land Code stipulates that the water fund category refers to the land covered by the surface water bodies, as well as the land occupied by the hydro-engineering and other facilities located on water bodies.

The water fund land area in YNAO is 7,814,300 ha.

<u>Reserved lands.</u> In accordance with the RF Land Code, the reserved land is the land in the state ownership or in municipality ownership, which is not allocated to individuals or legal entities, with an exception of the land included in the land re-distribution fund (described above).

The total area of reserved lands in YNAO is 5,162,200 ha (as of 01.01.2013).

8.4.1.3 DISTRIBUTION OF LAND RESOURCES FUND IN YNAO BY TYPE OF UTILITY VALUE

In the state land registry, land resources are also assessed on the basis of certain utility properties permitting their use for specific economic purposes. To this effect, the land resources are primarily divided into those that have the capability to be utilised for agricultural purposes (arable land, fallow land, land used for perennial crops, hayfields, pastures) and non-agricultural land resources (forests, shrubs, marshes, roads, built-up areas, ravines, sands, etc.).

Forests and areas with tree and shrub vegetation account for the largest share in the structure of land resources in YNAO. The distribution of these lands and other types of land resources by area is as follows:

- forests and shrubs - 24,550,300 ha or 32% of the Okrug's total territory,
- tundra areas - 22,939,800 ha or 29.8%,
- water bodies – 13,482,400 ha or 17.5%, and
- marshlands - 13,047,300 ha or 16.9% of the total YNAO area.

<u>Land occupied by roads.</u> The area occupied in YNAO by roads is 75,600 ha. Most of it (59,600 ha) belongs to the industrial land category. Some 4,700 ha of land occupied by roads is located on the land of populated areas.

<u>Other land resources.</u> This land category includes landfills for waste disposal, sands, land areas under conservation and other land currently not in use. It also includes land suitable for reindeer pastures.

The area of this type of land resources in YNAO is 25,348,000 ha, of which 22,939,800 ha is tundra land. Most land resources of this type are classified as agricultural land.

<u>Land resources used as reindeer pastures.</u> Reindeer pastures are located in the following ecosystems, where the existing vegetation cover is suitable for reindeer foraging:

- tundra and forest tundra,
- boreal forest (northern taiga).

Reindeer pastures can occupy various types of land resources (forests, marshlands, shrub tundra and other types of tundra).

The total land area suitable for reindeer pastures in the Okrug is 48,974,800 ha, of which 22,939,800 ha is on the tundra. Out of all land suitable for reindeer pastures, over 45 million hectares has been allocated for reindeer breeding to enterprises, organisations and individuals.

8.4.1.4 DISTURBED LAND

Various types of industrial activities and operations related to the development of mineral resources and earthworks result in the disturbance of soil and vegetation cover. Any land that has lost its utility value or has been subject to the adverse impact in the form of damaged soil cover, hydrologic conditions and factors of man-made origin as a result of industrial activities is considered to be disturbed land.

The total area of disturbed land in YNAO is 119,100 ha, including:

- 63,000 ha of agricultural land,

- 36,300 ha of forest fund land,
- 16,000 ha of industrial land,
- 1,500 ha of reserve land,
- 1,100 ha of land for populated areas,
- 1,000 ha of land for transport facilities, and
- 200 ha of land for other special purposes.

8.4.2 LAND USE IN YAMALSKY DISTRICT

The territory of Yamalsky District comprises the land of historically developed rural settlements, including:

- land for general public use (common land);
- territories under the traditional use by the local population,
- land required for the development of Yamalsky District,
- industrial lands,
- water bodies, and
- other areas within the District boundaries used for the needs of the local communities, regardless of the forms of land ownership and purpose-oriented designation[158].

Land distribution in Yamalsky District with a breakdown by the land use categories is presented in Table 8.29 below[159].

Table 8.29. Land distribution by land use categories in Yamalsky District, ha

Category	Total for the municipality
Total land area within the boundaries of the municipality, of which:	14,872,653[160]
Land for residential settlements	7,026
Land for industrial, transport, energy and defence facilities and other purposes	4,647
Forestry land	75,521
Water fund land	2,326,552
Reserved land	1,263,652
Agricultural land	11,195,255

Pastures account for 75.27% of land resources in Yamalsky District[161]. All agricultural lands in Yamalsky District are used as the reindeer pastures.

[158] Statute of Yamal District Municipality, ямальскийрайон.рф

[159] Source: Passport of Yamal District Municipality for 2004. Settlement of Yar-Sale, 2005

[160] All land in Yamalsky District is in the Federal land ownership.

Grazing land is categorized as follows depending on the seasons:

- Winter pastures;
- Early spring pastures;
- Late spring pastures;
- Summer pastures;
- Early autumn pastures;
- Late autumn pastures.

According to the map provided by the head of Ilebts Commune (see Annex A), summer pastures are mainly located along the western part of the Yamal Peninsula, while spring and autumn pastures tend to be located in the central and southern parts of Yamalsky District. Winter pastures are very limited in size and situated in the eastern and northern sections of the Peninsula.

Grazing lands used by enterprises often include all-season grazing land areas concentrated close to each other with clear boundaries between each brigade's land parcels.

Additional data referring to the land use in Yamalsky District, as well as cartographic information were obtained as a result of ethnocultural studies conducted in May-August 2013 (see Figure 8.27). These studies identify that a specific feature of the reindeer herding sector within the subject area is that the nomadic reindeer herders do not make annual migrations (*kaslaniye*) southwards, instead staying with their reindeer herds on the northern tundra. Reindeer herds owned by families and communities do not leave the northern part of the peninsula throughout the entire year, making only limited local circular migrations within a range of a few tens of kilometers. Reindeer herds owned by municipal enterprises undertake longer migrations than those of privately owned herds and spend summers at the western coast of the peninsula and migrate in winter landwards. However, they also do not leave the northern part of the peninsula throughout the year and stay north of the latitude of 70º E.

8.4.3 LAND USE WITHIN THE BOUNDARIES OF YLNG LICENCE AREA AND ON NEARBY TERRITORIES

The Yamal LNG licence area is located on the agricultural lands that are in the jurisdiction of MOP Yamalskoye and on the industrial lands that are in use by Yamal LNG.

The area of the South-Tambey gas condensate field development is the brownfield site previously used for industrial purposes. There are neither agricultural type facilities nor permanent dwellings in the locations of the Project assets. Tambey factoria is located 30km from the main Project facilities, within the Yamal LNG licence area. There are no other installations/assets of non-industrial designation in the licence area. The permanent population residing in Tambey factoria is small - 34 people according to the All-Russia population census of 2010 (see Section 8.2.3 and 8.2.4 for further details). This area is actively used by local reindeer herders for seasonal migration of reindeer herds.

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[161] Report by the Head of Yamalsky District Municipality "On achieved performance indicators of activities of Yamalsky District municipal administration in 2010 and planned target for the next three-year period", 2011

Ethnological field studies conducted during the period from May through August 2013[162] obtained additional information related to:

- the number of people and their reindeer stocks using the grazing land within the Project license area and its immediate vicinity
- specific aspects of land use in those areas.

Different phases of these studies were carried out in the city of Salekhard, the Yar-Sale and Seyakha settlements, as well as in the factorias of Tambey and Vanuy-Yakha. The assignment included expert interviews with representatives of the administration, heads of local communities and reindeer-breeding enterprises on issues related to the current status of traditional use of natural resources and the ethnocultural environment. A group of experts visited some nomad camps of reindeer herders located at that time in the vicinity of the Tamboy-To Lake and upstream of the Sabetta River mouth (a nomad camp of the Ilebts Commune). With the help of a guide (one of the local elders) they held several in depth interviews with the reindeer herders on issues of natural resources usage (reindeer husbandry, hunting, fishing, gathering etc.) and distribution of nomadic population within the Project area of influence.

According to the findings of the ethnocultural studies, the Project license area and the territory in its vicinity is used by members of the Ilebts Commune and some private reindeer owners with their families (see Figure 8.26).

[162] "Research of Traditional Nature Use and Ethno-Cultural Environment within the Area of Influence of the South Tambey Gas Condensate Field Development Project. South Tambey License Area", "Yamal LNG" JSC, Moscow-Sabetta-Petersburg 2013, prepared by FRECOM

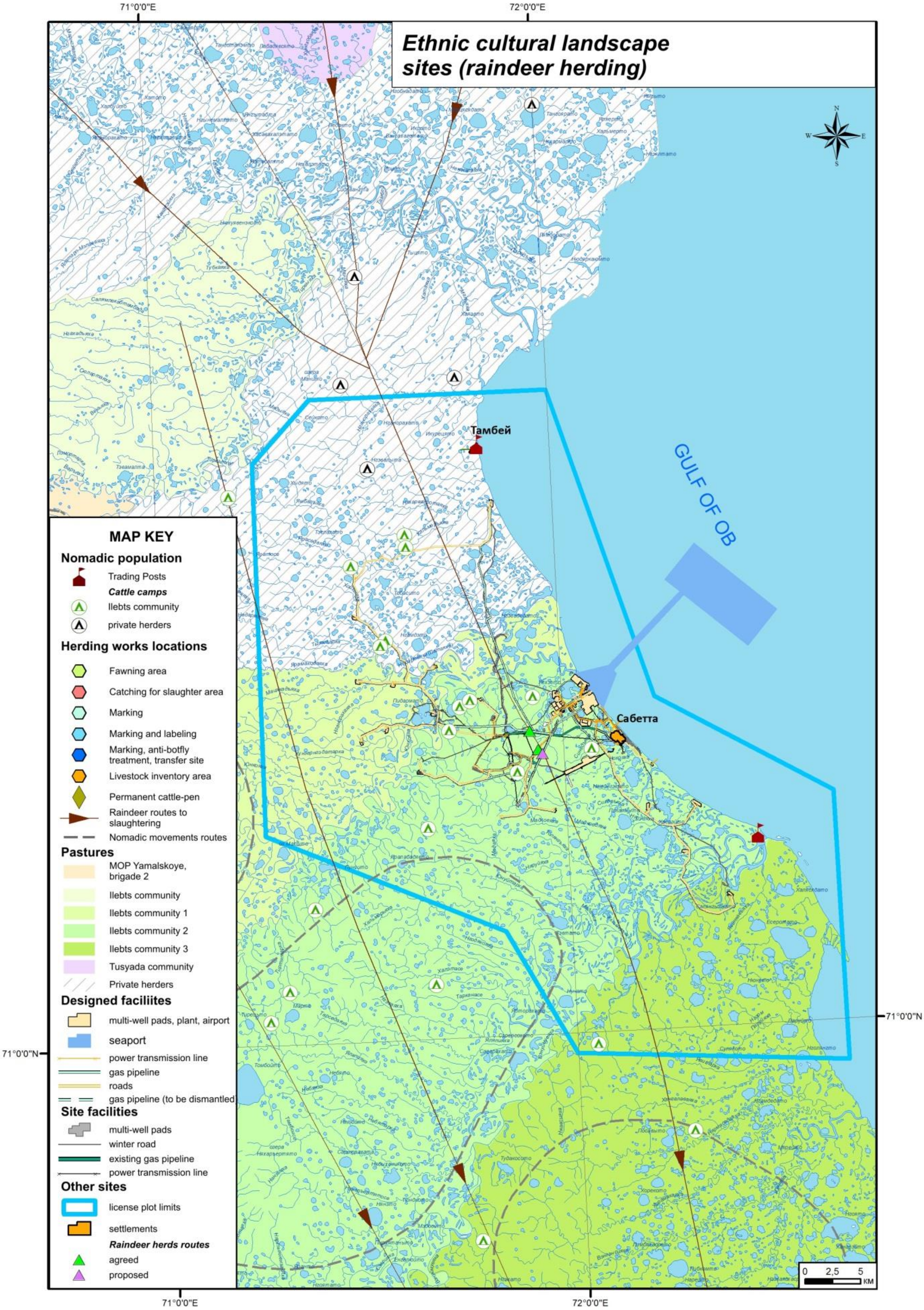

Figure 8.26: Land use within the Project license area and in its direct vicinity

According to the latest data, 56 families migrate within the license area. Exact information on current reindeer loads in the Project direct AoI is not available due to absence of systematic centralised state data interconnecting known numbers of stock and the particular pastures they are using. Reliable baseline information on reindeer loads is also difficult to ascertain as herds are constantly moving.

For the purpose of cooperation during joint nomadic migrations, several families form a provisional camp consisting of two or three *chums*. The nomadic migration patterns of these groups are almost identical: primarily they use the grazing land along the Sabettayakha and Vanuymueyakha rivers and their tributaries, as well as the areas between the rivers (the major surface water bodies in the area are shown on Fig. 8.27 below). The areas close to the water divide are used with a relatively low intensity. The migration pattern is circular, from the lower reaches of the Sabettayakha River along its right-hand bank up to its upper reaches; then from the upper reaches of the Sabettayakha River to the upper reaches of the Vanuymueyakha River and then toward its lower reaches. Some reindeer herders migrate along the left-hand bank of the Sabettayakha River (the peripheral zone of the area allocated for the Project development) and in the lower reaches of the Vanuymueyakha River on its right-hand bank; however, in the latter case the use of the land for grazing is not especially intensive because of the specific characteristics of that land (high degree of swamping, etc.).

According to the information provided by GU "Association for Economic Development of Indigenous Peoples of the North", traditional fishing grounds used by local communities in summer and autumn are located within the license area in the Sabettayakha and Vanuymueyakha river basins and on adjacent lakes.

The findings of the ethnocultural field studies have also confirmed that the main fishing grounds of the region are located on the eastern coast of the northern part of the Yamal Peninsula (the lakes of Libkomto and Nareyto, as well as the Tirvy-yakha, Vanuymueyakha, Sabettayakha, Varyakha and the lower reaches of the Tambey River), and primarily the estuaries of the Tambey, Sabettayakha and Vanuymueyakha rivers. During the late autumn season, reindeer herders come to this area from the central part of the Yamal Peninsula for seasonal fishing. Among them are private reindeer herders and members of communities, as well as (to a lesser degree) reindeer herders from MOP Yamalskoye. The Project license area is also used for bird hunting and gathering of waterfowl eggs, wild berries and mushrooms in the summer-autumn seasons.

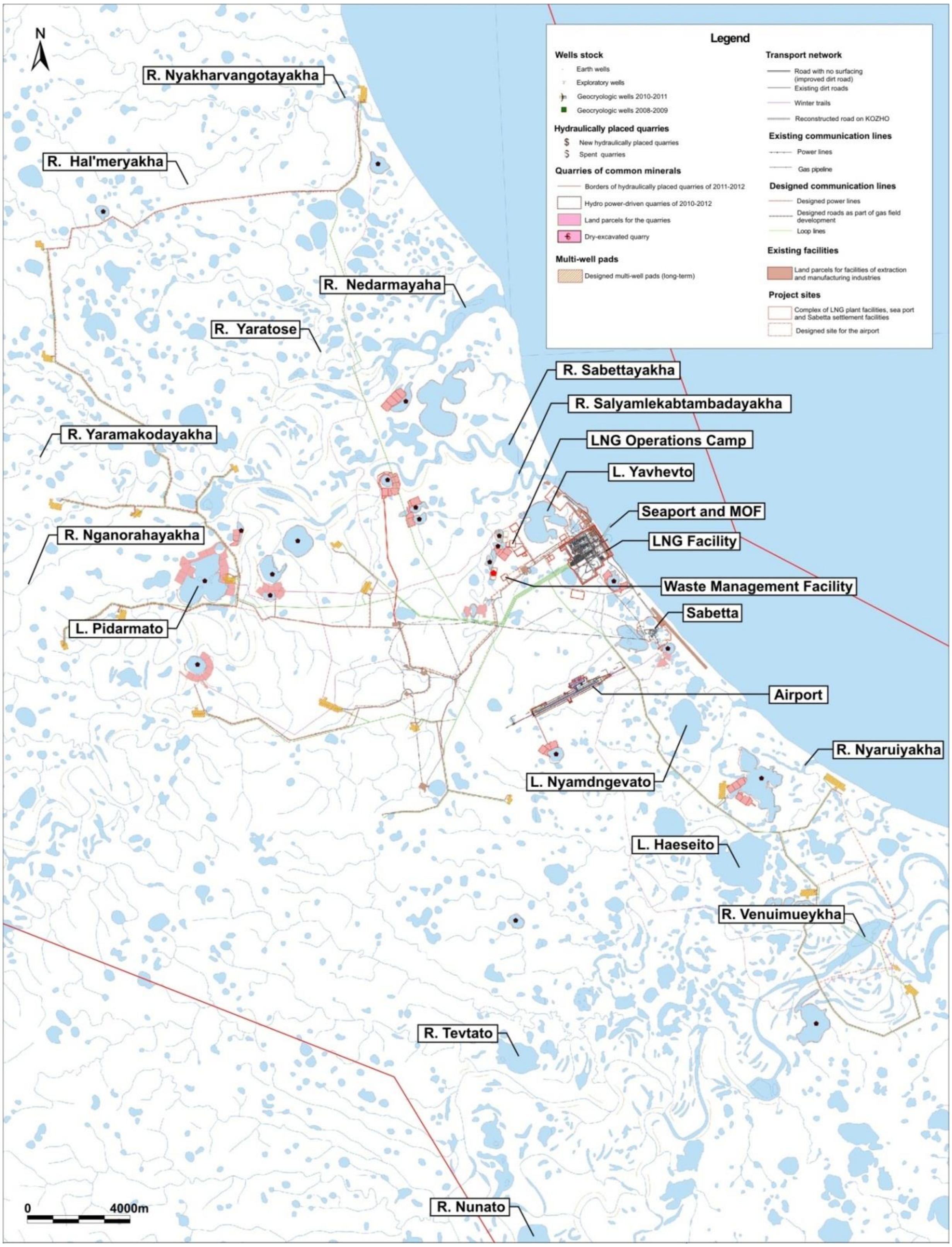

Figure 8.27: Major Surface Water Bodies Located on the Project Licence Area

Migration routes used by the reindeer herders are typically set up on the most convenient locations that are relatively passable (less elevated and less exposed to wind), including availability of favourably located water crossings. Migration routes of reindeer herder brigades are based on the traditional nomadic paths. Reportedly, each enterprise is provided with a map with the charted migration routes. However, these maps were not available during baseline data collection.

Descriptive information on migrating routes of MOP Yamalskoye with an indication of each herder brigade's reindeer stock size was provided in March, 2013 by the YNAO Department for Agricultural Sector Development. However, the insufficient level of detail of this data and the unavailability of accompanying map material do not allow this information to be used as a sole ground for the assessment of Project impacts on land use.

Data obtained as a result of the ethnocultural field studies mentioned above (May-October 2013), indicate that the routes of longer migrations in the northern part of the Yamal Peninsula are associated with the location of the nearest reindeer slaughtering facility in the settlement of Seyakha. Some migration routes partially cross the license area or run in its near vicinity.

Annually (once per year in autumn) the herds of the Tusyada Commune, Khabeyakha Commune, SPSK Ilebts, Brigade #9 of MOP Yamalskoye and Brigade #4 of OOO Valama are driven to the slaughtering facility through the license area. In addition, herds of Brigade #2 of MOP Yamalskoye are driven in the direct vicinity of the license area to the slaughtering facility in Seyakha. There are three routes for driving reindeer herds to the slaughtering facility (see Figure 8.28).

Routes for migration of reindeer herds to the slaughtering facility:

a) Route #1

The main route for driving reindeer herds to the slaughtering facility is located in the eastern part of the peninsula. It is used by Brigade #9 of MOP Yamalskoye, Brigades #4 and #5 of OOO Valama, and the Tusyada and Khabeyakha Communities. A reindeer herd for slaughtering is prepared by each of the above groups independently and driven to a gathering station located in the upper reaches of a nameless watercourse tributary to the Nganorakhayakha River, where the herds are combined to form a joint herd, which is then driven along the final section of the route. The route enters the Project license area 3 km to the south of the gathering station. The route then runs southwards, crossing the Nganorakhayakha River in its middle reaches (15 km from the river mouth) and the lower reaches of the Khalmeryakha River, and then exits the license area 2 km to the west from the upper reaches of the Yavitarka River.

b) Route #2

This route runs through the western part of the license area and is used by Brigade #5 of MOP Yamalskoye and by reindeer herders from one of the divisions of SPSK Ilebts. The herds enter the license area in the middle reaches of the Yabta-Nedarmayakha River and the middle reaches of the Khunzerngedatarka River, and exit the license area in the vicinity of Punsito Lake.

c) Route #3

This route runs to the west of the license area without crossing its boundary and is used by Brigade #2 of MOP Yamalskoye. The route runs from the middle reaches of the Varyakha River through the middle reaches of the Yalyatarp-Khalmeryakha River - the mouth of the Tyrabeiyakha River (a right-hand tributary of the Sabetayakha River) - the Tomboyto Lake - the Serto Lake to the settlement of Seyakha.

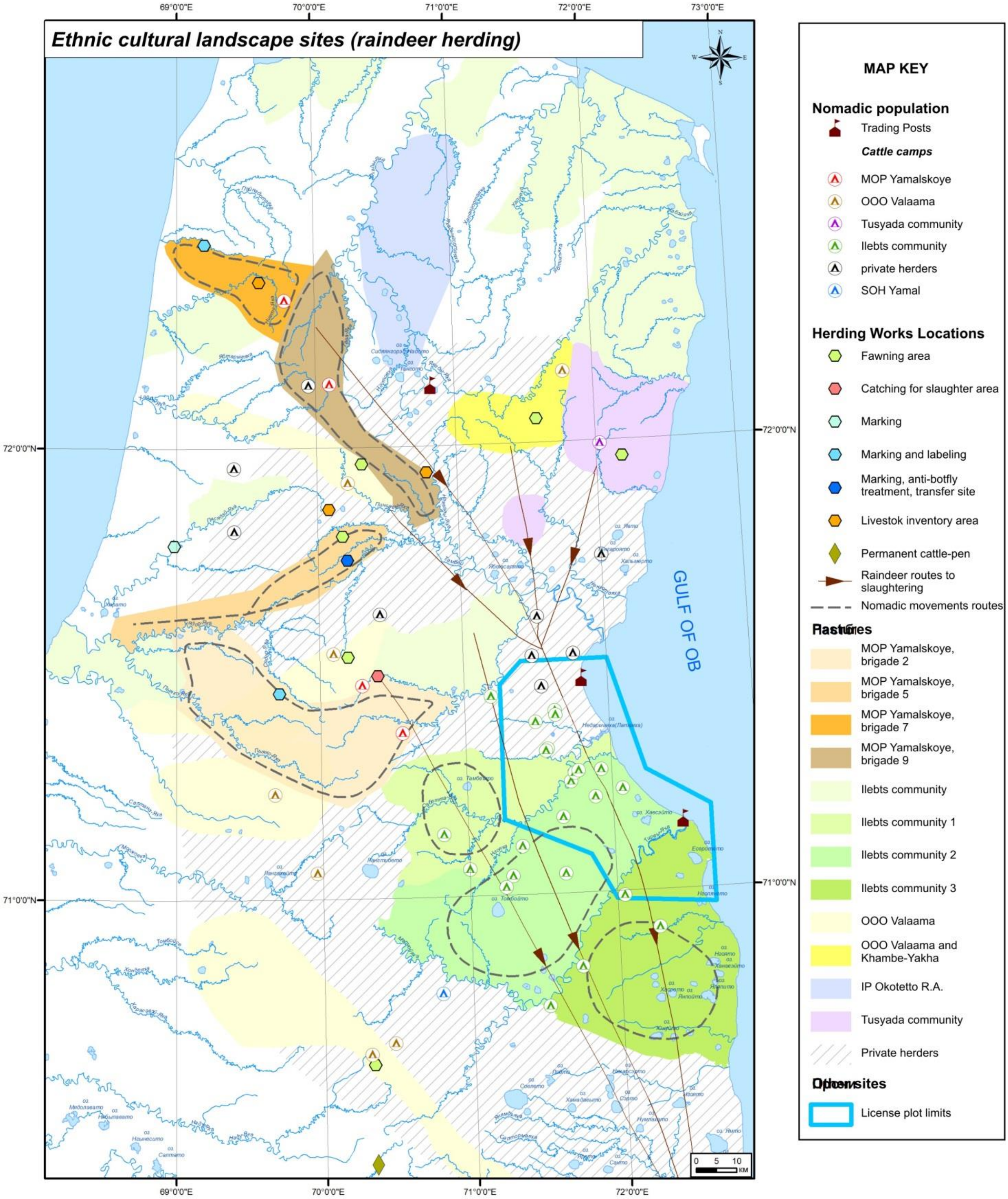

Figure 8.28: Land use and migration routes of reindeer herds in Seyakha tundra

According to an Arctic Research Centre researcher interviewed as part of the baseline preparation, the overall degradation of pastures in the Seyakha tundra and their reduced productivity as a result of the overgrazing lead to a gradual shift of the local herders' migrations along the coast of the Gulf of Ob further north toward the Malygin strait, as well as southward in the direction of Nadym.

8.5 SOCIAL INFRASTRUCTURE AND SERVICES

8.5.1 PUBLIC HEALTH SYSTEM

Altogether 43 hospitals (5,397 beds), 58 outpatient and policlinic facilities, 2,344 physicians and 6,468 medics/nurses are available in YNAO.

The average staffing level[163] is 93.7% for doctors and 95.9% for nurses.

The major healthcare issues in YNAO are:

- limited access to medical assistance for the rural population, particularly for the tundra people;
- shortage of qualified medical staff;
- inadequate provision of the rural population with medicines.

Medical aid to the population in remote areas is provided through five branches of the dedicated sanitary aviation located in Salekhard, Nadym, Tarko-Sale, Tazovsky settlement and in Seyakha village. The migratory population is also reached by mobile medical crews and designated itinerant paramedics.

The medical care to the Yamalsky District population is administered by[164]:

- one central district hospital in Yar-Sale settlement, consisting of four inter-district clinics, one out-patient clinic and one stationary paramedic station;
- 25 mobile paramedic units to serve migratory population, currently staffed with 23 paramedics and 14 health assistants. In view of industrial development activities in the district, a medical assistant is always on duty at the Ob – Bovanenkovo railway construction site. Information on the medical staffing levels in Yamalsky District is shown in Table 8.30.

Table 8.30: Availability of Medical Personnel in Yamalsky District, 2011-2012

	2011	2012
Number of doctors	54	52
Doctors /population ratio, per10000 people	32.95	28.70
Number of doctors who obtain the specialist certification	54	47
Outpatient clinics / population ratio, per10,000 people	150.8	147.7
Number of middle-level medical staff	203	193
Number of middle-level medical staff who obtain the specialist certification	190	193

[163] Level of medical staffing is calculated as a ratio between a number of medical vacancies taken and a number of staff positions required for a certain medical facility, expressed in percentage (%).

[164] Report on socio-economic development of Yamalsky Municipal District. 2012. Source: ямальскийрайон.рф

Table 8.30: Availability of Medical Personnel in Yamalsky District, 2011-2012		
Number of middle-level medical staff who obtain the qualification category	161	149
Middle-level medical staff / population ratio, per 10,000 people	123.9	119.6

Source: Report on socio-economic development of Yamalsky Municipal District, 2012

The levels of bed capacity in the Okrug and in the administrative districts (as of the end 2012) are shown in Table 8.31.

Table 8.31: Bed capacity indicators in YNAO, 2012

Administrative units (Municipal Districts, Cities)	No. beds	Bed/population ratio, per 10000 people	Hospital admission level, per 1000 people	Average duration of treatment, days	Hospital mortality
YNAO	4,960	92.4	243.1	11.2	0.6
Shuryshkarsky	95	96.9	298.0	10.2	0.6
Priuralsky	160	105.8	306.7	10.4	0.4
Yamalsky	*158*	*96.6*	*320.9*	*8.9*	*0.3*
Tazovsky	157	91.3	295.0	9.3	0.3
Nadymsky	550	80.5	218.1	10.7	0.7
Purovsky	351	67.8	207.3	9.4	0.7
Krasnoselkupsky	72	120.9	332.9	10.6	0.4
City of Novy Urengoy	847	75.5	198.4	10.4	0.6
City of Salekhard	1,006	225.4	385.2	16.4	0.8

Note:

highest parameter

lowest parameter

Source: YNAO Department of Public Health, 2013

Indigenous peoples, including the nomadic population of YNAO, have access to free medicine supply. During traditional festivals (Reindeer Breeder's Days) the tundra people are provided with free food for babies (under two years of age) and free medical kits with first-aid medicines.

However, the indigenous peoples (including the nomadic population) do not receive medical services of the same quality as people living in villages or towns. This is due to limitations in the levels of qualified medical personnel in district centres, and more particularly in smaller villages where doctors specialising in specific areas are practically absent. Despite relatively high numbers of outpatient clinics and hospital beds, the level of coverage by medical and preventive services availability to the population (especially the nomadic population) remains low. General therapeutic care is not available to residents of the tundra, let alone specialised care.

During the expedition "Yamal Arctic 2012", interviews with200 representatives of the local population living in Gyda, Seyakha, Mys Kamennyi and Novy Port were performed by questionnaire. The questionnaire mainly included items related to health and medical services[165].

Out of the total number of interviewed individuals, 151 (126 women and 25 men) represented indigenous population and 49 persons (34 women and 15 men) were interviewed as representatives of the immigrant population (hereinafter referred to as 'alien' persons). However, by the moment of conducting the research these people had been living in the abovementioned settlements for a sufficient period of time.

Half of the indigenous respondents and one third of the 'aliens' mentioned that their health had been affected due to the inadequate medical services. About three quarters of all interviewees believed that changes in the medical care were needed, but only one fifth of the respondents pin their hopes on the efforts and decisions made by the government agencies and authorities. Mainly indigenous respondents expected measures to be taken by the authorities, but at the same time they were least sure that any changes were probable in the field of public healthcare.

Air medical services are provided for the nomadic population. However, tundra residents do not have proper communication with prevention and treatment facilities. Many reindeer herders are willing to, and some do use cellular communications or portable radios. However, this does not fully resolve the communication problems due to poor cellular coverage and a lack of portable radio equipment.

Yamal LNG medical personnel stationed at the medical unit within the Project licence area (Sabetta camp) currently comprise four staff per 12-hour shift, i.e. eight medical staff in total. Emergency medical treatment at this unit is available to all personnel present at the South Tambey gas field and also to local residents. The first-aid station is capable of accommodating four patients. Regular medical examinations of employees are organised at the site (including checks of drivers for alcohol). According to information from the medical staff, typical cases being treated include eye injuries. Some nomadic people informally resort to the services of this first aid station or to obtain medicines, most frequently in relation to minor health disorders (eye, acute respiratory diseases, etc.)[166].

8.5.2 EDUCATION

The YNAO public education system consists of 507 educational institutions, including 387 institutions under the jurisdiction of government education authorities.

Altogether 29,600 children attend one of 196 pre-school educational institutions and six educational institutions for children of pre-school and elementary school age.

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[165] See E.R. Mirdaleyeva, A.I. Popov, A.A. Lobanov "Healthcare in Difficult to Access Areas of Yamal. From a Patient's Viewpoint", GKU YaNAO "Arctic Research Centre", Salekhard, 2012

[166] Nevertheless, it should be pointed out that during the survey performed in December 2012 (see Section 8.1), only one out of 38 respondents migrating within the Project area with his family / community / enterprise indicated that Sabetta was a possible place for receiving medical services.

General education is provided by 143 general education institutions, including two non-government Christian Orthodox gymnasiums. Educational institutions consist of 15 primary, nine basic and 111 secondary full-time federal and municipal institutions of general education and 6 evening general education schools. Of all the full-time secondary comprehensive schools, 85 (63%) comprehensive schools are located in towns and 50 schools (37%) are in rural areas.

Advanced level programmes are implemented by 14 general education schools with 11,200 students including five gymnasiums, one lyceum and eight schools with enhanced study of subjects.

There are 42 additional education institutions in YNAO, comprising 24 educational centres, seven community centres, 8 schools and 3 stations. Children's additional education institutions are found in all towns and districts of YNAO.10 children's additional education institutions are located in rural areas.

Ten state-owned vocational education institutions, including five primary and five secondary vocational institutions function in the Autonomous Okrug in accordance with the primary and secondary vocational education programme. A non-government vocational education institution, functioning in the Okrug under the sponsorship of OAO Gazprom, is the Novo-Urengoy Technical School of Gas Industry.

The YNAO's education system faces the following issues[167]:

- Insufficient accessibility of pre-school education;
- limited opportunities for high quality education for physically challenged children and young people;
- insufficient development of general, additional and vocational education in terms of incentives for technical creativity of students, engineering and inventive activities commensurate with economic needs of the region;
- lack of correspondence between the special subjects provided by vocational institutions and the future needs of the YNAO labour market;
- lack of correspondence between the existing system of advanced training of school teachers/management staff and targets of the innovative model of education.

In Yamalsky District, there are 18 educational institutions in total, including:

- seven pre-school educational institutions;
- six comprehensive educational institutions (schools/boarding schools);
- one vocational training school;
- one children's additional educational institution;
- one municipal educational institution for orphans and children without parental support;
- two municipal institutions of pre-school and primary education.

The more detailed data on these institutions and the pupil/capacity ratio is presented in Table 8.32.

167 'Strategy for Socio-Economic Development of YNAO till 2020', http://de.gov.yanao.ru/index.php?option=com_content&view=article&id=263.

Table 8.32: Educational institutions in Yamalsky District

	2009		2010	
	No. of institutions	**No. of pupils/places**	**No. of institutions**	**No. of pupils/places**
Pre-school	7	555/459	7	563/467
Primary schools-kindergartens	2	555/459	2	98/121
Boarding schools (secondary education)	6	3113/3044	6	3215/3044
Activity centre for school children	1	1274	1	1127
Vocational training (apprenticeship) school	1	128	1	124
Orphanage	1	50/70	1	46/70
Total	18	3932*	18	3922

Source: Report on Socio-Economic Situation in Yamalsky District, 2011.

A comprehensive boarding school is located in Seyakha village. It has 525 pupils, including 447 Nenets children.

The breakdown of education levels in Yamalsky district is as follows:

- 33% of the population has received vocational education (with 6% having high vocational education;
- 20% with secondary education and 5% with primary education);
- 62% of the population has received general education (with 15% having comprehensive secondary education,21% compulsory general education and 26% primary education);
- 5% of residents in Yamalsky District have not received primary education.

Due to the prevalence of rural communities and the lack of vocational and high education institutions, the educational level of the Yamalsky District population is relatively low.

The issues typical for the educational institutions in the District include the following:

- the number of students in boarding schools considerably exceeds the pupil capacity, including the available bed and canteen capacities;
- the lack of suitable classrooms with the resulting need to arrange tuition in two shifts per day;
- the lack of dedicated facilities for the children’s activity centre;
- poor condition of the buildings.

8.5.3 SOCIAL INFRASTRUCTURE

At present there are 226 cultural institutions (five federal and 221 municipal institutions) in YNAO, including:

- 78 municipal libraries; 83 social/recreation institutions with branches (national culture centres, recreation centres, youth clubs and culture/recreation centres, handicraft centres)
- 38 general arts and cultural educational institutions

- 19 museums
- three cultural institutions of other types.

115 of all cultural institutions are located in rural areas.

Major cultural infrastructure issues include:

- shortage of space that meets sanitary and fire protection requirements (the majority of facilities are made of wood and date back to the 1960s/70s);
- poor material and technical base of rural institutions of culture (absence of internet access, lack or considerable wear of computer equipment, specialised equipment and furniture); this considerably reduces attractiveness of these cultural institutions for people;
- shortage of professional personnel and specialists with higher vocational education (including IT professionals);
- different level of the infrastructural development of cultural institutions in rural areas compared with urban areas resulting in inequality in terms of access to information and benefits of culture.

YNAO has 883 sport facilities, including 386 gyms and 33 swimming pools, and 174 open athletic facilities (fields and grounds).

The major issues associated with physical culture and sports include:

- inadequate provision with modern sport facilities;
- unequal opportunities for rural and urban population of YNAO.

Youth institutions consist of 26 community-based clubs for teenagers and young people and 27 clubs and associations for young families.

Out of all institutions, 30 (i.e. 76.9%) are located in urban areas of YNAO; nine institutions (23.1%) are based in municipal districts.

Major youth policy issues include:

- lack of modern infrastructure;
- low level of material and technical support of the institutions.

YNAO has six public libraries, of which four are part of municipal social/recreation institutions, the Okrug's Ethnographic Museum located in the city of Salekhard, Yamal Children School of Music, and a municipal institution of supplementary children education with its two branches in Mys-Kamenny and Seyakha. The current book stock totals 85,059 depository items. In 2011, the libraries received 4,878 new books; the purchase was funded by the local budget and the regional target programme Culture of Yamal.

MUK Yamalsky District Museum currently has 9,966 items/exhibits. This number increased compared to 2010 thanks to stocking of the museum's ethnographical and historical collection through the implementation of a Culture of Yamal target programme and a "Donation" campaign that resulted in more than 200 various museum items having been donated by the public.

In 2011, several programmes were implemented in the district, including regional and municipal task programmes "Culture, language and traditional way of life of indigenous small ethnic communities of the North in YNAO, 2008-2011". The municipal programme helps subsidise organisations engaged in the service and maintenance of trading outposts, delivery of goods to these outposts, and provision of tundra small ethnic communities with firewood.

The implementation of the regional target programme helps pay annual higher education scholarships, refund expenses on extramural courses and accommodation in student's hostels. It also subsidises acquisition of mobile/cellular phones, minipower plants, tarpaulin, stoves, reindeer hides that are used for bedding or as covers and poles used for assembling traditional portable dwellings (*chums*) for the nomadic population.

The following activities are being implemented under agreements on social and economic development of Yamalsky District signed with energy companies operating in YNAO:

- financing of festivals dedicated to the Reindeer Breeder's Day and the Fisherman's Day;
- financing procurement and delivery of firewood and fuel/lubricants to nomadic population;
- acquisition of New Year and Christmas presents for children of indigenous families;
- transportation of nomadic people to areas difficult of access and provision of aircraft services for local agricultural enterprises;
- payments for training and accommodation of students (indigenous people) at the Novy Urengoy Technical College of Gas Industry (founded by Gazprom);
- procurement and delivery of firewood, fuels, foodstuffs and primary commodities to trading outposts.

8.6 SAFETY AND SECURITY

8.6.1 REGIONAL AND LOCAL SAFETY ISSUES

8.6.1.1 NATURAL AND MAN-INDUCED HAZARDS

Natural and man-induced hazards in YNAO include those associated with:

- extreme natural climatic conditions;
- floods;
- natural fires;
- potentially hazardous industrial facilities primarily associated with the production, processing and transportation of oil and gas;
- predominantly wooden housing in inhabited areas.

Ice clogging (jams) are the most likely sources of emergencies during spring high water. Flooding hazards are high in Nadymsky, Purovsky and Shuryshkarsky districts, which are regularly exposed to flooding.

Approximately 93,000 people in 43 settlements in the YNAO are exposed to natural fire risks[168].

There are currently 409 potentially hazardous industrial facilities operating in YNAO, including 270 industrial facilities engaged in production, processing, storage, and transport of oil and oil products.

In the period from 2004 to 2008, two target programmes were implemented in the Okrug:

- Reduction of risks, mitigation of effects and insurance coverage of natural and industrial emergencies (2004-2008);
- Fire control in YNAO (2005-2007).

In addition, a target programme for protection of people and territories from natural and industrial emergencies, including fire safety provisions, was implemented in the region in 2008-2010.This period was characterised by a considerable reduction in the number of incidents and fires and associated casualties and material damage. The region has developed and is implementing an oil spill emergency response system. Emergency response and firefighting teams receive new modern equipment and facilities. As a consequence of comprehensive fire prevention measures, the number of fires dropped from 960 in 2001 to 802 in 2009. In 2009 967 people were rescued from fires, with the property damage costs of over totalling over 860 million RUB.

In 2010, the YNAO Governor approved a long-term target programme “Safety of living in the YNAO, 2011-2013”. The programme focuses on prevention and response to natural and industrial emergencies, development and implementation of inter-municipal and regional measures for civil defence, protection of population from emergencies, fire safety. The programme implementation will be financed from the YNAO budget in the amount of 6.95 million RUB, including 3.53 million RUB allocated for 2011.

168Okrug Long-Term Programme ‘YNAO Population Safety for 2011-2013’, http://www.89.mchs.gov.ru/activities/detail.php?ID=15646

This programme was developed by experts of the YNAO Department of Civil Defence and Fire Safety. The authors emphasise that this is a comprehensive strategic development document.

8.6.1.2 SOCIAL SITUATION AND CONFLICTS

The social situation in the Okrug is characterised by issues common for the northern Russian territories. Those include phase-out of unprofitable local industry and associated unemployment, cuts in public investment in social infrastructure development, fuel shortage, growing morbidity and mortality rates amongst indigenous population, and increased levels of alcoholism, crime incidence and divorce.

Alcoholism is particularly acute amongst the indigenous peoples in YNAO. According to statistics, the number of people diagnosed with chronic alcoholism and alcoholic psychosis is increasing every year and is several times higher than the number of patients registered with other illnesses. It is likely that the actual scale of alcohol addiction may be greater than officially reported, as many people with this type of dependency do not resort to medical assistance and, consequently, are not registered as such. As both men and women are susceptible to alcohol addiction, this leads to social disarticulation, acts as one of the major causes of high morbidity and low life expectancy amongst indigenous people. Medical reports show that methods of psychological therapy (hypnosis, etc.) are increasingly used to treat alcoholism. However, treatment effects are often short-lived and the problem of alcohol addiction amongst indigenous people persists.

Disruption of the indigenous traditional way of life since the breakdown of the Soviet system is considered one of the main reasons of higher incidence of pathologies, infectious diseases and alcoholism among the IPN community.[169]

As of the end of 2012, the incidence of alcohol addiction and alcoholic psychosis among the entire population of YNAO was164,3 per 10,000 people. The rate of drug addiction (based on registered cases) in the Okrug was 26,0 per 10,000 people in 2012[170].

The 2013 data show that the total number of patients with drug addiction registered under medical surveillance in YNAO was 1,329, as compared with 1,080 people in 2011. The dynamics of this indicator between 1997 and 2012 is shown in Figure 8.29.

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[169]The Yamal-Nenets Centre for Prevention and Combating AIDS and Infectious Diseases. HIV prophylaxis among the indigenous population of YNAO. By Dr. L.Yu. Volova.

[170] The YNAO Department of Public Health. Healthcare in Yamal-Nenets Autonomous Okrug in 2012. Statistical compendium. Salekhard, 2013.

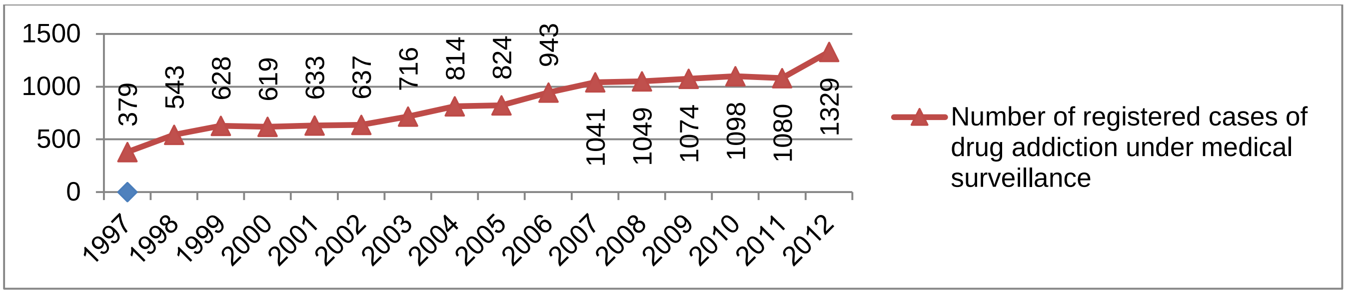

Figure 8.29: Number of registered cases of drug addiction under medical surveillance in YNAO, 1997-2012

Source: "Centre for Hygiene and Epidemiology in YNAO", 2013[171]

Among the municipal districts, the highest incidence of drug addiction is registered in the following administrative units:

- City of Noyabrsk 27.29 per 100,000 people;
- City of Gubkinsky 28.27 per 100,000 people; and
- Purovsky District 17.46 per 100,000 people.

No cases of drug addiction have been registered in Krasnoselkupsky, Yamalsky and Shuryshkarsky Districts.

The highest incidence of chronic alcoholism and alcoholic psychosis has been observed in:

- Krasnoselkupsky District – 2,997.9 per100,000 people;
- Tazovsky District 2,753.6 per 100,000 people;
- City of Salekhard 2,897.5 per 100,000 people; and
- Priuralsky District 2,551.0 per 100,000 people. [172]

In Yamalsky District this indicator was 2,377.1 per 100,000 people (2011 data).

These levels are considerably higher than the national average indicator in 2012: the incidence of registered cases of chronic alcoholism and alcoholic psychosis was 1,304 per 100,000 permanent population of Russia. [173]

The incidence of inhalant abuse is the highest in the following administrative units (2-3 times higher than the Okrug average):

- Nadysmky District – 44.5 per100,000 people;
- City of Labytnangi – 30.0 per100,000 people;
- Yamalsky District – 24.5 per100,000 people.

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[171] Federal State Healthcare Institution "Centre for Hygiene and Epidemiology in YNAO". Analysis of dynamics in substance abuse, chronic alcohol addiction and alcoholic psychosis in Yamal-Nenets Autonomous Okrug. Salekhard: 2013.

[172] Ibidum.

[173] Source: Demoscope Weekly http://www.demoscope.ru/weekly/2013/0547/barom04.php

Alcoholism appears to be less common among the nomadic population compared to the settled indigenous population, although this cannot be verified as no disaggregated statistical data exist for settled and nomadic indigenous population. Nevertheless, according to the information provided by the researcher of the 'Arctic Research Centre' interviewed as part of the baseline studies, alcohol addiction is not an acute issue for reindeer breeders migrating in the area as alcohol consumption prevents them from performing their traditional activities or significantly complicates their usual way of life. At the same time, alcohol addiction appears as a serious issue in case when indigenous peoples settle down and become involved in less traditional occupations (working in construction or security industries, performing unskilled maintenance works, etc.).

Disputes within the IPN community can occur between families of private reindeer herders and larger reindeer-breeding enterprises. Such discord can be associated with conditions/succession of use of certain seasonal grazing areas. However, it is noteworthy that such territorial disagreements between herders using neighbouring pastures are typically settled in an amicable way. At the same time, disruption of traditional migration routes as a result of industrial development could further aggravate this situation if reindeer herders have to change their habitual routes and encroach on territories traditionally used by neighbours.

Tensions between individual groups of reindeer herders can also be caused by routine controversies, for example, in connection with disagreements over the organisation of reindeer slaughtering and the processing of related produce. Numerous complaints and, not infrequently, overt discontent of the local population are caused by the existing formal regulations for hunting, particularly some inconsistencies and contradictions in regulatory acts and the fact that they do not always reflect the local context and realities. Reportedly, the main areas of discontent are monopolisation of purchasing prices for the supplied reindeer meat and regulations for obtaining licenses for the possession and use of firearms.

8.6.1.3 PSYCHOLOGICAL STATE OF LOCAL POPULATION

During the "Yamal Arctic 2012" expedition, a separate area of research was to investigate psychological characteristics of working-age local population living in Gyda, Seyakha, Mys Kamennyi and Novy Port settlements[174]. Within this task 205 persons were interviewed. Representatives of indigenous population amounted to 152 individuals (25 men and 127 women), which comprised 74.2% of the total number of research participants. The survey also covered 53 representatives of the immigrant population (incl. 15 men and 38 women, which accounted for 25.8% of the total number of the respondents). However, by the moment of conducting the research these people had been living in the above mentioned settlements for a sufficient period of time.

The interview-based assessment of the respondents' physiological and psychological comfort, as well as their inner well-being state revealed the following findings:

- Excellent state 9.8%;

[174]See T.L. Popova, A.I. Popov, A.A. Lobanov, "Psychosocial status of population of settlements in Arctic regions of YaNAO". In: Scientific Research Transactions of Yamal-Nenets Autonomous Okrug. Arctic Medicine, Biology and Ecology", Issue 3 (76), Salekhard, 2012

- Good state 39.2%;
- Satisfactory state 40.6%;
- Poor state 6.7%.

The assessment of psychological stress has indicated that the proportion of people affected by stress among the immigrant group of respondents is higher than among the indigenous residents (77.3% and 69.7%, respectively), besides, the level of stress was higher among men as compared to women in both groups. An analysis of potential causes of stress has revealed that 85% of the respondents belonging to the immigrant group were affected by occupational stress related to vocational maladaptation; no gender variations were identified in this case. The results of the study have indicated that chronic fatigue is common for a half of immigrants (51%). Stresses associated with daily life routine affect women more frequently than men (44.7% against 40%, respectively).

An analysis of data related to dissemination of social stresses within the population of the IPN has indicated that occupational stresses affect more than two thirds of the respondents (69.7%). More than a half of the IP representatives indicated that they were physically and psychologically exhausted by the end of each day. Stresses associated with household work are reported three times more frequently among women (indigenous residents) than among men within the same group (40.1% against 12%, respectively).

A comparative analysis between the immigrants and the indigenous residents interviewed during the survey has demonstrated that occupational stress is more common for both groups. Immigrants tend to experience a higher level of emotional stress. Stress of a social everyday life nature affects immigrants more frequently; the level of their overall exhaustion, dispirit and negative personality changes is higher than in case of the respondents from the indigenous group.

Investigations have also indicated that 38% of the respondents experience anxiety, 54% have a feeling of tension, irritability and the disruption of sleep patterns. 35.7% of the respondents reported experiencing depression.

8.7 TRANSPORT INFRASTRUCTURE

The framework of the existing YNAO transport system was created during a large-scale investment programme for the development of oil and gas industry between 1970 and 1990. The inland transport system of the region is divided in two transport areas: the western and the eastern areas. The western transport area is based on the Ob River with a branch line of the Northern Railway system approaching the river near the town of Labytnangi (see Figure 8.2). The heart of the entire transport system is the Salekhard-Labytnangi industrial and transport centre, in which massive handling operations involving water and railway transport occur. The Obskaya-Bovanenkovo-Karskaya railway was completed in 2010 and is used for delivery of supplies required for development of the Yamal oil and gas fields.

The eastern transport area is based on the use of the Novy Urengoy-Tyumen section of the Sverdlovsk Railway, as well as the Nadym, Pur, and Taz rivers.

In contrast to the western area, the eastern transport area is characterised by a relatively well-developed network of motor roads linked to the National road system. In the early days of oil and gas development in YNAO, the bulk of supplies arrived by the Ob River to the ports of Nadym and Korotchayevo. These ports are now also used for deliveries of goods to the Northern Territories.

The most serious transport-associated issue is the onshore connection of the two transport areas by railways or motorways. In particular:

- the total length of hard-surface public roads is just 4.1 km
- The density of hard-surface public roads is only 0.03 km per 1,000 km^2 of the territory.

Pipeline transport is of particular importance for the transportation of main products of the oil and gas sector: oil, gas and gas condensate. YNAO has one of the world's largest systems natural gas pipeline systems. Major issues associated with the transport of gas, oil and gas-condensate include:

- lack of a uniform gas condensate transport system;
- wear of oil and gas transport system equipment;
- limited development of long-distance oil pipeline transport.

Yamalsky District is characterised by very limited accessibility and a relatively poorly developed transport infrastructure. The absence of roads and railways is a notable feature of the District's transport infrastructure which is dependent on aviation as the main means of transportation and connection between the settlements. Based on the 2009 data, the overall length of the hard surface roads of general use in Yamalsky District is only 4.1 km. The road network density (road length per area) is 0.03 km of surfaced roads of common use per 1,000 km^2.

Implementation of large-scale development projects in the region is not possible without adequate air and rail transport systems. At present, a considerable volume of supplies is delivered to Yamalsky District by sea during summer navigation period (via the Port of Kharasavey).

A new railway line from Obskaya to Bovanenkovo (525 km – see Figures 8.2 and 8.14) was built to allow all-year cargo and passenger transport to Yamal. The Bovanenkovo field development project included the construction of an airport which was completed in 2012.This airport has a runway length of 2,625m and is capable of receiving a wide range of aircraft types. OAO Gazprom and the YNAO Government have jointly prepared a "Programme for integrated industrial development of hydrocarbon fields on Yamal peninsula". The basis for the future industrial development of the peninsula is being prepared now, including creation of a transport network (see Figure 8.30):

- a new railway from Obskaya to Bovanenkovo is partially completed;
- a new northern section of the Obskaya-Bovanenkovo railway is being designed;
- a road from Kharasavey to Bovanenkovo is at the design stage.

Figure 8.30: Existing (green) and potential rail routes in Yamalsky District

Source: Gazprom[175]

Helicopters are the only all-year means of transport from Sabetta to Novy Urengoy and Salekhard. The Gulf of Ob can be used for transportation only during the navigation period and in late winter

[175] "The importance of railway for the implementation of Yamal mega-project". Source: http://www.gazprom.ru/about/production/projects/mega-yamal/railway/

when ice is thick enough to allow construction of a winter road (3 to 4 km). Onshore transportation is limited to temporary winter roads.

According to the information provided by the IP representatives during the research conducted in December 2012 (see Section 8.1), the main means of transport used by nomadic population migrating within the Project area are reindeer-sledges, snowmobiles and boats.

8.8 INDUSTRIAL SECURITY

Security of industrial enterprises is provided in accordance with the requirements of the current legislation of the Russian Federation:

- On private detective and security activity in the Russian Federation, Federal Law #2487-1 of 11.03.1992;
- On Police, Federal Law #3-FZ of 7.02.2011.

These laws contain no binding provisions or requirements concerning security provisions for industrial facilities. However, a list of facilities subject to mandatory State security guarding is included in Appendix 1 to Government Decree #587 of 14 August 1992 “Issues of private detective and security activity”. Although oil and gas facilities are not included in this list, State security control is required for the seaport borders and seaport infrastructure facilities required for safe marine navigation.

Industrial security in the territory of YNAO and Yamalsky District is provided by corporate security services. Some enterprises use the services of private security agencies. Typical security measures at existing industrial facilities include automated security systems (including visual surveillance, alarm buttons, access control systems, safety sensors/ intrusion detectors, and fire alarms), guard posts and perimeter protection. Guards may be armed.

Each facility is guarded in accordance with plans that include emergency response provisions. Facility personnel receive safety and emergency training. Each security post has respective incident notification procedures.

In order to create and implement an efficient security system, each industrial facility:

- establishes a system of internal and external inspections,
- sets up a specific safety/security concept that is developed with due account of the required engineering and technical aspects, and
- ensures that physical fitness of the security personnel is adequate for the protection of employees and assets

8.9 CULTURAL HERITAGE

8.9.1 GENERAL APPROACH TO DEFINING ETHNO-CULTURAL CHARACTERISTICS OF THE INDIGENOUS PEOPLES OF THE NORTH

To date, the historic and cultural heritage of indigenous peoples living in the Project area of influence has not been studied in-depth. However, it is well known that the places of worship[176] and associated sanctuaries form an essential element of historical and cultural heritage of the indigenous peoples. Sacred sites are unique monuments of the traditional indigenous culture. Historically, they symbolised people's desire to secure success in reindeer-breeding and hunting, preserve their families in good health, and to get rid of evil spirits. Local people traditionally turned to sacred sites for assistance with surviving in the harsh environment of the Arctic and such sites continue to play an important role in the community and family life of the Nenets and other IPN.

In legal terms, family, ancestral and ethnic sacred sites are defined as "natural objects or joint creations of Man and Nature, which are located in the native living environment of indigenous peoples and are used by these people for religious practices" (YNAO Law #48-ZAO as of 6 October 2006, hereinafter referred to as the ""Law").

According to Article 8 of this Law, tangible cultural heritage of IPN living in the YNAO territory, include:

- family, ancestral and ethnic sacred or religious places (sites);
- family and ancestral burial grounds;
- family, ancestral and ethnic memorial places;
- places where traditional crafts are practised;
- other areas and objects of exceptional value for the indigenous people.

As a rule, economic activities in locations featuring sacred sites are restricted or prohibited. These regulatory provisions help to identify and preserve sacred sites as substitutes of temples, i.e. as equivalents of buildings of religious or spiritual purpose. In fact, sacred sites *per se* represent temples out in the open. They are characterised by such attributes of a temple as strict architecture of sacral space, religious sculpture (structures), specific religious symbols and attributes, a place for sacrificial offerings, a code of conduct and the specific procedures for rituals and ceremonies. The principal difference between sacred sites and temples, which are, as a rule, open for mass spiritual practices, is a distinctly esoteric character of a sacred site, i.e. its accessibility and even knowledge of its existence is restricted to a limited circle of initiated individuals closely linked to this place through the ancestral lineage.

According to legislation, sacred sites and burial sites of indigenous peoples shall only be used for their traditional (original) functional purpose.

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[176] According to a commonly accepted definition, a religious place is a space designated for worship of divine powers or a place believed to possess special spiritual or supernatural properties. The role of such places is often ascribed to natural areas or components of natural landscape, such as sacred springs, water bodies, trees, scenery or rocks. Traditional burial grounds can also be considered sacred sites. Sites associated with the forces of nature are typical places of worship for the Indigenous Peoples of the North.

Studies aimed at the identification of sacred sites and burial sites of indigenous peoples, as well as any other activity aimed at survey, investigation or use of such places and sites, is permissible provided it:

- causes no damage to sacred sites and burial grounds of indigenous peoples;
- complies with the legal status of traditional use areas, i.e. does not prevent indigenous peoples from using these areas in accordance with their functional purpose.

8.9.2 TANGIBLE CULTURAL HERITAGE

Sacred sites are tangible monuments of spiritual culture, which have a time-honoured history and are, therefore, characterised by conservative forms and methods of religious practice. Most tangible objects of traditional cultural heritage, such as **sacred sites and sanctuaries**, are elements of natural landscape, with the terrain, associated with certain religious and mythological conceptions of indigenous peoples, being their main typological attribute. In the Nenets language, “sacred site” is referred to as “*khebidya ya*” (literally: “*khebidya*” – sacred, “*ya*” - land) or “*khekhe ya*”, meaning the “land of the master spirit” (spirit in charge of a particular place or trade). As a rule, each place of worship has a legend associated with it that explains its origin and purpose. In these areas, economic/industrial human activities are prohibited or restricted.

All sacred sites are of supreme sacral significance for indigenous peoples. Continental/terrestrial components of sacred landscape are mostly elevations, such as hills, high river banks, mounds, rocks, or isolated trees[177]. A separate group also includes watercourses and water bodies. Sacred sites often have no distinct boundaries, merging with the surrounding (non-sacral) environment. Sanctuaries are usually situated near prominent natural objects, e.g. stones remarkable for their size or shape, on hilltops, lake shore, etc.

There are several distinctive categories of sacred sites that are worshipped by IPN.

- Places of sacrificial offerings to traditional gods and high-ranking spirits. These are places of regular ritual practices located near settlements or in areas of traditional use.
- Revered hills and elevations. Local populations usually assign special value to small elevations called in Nenets “*kot-mykh*”. It is forbidden to engage in any activity there or tread on top of these elevations. Sacrificial offerings are made during chance passing-by or as a planned ritual (in fulfilment of a vow). Some objects of family worship are isolated boulders in the tundra or notably shaped stones included among other sacred things worshipped by families. In dull winter weather or on a sunny spring day, when the horizon merges with the ground and the sky, these objects can serve as landmarks from a long distance and are used as reference points by the nomadic people migrating in the tundra. An isolated burial place or burial grounds on a hilltop may serve the same purpose.
- Revered islands called *pugor (pugyr)*, including the sections of land that expose temporarily during the low water levels in rivers.

[177] This information was confirmed by the results of the survey conducted in December 2012 (see Section 8.1). All of the IP representatives who answered this question (23 individuals) indicated that mounds or elevations dominating above the surroundings were the specific landscape features of a sacred site.

- Sacred river waters (pools of deep water or ponds) are revered as homes of local master spirits (in charge of certain locations). Offerings are made by indigenous peoples when passing by the place.
- Forbidden areas. These sacred sites are similar in nature to the previous category. Forbidden areas are believed to be in command of the local spirits in charge. These areas are subject to a set of restrictions and taboos (it is forbidden to loiter, work, make noise, go ashore, etc.). Most forbidden areas are water bodies or aquatic areas, such as lakes, inshore areas, estuaries, rivers and bays. The "Spirit of the Sea" is traditionally considered to be the Father of all water spirits.

In summary, most religious sites are specific landforms or parts thereof and each locality is believed to have its master spirit who must be revered. Traditionally, a place was declared sacred by a shaman. Shamans also specified whether a given sacred site was to be worshipped by all indigenous peoples adhering to traditional beliefs or only by people from a certain family or the kin. The spirit of the ancestral place is considered to be both the master of the ancestral territory and a personified deity to be worshipped through rituals and other religious doings.

The tundra Nenets have **sacred sites** (**sanctuaries**) that are worshipped by individual settlements, the kin, or families. Such places are often located in areas that are not readily accessible, and where it is forbidden to hunt, fish, gather berries or cut trees. Sites of sacrificial offerings were typically also set up in not easily passable and dangerous locations on the migration routes such as at water crossings used by a reindeer herd and herders on sledges. In such locations there is always a risk of losing animals and all belongings, including clothing, household items and *chums* in case a sledge topples. To secure against such accidents, a reindeer was sacrificed to the master spirit prior to the crossing, the place of sacrifice becoming a sacred site with time.

Sacred sites are still present in the tundra areas of traditional use and residence of the nomadic indigenous population. The fact that these sites are regularly visited and used for sacral rituals and ceremonies or conversely strict adherence to the bans on visiting them during certain periods indicates that they continue to be the functional facilities of worship[178].

In general, a considerable amount of work aimed at the identification and mapping of sacred sites has been performed in YNAO as a whole. At present, in view of progressive industrial development of the territory, the overall strategy of protection of sacred sites in the region has changed. Indigenous people have come to recognise the need for preventive protection measures, and their incorporation into territorial land-use planning schemes. Development by the state of a digital database of the indigenous sacred sites is considered to be a preliminary step in the process of assessment of environmental and social impacts of intensive industrial development. For example, in 2000-2001, the public and scientists of the Tazovsky District created a database of sacred sites and performed mapping of tangible cultural heritage[179]. A list of the known cultural and historical

[178] Nevertheless, according to the survey results (December 2012), these areas are visited very seldom: the overwhelming majority of the respondents who answered this question indicated that it happened from once per year to once per every 3 to 5 years. Four respondents did not indicate the frequency of visits, but mentioned that it happened as soon as they had an opportunity to do so. One respondent had never visited ritual sites and 16 respondents did not answer this question.

[179] The Conservation Value of Sacred Sites of Indigenous Peoples of the Arctic: A Case Study in Northern Russia. Project Report under the editorship of O. Murashko, 2004

objects found in Yamalsky District is available from the official website of the YNAO Department of Culture[180], with the total number of registered sites and objects in the District reaching 181, including monuments, notable sites and other features. A summary of that is also presented in Table 8.33 below.

Table 8.33: Sites and objects of cultural heritage in Yamalsky District, as at 01.02.2013

Monuments			Places of interest/ Notable sites		Other registered objects/features			
Federal importance	Regional importance	Local importance	Regional importance	Local importance	Total	Archaeology	History/ architecture	Ethnic culture
-	1	-	5	-	175	160	-	15

Source: YNAO Department of Culture, 2013

Prior to the Yamal LNG Project, the area under consideration had been insufficiently investigated in terms of tangible cultural heritage of indigenous peoples, particularly with regard to the sites of significance for individual communities, the kin or families.

With the aim of filling this gap desk studies of the area designated for construction and operation of the facilities for gas production, treatment and liquefaction, as well as for LNG and gas condensate shipment were conducted in 2007-2012. The findings of those studies are presented in the reports listed below:

- Buslov I.A. Conclusions on historical and cultural assessment of land plots for performance of seismic exploration works in the South-Tambey area in 2007—2008. //Archives of the YNAO Department of Culture, registration number 312.
- Buslov I.A. Conclusions on historical and cultural assessment (desktop study) of land plots allocated for construction of roads to wells P-21 and 75, well p-109, and the road connecting the ORPI borrow pit with the existing road, South-Tambey GCF, prepared for Yamal LNG in 2009. //Archives of the YNAO Department of Culture, registration number 1232.
- Buslov I.A. Conclusions on historical and cultural assessment (desktop study) of land plots allocated for construction of exploratory wells 3000 m, exploratory wells 157-R, 155-R, 152-R (Group Well Design #194/07-283-RB); access road to well #7, South-Tambey GCF, prepared for Yamal LNG in 2009. // Archives of the YNAO Department of Culture, registration number 1658.
- Buslov I.A. Report on historical and cultural investigations (desktop study) of land plots allocated for construction of the following Yamal LNG facilities: water intake facility of well #157r, water intake facility of well #155r,water intake facility of well #152r, South-Tambey Licence Area, 2011. // Archives of the YNAO Department of Culture, registration number 1803.
- Buslov I.A. Report on historical and cultural investigations (desktop study) of land plots allocated for construction of dredged sand pit #3 (48.498 ha), Yamal LNG, South-Tambey GCF, 2011. // Archives of the YNAO Department of Culture, registration number 1852.

[180] Information on cultural heritage sites located in Yamal-Nenets Autonomous Okrug, as of 1 February 2013. Source: http://www.cultura-yamala.ru/obektinaslediya/spiskiobjects/

- Buslov I.A. Report on historical and cultural investigations (desktop study) of land plots allocated for construction of dredged sand pit #202 (15.6826 ha), Yamal LNG, South-Tambey GCF, 2011. // Archives of the YNAO Department of Culture, registration number 1853.
- Buslov I.A. Report on historical and cultural investigations (desktop study) of land plots allocated for construction of dredged sand pit #204 (21.4824 ha), Yamal LNG, South-Tambey GCF, 2011. // Archives of the YNAO Department of Culture, registration number 1854.
- Buslov I.A. Report on historical and cultural investigations (desktop study) of land plots allocated for construction of dredged sand pit #205 (30.3853 ha), Yamal LNG, South-Tambey GCF, 2011. // Archives of the YNAO Department of Culture, registration number 1855.
- Buslov I.A. Report on historical and cultural investigations (desktop study) of land plots allocated for construction of dredged sand pit #206 (52.3455 ha), Yamal LNG, South-Tambey GCF, 2011. // Archives of the YNAO Department of Culture, registration number 1856.
- Lysenko I.A. Report on archaeological investigations of the land plot allocated for design and construction of Yamal LNG Project facilities in the South-Tambey GC field area, Yamalsky District of YNAO, 2012. // Archives of the Archaeological Heritage Fund, registration number 329.
- Archaeological Heritage Fund. Field archaeological investigation of the land allotment for design and construction of the Complex for production, treatment and liquefaction of gas, export of LNG and gas condensate at the South-Tambey Gas Condensate Field. Moscow: 2012.
- Report on social studies conducted by OOO FRECOM within the framework of engineering survey for the LNG Plant construction, 2012.

The above listed reports are based on the available literature and archives and on a limited field survey carried out during summer 2012. The studies identify only three cultural heritage sites, which were listed in the Regional Registry of Historical and Cultural Heritage.

During the development of the Project design documentation in 2011, Yamal LNG received an official letter from the YNAO Agency for Protection and Use of Cultural Heritage(#3901-17 -01/55 of 11.10.2011) stating that three previously identified cultural heritage sites listed in the YNAO Historical and Cultural Heritage Registry are located within the area of South-Tambey field development.

These cultural heritage sites are located outside of the area of direct impact associated with construction of the Project facilities. However, two of the sites are located within the Yamal LNG licence area, namely:

- *Neycheda* Sanctuary (“Hill of Heads”) is located near Sabetha. It is a round mound with reindeer antlers and skulls on the top.
- *Siulortse* sacred site (“Seven Small Hills”) consists of seven small mounds varying in height from 100 to 120 cm. The biggest mound is crowned with a grey stone and a heap of reindeer antlers and skulls.

The third sacred site, known as *Khalvure Seda*, is situated outside of the licence area. During preliminary consultations with experts of the YNAO Agency for Protection and Use of Cultural Heritage it was recommended that additional field surveys should be undertaken within the Project licence area and in its close vicinity, with a focus on the areas that have highest potential for the presence of cultural heritage. The purpose of these detailed field studies is to determine the exact locations of cultural and historical sites in relation to the areas of the Project activities. Yamal LNG conducted such additional studies, including an archaeological survey and the identification of sacred sites that are of cultural and spiritual importance to the local population for the period of May - August 2013.

These studies were conducted within the Project license area and in a 10km wide protection zone around the license area[181]. The studies identified 11 sacred and specially worshipped sites, seven of which are categorized as sacred sites and four are cemeteries (see Table 8.34 and Figure 8.31 below).

Table 8.34: Sacred and specially worshipped sites in the Yamal LNG license area and in the 10km wide protection zone

	Description	Location	Coordinates
1	Sacred site Khevlutykhe	Right-hand bank of Sabettayakha River (2km south of Nyaavtato Lake)	N 71º11' E 70º57'
2	Sacred site Tybkalembyakhe	Left-hand bank of Sabettayakha River (4km east of Tasiy-Yakhakhnato Lake)	N 71º11' E 71º12'
3	*Sacred site Siu Lortse (Seven Hills)*	*Between an tributary to Sabettayakha River and Lambeyakha River*	N 71º12' E 71º*39'*
4	Sacred site Yara-Yakha-seda (Sandy rivulet)	Bank of Lambeyakha River	N 71º11' E 71º36'
5	*Sacred site Neucheda*	*Upper reaches of Sinedyakha River*	N 71º12' E 72º*0'*
6	Sacred site *Khalvure e seda*	*Tributary of Ngem Paruyakha River*	N 70º58' E 72º*12'*
7	Sacred site	At branch stream of Nyavtayun	N 71º10' E 72º23'
8	Cemetery Khalmer-yakha	Upper reaches of nameless right-hand tributary of Khalmehyakha River (tributary of Vanuymueyakha River)	N 71º6' E 71º40'
9	Cemetery	Bank of a nameless right-hand tributary of Sabettayakha River	N 71º11' E 71º36'
10	Cemetery	Bank of Khalmeryakha River 6.5km from the river head (tributary to Nyakharvangotayakha River)	N 71º24' E 71º37'
11	Cemetery	Bank of a nameless right-hand tributary of Tirviyakha River, 3.5km west of Manito Lake	N 71º32' E 71º20'

* The sacred sites in italics are officially included in the Register of Historic and Cultural Heritage.

[181] "Research of Traditional Nature Use and Ethno-Cultural Environment within the Area of Influence of the South Tambey Gas Condensate Field Development Project. South Tambey License Area", "Yamal LNG" JSC, Moscow-Sabetta-Petersburg 2013, prepared by FRECOM

The location of the sacred sites within the Project license area is associated with the routes of annual migrations of reindeer herders using this territory:

- Most sacred sites and sites of special significance are concentrated between the Sabettayakha and Vanuymueyakha Rivers: (*a*) sacred site Siu Lortse (see Table 8.34, #3); (*b*) sacred site Yara Yakha Seda (#4); (*c*) sacred site Neucheda (#5); (*d*) sacred site at branch stream of Nyavtayun (#7); (*e*) cemetery on the bank of a nameless right-hand tributary of Sabettayakha River (#9); (*f*) cemetery in the upper reaches of nameless right-hand tributary of Khalmehyakha River (#8).
- In the northern part of the license area (north of the Sabettayakha River) there are two sacred sites and two cemeteries: (*a*) sacred site Khevlutykhe (#1); (*b*) sacred site Tybkalembyakhe (#2); (c) cemetery on the bank of Khalmeryakha River (#10); (*d*) cemetery in the vicinity of Manito Lake (#11).
- In the southern part of the license area (south of the Vanuymueyakha River) there is one sacred site, Khalvure e seda (#6).

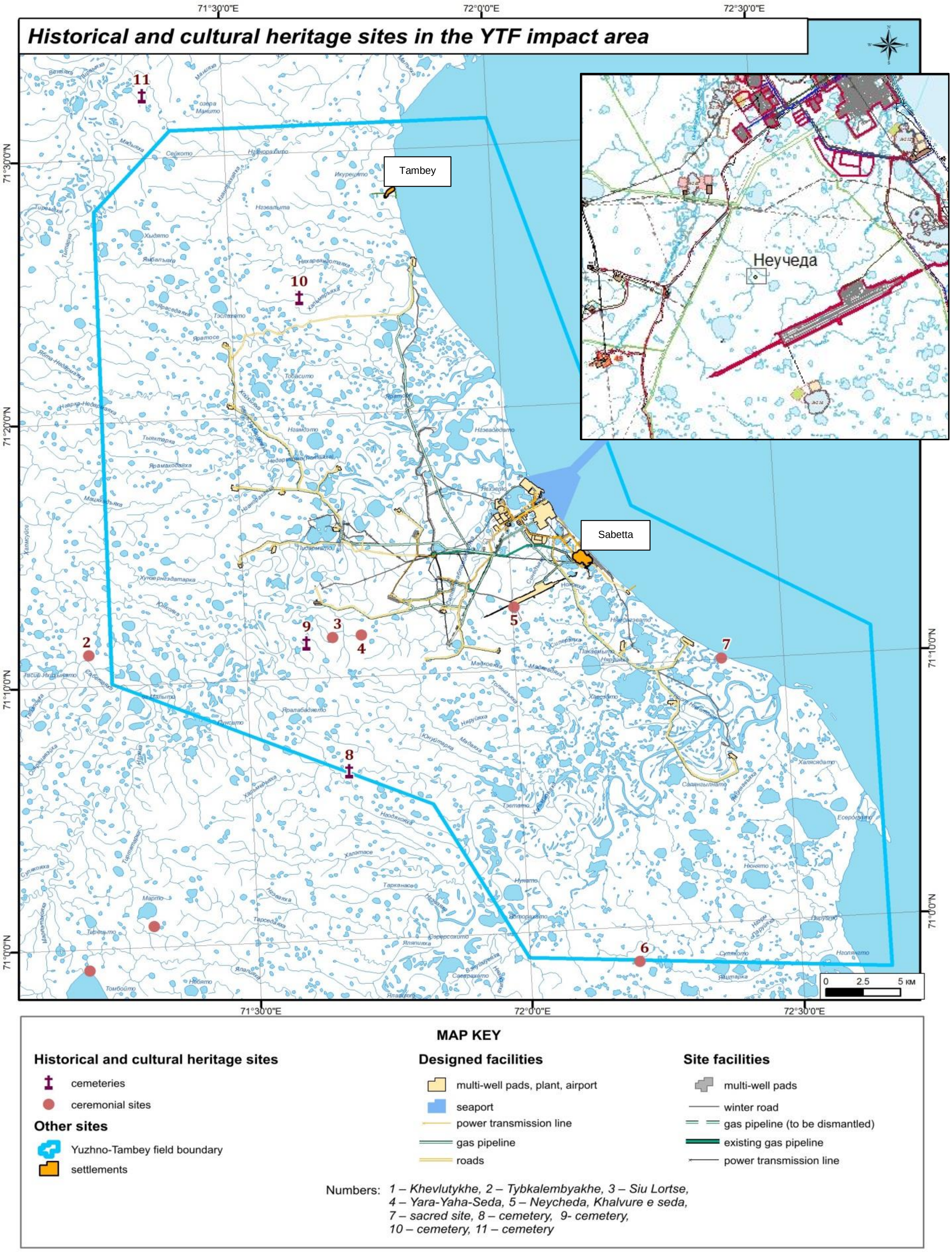

Figure 8.31: Location of sacred sites within the Project license area and in the zone affected by the Project

In the course of the ethnocultural field studies, some information was collected that suggests that one of the important elements of the indigenous communities' culture continues to be a system of beliefs associated with worship of sacred sites and sites of special significance. Indigenous peoples still make a traditional distinction between the existing objects of historic and cultural heritage related to families and kin relationships and sites/objects which are of special importance for the entire indigenous population of the region. There is also functional categorization of such objects: the interviewed persons referred, for example, to sites associated with specific types of customary use of natural resources (reindeer husbandry, fishing, hunting). For example, the sacred site of Yara Yakha Seda is associated in the beliefs of local residents with hunting for polar foxes.

At the same time, in the course of studies of beliefs associated with worship of sacred sites and sites of special significance, some aspects have been revealed that suggest a gradual withering away of long-established cultural tradition in this particular respect:

- Beliefs associated with objects of historic and cultural heritage are maintained predominantly by people of older and middle age.
- Sacred sites are visited at considerable intervals and without any certain periodicity.
- Nowadays some traditional ritual ceremonies associated with worship of sacred sites have been forgotten by the major part of the IPs.
- The taboo for disclosure of information related to sacred sites and associated objects has become less strict.

During May-August 2013 an archeological survey of the South Tambey license area was carried out[182]. Within the framework of the survey, sites with both good and unlikely prospects for archeological discoveries[183] were investigated within the zone to be affected by the planned development in accordance with the provided Project design documentation, as well as an additional area where such a survey is compulsory, i.e. within a range of 25 m at both sides of planned linear facilities and 50 m from the outlines of areal facilities.

The survey also examined some objects outside of the zone where an archeological survey was compulsory. This focused on objects related to current customs and way of life of the indigenous peoples of the North, and in particular sites used for temporary and seasonal camps (*chum* camps), hunting tools (traps, etc.), ritual sites, burial grounds (*khalmers*). The surface of such objects was thoroughly examined, their location was determined with global positioning devices, and photographs were made.

In the process of the archeological survey, 49 sites were investigated, one object of cultural heritage identified and 65 stratigraphic cross-sections plotted.

The identified object of cultural heritage was an ancient settlement - Salyangylnato 1 - located at the axis of the planned corridor for linear facilities to well cluster #25 (see Figure 8.31). The planned corridor crosses the settlement site in the direction of NW-SE. Construction work in this area has the potential to damage or even completely destroy this cultural heritage object. In light

[182] "Historical and Cultural Survey of Land Provided for the Facilities of the South Tambey Licence Area, the Yamal Region, Yamal-Nenets Autonomous Okrug, Moscow– Sabetta 2013", developed by FRECOM

[183] Sites with good prospects are those where the probability of finds is high; at sites with unlikely prospects the probability of finds is low, but potentially possible; sites with no prospects are those where there is no probability of discovery of any objects of cultural heritage due to specific landscape and topographic features or where any finds are impossible with the aid of conventional and commonly used methods of survey and existing technical means.

of this, Yamal LNG has decided that the facilities corridor will be re-routed to bypass the Salyangylnato 1 site (the orange line in Figure 8.32).

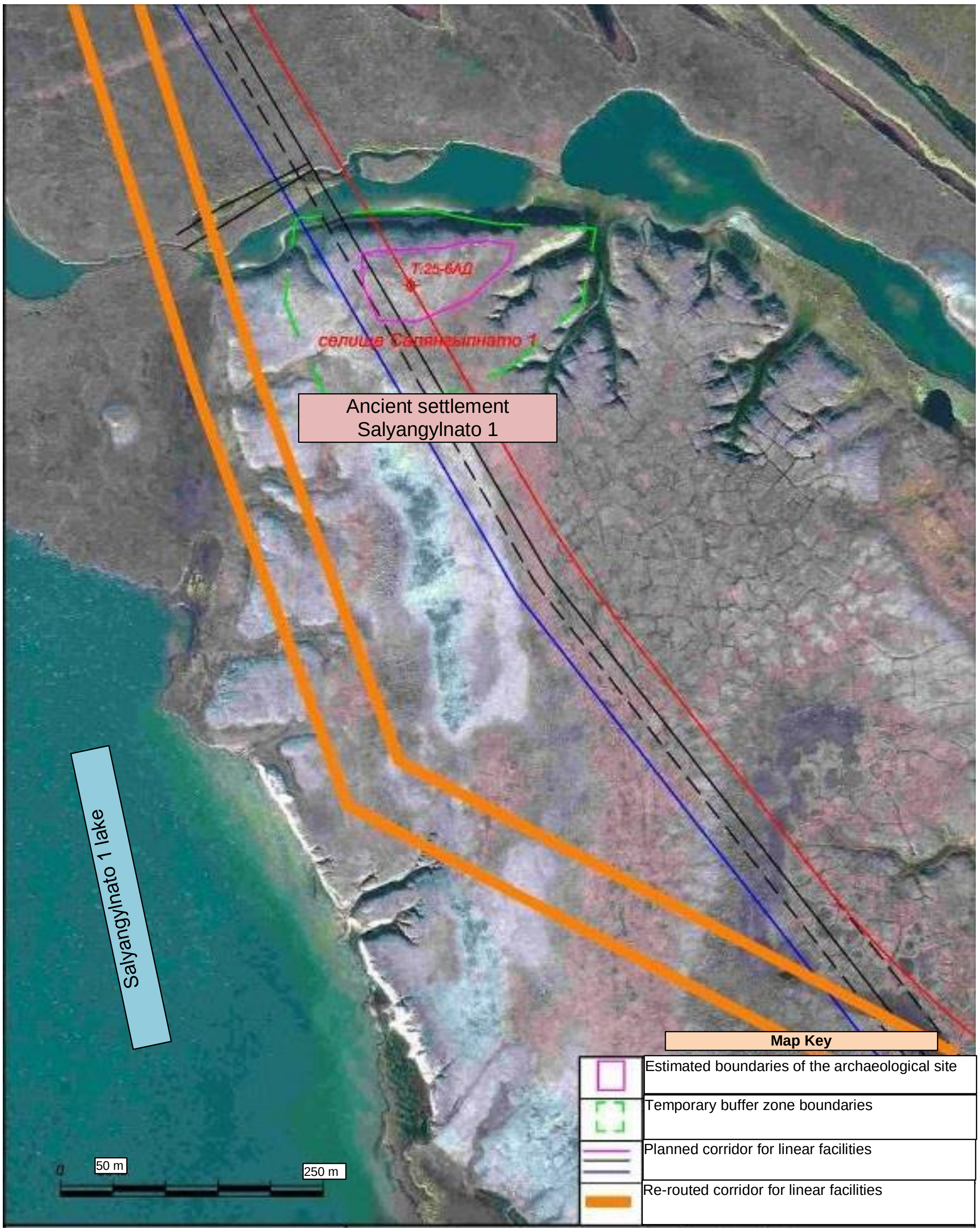

Figure 8.32: Location of the identified object of cultural heritage "Ancient Settlement Salyangylnato 1" in relation to the planned corridor route

8.9.3 INTANGIBLE HERITAGE, TRADITIONAL BELIEFS AND SPIRITUAL CULTURE OF THE INDIGENOUS PEOPLES

Spiritual aspects of cultural heritage are primarily associated with the traditional way of life, rituals and habits of indigenous peoples of the North.

Shamanism has always been, and remains, the most widely spread form of traditional **religious beliefs**. A very common cult is associated with traditional use of natural resources (hunting, fishing) and is expressed through sacrifices offered to the “Masters of Nature” and guardian spirits of traditional trades (areas of traditional use). Another ancient form of religious belief preserved today is the kin-ancestry cult, which is associated with the worship the family's guardian spirits and the departed spirits of ancestors.

The cult of worshipping sacred sites and associated rituals and standards of behaviour are deeply rooted in the traditional religious belief of indigenous peoples. These beliefs have been entirely preserved by today’s nomadic reindeer herders. The religious beliefs of the Nenets, who comprise the majority of the indigenous population in the Yamal tundra, are complex and elaborate. They consist of a pantheon of various spirits and rules of human relationship with these entities.

One of the most important figures in the Nenets’ pantheon is *Num*, the spirit of heaven. A white reindeer is to be sacrificed to *Num* in spring and autumn of every year. The sacrifice takes place in an elevated open place. The head of the dead animal is mounted on a pole with the muzzle facing the east. According to traditional beliefs, *Num* commands weather and acts of nature, such as snow, blizzard, rain, and lightning.

The Nenets have preserved and continue to practice cults of the so-called master spirits (spirits in charge of some location or resource), e.g. *ya yerv* is the spirit of the land, *iv yerv* is the spirit of the water, *yakha yerv* - the spirit of the river, *to yerv* – the spirit of the lake, *pedara yerv* – the spirit of the forest, etc. They believe that good luck in reindeer herding, hunting or fishing depends on these spirits. People have therefore always tried to win their favour by sacrificial offerings and gifts.

The most revered spirits *are ya yerv* (the master of the land) and *ya yerv ne (*the mistress of the land). These are *good spirits* as they give reindeer moss, herbs, shrubs. *Nga* is the underground spirit of diseases and death. To avoid misfortunes, one must sacrifice to *Nga* a dog or a reindeer. According to traditional beliefs, the underground world is populated by small evil spirits called *ngyleko*, who are the source of all human diseases. They can be kept away by the sound of hand bells or metal pendants that are part of traditional attire. The Nenets’ worship of ancestors is manifested in rituals and ceremonies practised on burial grounds (*khalmers*).

Multiform cults of nature are associated with sacrificial offerings, feeding and entertainment of spirits symbolising elements of worship of supreme forces. Appeals to the forces of nature for help and protection are interpreted by Nenets as requests for certain favours or support for which a deity approached must be “rewarded” by a sacrifice. Specific forms of religious practices and rituals depend on the object and purpose of the sacrifice.

As mentioned in the previous section, sacred sites have a special status recognised by indigenous peoples. Taboos and rules of behaviour depend on the type and purpose of the site. A common feature is that information on sacred sites is handed down within a family. In the past, in was forbidden to tell foreigners, including representatives of other tribes or families, about sacred places. This taboo persisted for fear of desecration or destruction of sanctuaries by strangers. This protective attitude to sacred sites and sanctuaries still prevails amongst indigenous people. At the same time, this selective approach in terms of access to information about sacred sites limits potential opportunities for the development of ethno-tourism, which would imply visiting the sites of cultural or spiritual importance by non-local population.

Traditional requirements specify the time of day preferable for visiting/attendance, strict code of conduct for visitors, rules for sacrifice and procedures for leaving the sacred site, etc.

In accordance with traditional religious beliefs, it is forbidden to utter bad or profane words, take photographs or capture on video, disturb or “offend” sanctuaries, i.e. to engage in hunting, destroy vegetation, make fires in the immediate proximity to the site, make noise, etc. Acts of desecration are inadmissible. It is forbidden to collect and take away offerings or “feedings”. Some sacred sites can be accessed by men only, with women having to use alternative sites specially designated for females. According to traditional beliefs, violation of the established rules will incur displeasure of gods and spirits, manifesting itself in the form of diseases, epidemics, drought, and other disasters. Overall, sacred sites are associated with a complex system of ethical behaviour that is upheld by the indigenous people.

According to “The Russian Arctic”, a reference book for civil servants published in 2001, special rules of behaviour must be observed in areas recognised as sacred sites. It is characteristic of the IPN to have deferential attitude[184] to their ancestral burial grounds (these can be sleds or special blockhouses resting on the ground or hoisted and fixed on trees), ancestral sanctuaries, habitations of local spirits or of spirits protecting shamans and ordinary people. Foreigners are forbidden to enter these sites, let alone touching or collecting objects. If a foreigner accidentally finds himself in such a place, he is obliged to give the resident spirits something to drink and eat. It is forbidden to approach or walk away from such places in a straight line; one must first walk around the place following the sun[185].

The Russian state recognises the importance of protection of sacred sites and the need for specific rules to preserve the traditional cultural and historical heritage of the IPN[186].

Spiritual traditions are primarily preserved by the elderly. However, many rites, although in a somewhat transformed form, are still widely practised. This primarily applies to commemorative and burial ceremonies, whereas wedding rituals have been strongly influenced by urban culture. Childbirth-related ritualism has reportedly become a relic.

Yamal Nenets’ child-rearing practices are gender-oriented. Girls are taught stitch-craft, hide dressing, and sewing. Women are also responsible for setting-up of *chums*, child care. Girls learn these skills in the process of games. At a certain age they learn about rules of conduct associated with the so-called “ritual impurity”. Females are forbidden to walk around the *chum* or enter the so-called “men’s half” of the *chum*. Women are not allowed to walk over men’s working gear, approach the “sacred sledge”, etc.

Traditional economic activities are reflected in specially organised public events. The first Sunday of April[187] is marked by a traditional gathering of reindeer herders and hunters in Yar-Sale. This

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[184] Typically, people visit only the burials of their own relatives and ancestors and the actual visits tend to be kept in secret.

[185] The Russian Arctic. A Reference Book for Civil Servants. Moscow, 2001

[186] Federal Law #73-FZ of 25.06.2002 “On Cultural Heritage (Monuments of Culture) of the Peoples of the Russian Federation”; YNAO Law #48 of 6.10.2006 “On Cultural Heritage in the Yamal-Nenets Autonomous Okrug”

[187] Timed to 7 April, also known as the “Crow’s Day”. For indigenous peoples, particularly Khantys, the Crow has always been a sacred bird, a symbol of life and a herald of spring. The Crow’s Day remains to be one of the most honoured festivals on Yamal. On this day it is forbidden to cut trees or chop firewood or to sew. A reindeer is sacrificed to gods in a supplication for understanding, mercy and wellbeing. The hide and skull of the sacrificed animal are hung up on a sacred tree. Having partaken of fresh meat, the celebrants must drink two glasses of fresh reindeer blood. Source: http://yamaltour.ru/

tradition dates back to the 1960s. This festival is a significant event in the life of both reindeer-herders' families and other residents of the district. The festival attracts a large number of guests. Reindeer sled races and arctic sports competitions are very popular.

Support from regional authorities includes: financing of publishing activities, organisation of exhibitions, contests, festivals, congresses, traditional ceremonies, shooting of videos about indigenous people, ethnographic and folklore expeditions, promotion of traditional sports, publication of booklets and advertising materials, promotion of vernacular arts; purchase of costumes for folklore groups, works of decorative-applied arts and other exhibits for the Okrug's ethnographic museums; provision of folk craftsmen with materials, such as skins, furs, cloth, and beads. Attributes of traditional culture of indigenous people are widely used as regional symbols, e.g. traditional ornaments, images of reindeer and *chums*.

8.10 SUMMARY

In summary, the following key aspects of the socio-economic baseline are of particular importance to the assessment of the Project's potential social impacts:

- Key social receptors in the Project direct AoI include residents of Tambey village/factoria, Seyakha village and nomadic reindeer herders that use the licence area periodically as part of their traditional migrations;
- Project site is located in the Arctic zone, which is characterised by extreme climatic and geographic conditions and a very low population density averaging 0.7 people/km;
- Primarily due to its remote location and harsh climate, the Project area had been previously under investigated in terms of land use, livelihoods and traditional practices of IPs, cultural heritage sites, etc. In view of this, Yamal LNG commissioned dedicated research to obtain the necessary baseline information on these issues.
- As a result of natural increase, the population in YNAO is gradually growing. The total size of the nomadic population has also shown a tendency for growth in recent decades.
- Trends for both inter-regional and international migration are positive. This is largely related to the development of the oil and gas industry and associated sectors.
- The oil and gas industry is the backbone of the YNAO economy which accounts for over 88% of industrial production. The largest gas and gas condensate fields and promising development areas on Yamal Peninsula and neighbouring areas are located in the elevated areas between the Seyakha-Mordyyakha and Naduy-Yakha river valleys and in the Nadym-Pur-Tazovsky region (see also Chapter 13 for details).
- An advantage associated with the industrial development of the district is additional opportunities for reindeer meat sales to industrial workforces in the region. This offers the opportunity for additional sales and increased locations where meat can be sold.
- 70% of the total population of Yamalsky district are IPN. The key characteristics of the IPN are their preservation and sustenance of traditional livelihoods and forms of economic activity, such as reindeer herding, hunting, fishing and gathering.
- Access to medical assistance for the rural population is limited, particularly for the tundra people.
- The size of the reindeer population in YNAO continues to increase, but is significantly constrained by the shortage of suitable grazing areas and pasture capacity. Currently, the reindeer population in some areas considerably exceeds the capacity of pastures (by 50% in Yamalsky District).

9 ENVIRONMENTAL IMPACTS, MITIGATION AND MONITORING

9.1 INTRODUCTION

This chapter presents the assessment of the potential environmental impacts associated with the project, together with a description of the mitigation controls and monitoring measures that will be implemented throughout the lifecycle of the Project. The impact assessment has been undertaken in line with the ESIA process described in Chapter 3, and the identification of impacts to be assessed follows from the development of the Scoping Report (see Appendix 1 to the ESIA).

This Chapter is structured as follows:

Section 9.2	Air emissions	Includes consideration of impacts on air quality, atmospheric deposition and emission of greenhouse gases.
Section 9.3	Geology, geomorphology and soils	Includes the assessment of thermal, mechanical, chemical, physiochemical and biological impacts.
Section 9.4	Surface water	Includes consideration of freshwater and marine surface waters. Freshwater impacts considered include sediment runoff, effects on river hydrology and wastewater discharges. Marine water impacts considered include sedimentation and turbidity effects of dredging, and discharge of treated waste waters. Associated impacts on aquatic flora and fauna are cross-referenced to Sections 9.9 and 9.10. Impacts associated with water abstraction are cross-reference to Section 9.6.
Section 9.5	Groundwater	Includes consideration to impacts on groundwater, including potential impacts associated with drilling, accidental release of contaminants and discharges to deep strata.
Section 9.6	Water supply	Addresses impacts from the abstraction from freshwater and marine sources.
Section 9.7	Waste management	Describes the management of wastes during the lifecycle of the project and the associated impacts. Cross-references are provided to Section 9.2 in relation to air impacts from incinerators and Sections 9.4 and 9.5 for potential impacts to surface and groundwater associated with the landfill controls.
Section 9.8	Noise and vibration	Address airborne and underwater noise impacts on human and fauna (for latter see also links to Sections 9.9 and 9.10). It also addresses terrestrial vibration.
Section 9.9	Terrestrial flora and fauna	Addresses impacts to terrestrial and freshwater flora and fauna (including avifauna). For noise impacts on terrestrial fauna see also Section 9.8

Section 9.10	Marine flora and fauna	Addresses impacts on marine flora and fauna. Impacts associated with sedimentation effects from dredging also considered in Section 9.4, while underwater noise impacts on marine fauna are also considered in Section 9.8.
Section 9.11	Landscape and visual	Considers landscape and visual impacts, with additional consideration of visual effects of land reinstatement and flaring also cross-reference to Sections 9.9 and 9.2 respectively.
Section 9.12	Geohazards and emergency response	Addresses geohazards (including seismicity, permafrost heave/thaw, extreme cold, snow cover and severe winds) and emergency response (including major hazards and oil spills).

9.2 AIR EMISSIONS

9.2.1 INTRODUCTION

Emissions to atmosphere will occur at all stages .of the proposed Project lifecycle, including: construction, commissioning and operation (for decommissioning impacts see Chapter 11). Such emissions include the release of air quality pollutants and greenhouse gases (GHG). Impacts on the environment from atmospheric emissions during each stage of the project lifecycle differ significantly in duration, scale and magnitude.

9.2.1.1 AIR QUALITY

The Project is located in a sparsely populated area and hence potential air quality impacts will be in relation to:

- Human health. Health effects on the Project workforce and migratory land users (principally nomadic reindeer herders – see Chapters 8 and 10 for further details). These impacts are assessed through consideration of:
    - Impacts on air quality levels at the Project's main accommodation camps, namely the Sabetta Camp (during construction and operation) and the LNG workers' accommodation camp (during operation), as the primary closest human receptors. Temporary satellite contractor accommodation camps located around the Licence Area are also considered as necessary. This assessment is undertaken through comparison with the Project's adopted air quality standards (see below and also the Project Standards Document in Appendix 2).
    - The development of the Sanitary Protection Zones (SPZ) around the project's principal operating facilities that are developed under Russian Federation for the protection of human health against impacts associated with air quality, noise, vibration etc. Separate SPZ are set for the following Project facilities:
        - Well pads (during drilling and operation)
        - Camp utilities areas
        - LNG plant and infrastructure
        - Airport

  - Seaport
  - Waste facilities area.
- Ecology. Air quality impacts on ecology are assessed through consideration of predicted air quality levels compared with project standards for the protection of vegetation, and in particular lichen which is an important food source for reindeer (see below and also the Project Standards Document in Appendix 2).

Baseline meteorological characteristics and air quality conditions are given in Chapter 6 of the ESIA, and are based on data provided by GU Yamal-Nenets CGMS. In addition, the most recent available five years' worth of meteorological data from the meteorological station at Tambey were used as input for the dispersion modelling undertaken for the operational phase (see below and also Annex B).

The atmospheric emission sources and volumes are described by phase in the relevant sub-sections below. In general terms, air emissions are a result of combustion processes and dust emissions from earth works and road vehicles. The pollutants of primary concern in terms of air quality from these sources are as follows:

- Combustion sources: Oxides of nitrogen (NO_X), sulphur dioxide (SO_2), carbon monoxide (CO) and particulates (carbon/soot). (It should be noted that the levels of sulphur in the field gas are extremely low –see Chapter 4 - and hence the primary sources of SO_2 relate to diesel power equipment and shipping.)
- Earthworks: dust/suspended solids.

The air quality standards adopted by the Project for the key combustion pollutants are summarised below.

Table 9.2.1: Adopted Project Air Quality Standards

Pollutant	**Application**	**Time Average**	**Ground level concentration (GLC) limit**
NO_2	Human health	20 minutes	200 µg/m^3
		1 year	40 µg/m^3
NO_x	Vegetation	1 year	19.5 - 24 µg/m^3
SO_2	Human health	10 minutes	500 µg/m^3
		24 hour	20 µg/m^3
	Lichen	1 year	10 µg/m^3
CO	Human health	15 minutes	100 mg/m^3 (WHO Standard)
		20 minutes	5 mg/m^3 (RF standard used for regulatory assessment/SPZ determination)
		8 hours	10 mg/m^3 (WHO Standard)

Table 9.2.1: Adopted Project Air Quality Standards			
Pollutant	**Application**	**Time Average**	**Ground level concentration (GLC) limit**
Particulates (as PM_{10})	Human health	20 minutes	300 µg/m^3
		24 hour	50 µg/m^3
		1 year	20 µg/m^3

Air quality modelling was undertaken using the UPRZA Ekolog modelling software (version 3.0) as part of the Russian Federation OVOS approvals process, and included:

- Assessment of air quality impacts during the construction period assuming peak usage of construction equipment/emission sources.
- Assessment of air quality impacts during the operational phase to determine the dimensions of the SPZ based on consideration of a worst case upset condition.

However, the OVOS methodology for operation phase air quality impact assessments does not consider normal operations or a wider range of potential upset conditions. With due consideration to these limitations, and also to the presence of relatively large-scale combustion sources during operations (as compared to the construction phase), a more detailed re-assessment of operational air quality impacts has been undertaken for the development of this ESIA. This has been undertaken in line with IFC EHS Guidelines using the ADMS dispersion modelling software and is presented in Section 9.2.3. The development of the approved SPZ is also provided in Section 9.2.3.1 for completeness.

The assessment of construction period air quality impacts presented in the OVOS assumes simultaneous use of all potential emission sources, and is therefore considered to be conservative. This conservativeness, coupled with the fact that construction phase emissions are of lower significance than those during operations, means that more detailed modelling for the construction phase is not merited. Section 9.2.2 therefore presents a summary of the construction phase air quality impact assessment undertaken for the OVOS submissions.

Background air quality levels in the Project Licence Area that have been used in the statutory assessment of air quality for the development of the SPZ were based on data provided by the CGMS Centre (see also Chapter 7) and are summarised in Table 9.2.2 below.

Table 9.2.2: Background ambient air quality concentrations, mg/m^3		
Pollutant	**Background Levels**	**MACm.s. in populated area ambient air**
Nitrogen dioxide	0.056	0.2
Sulfur dioxide	0.011	0.5
Carbon monoxide	1.8	5
Suspended solids[1]	0.140	0.5

[1] This is covers all particulate matter

The above levels include a (likely dominating) contribution from industrial emission sources (e.g. emissions from existing well pad activities and the existing camp facilities) in the Project Licence Area that will either cease or be effectively be superseded by Project emissions. The use of the above values for the baseline within the air quality assessment is therefore highly conservative, with actual baseline levels from non-Project sources likely to be significantly lower (this is corroborated by other baseline air quality studies undertaken in 2006 that indicate generally lower levels of air quality pollutants even near existing well pads – see Chapter 7 for further details).

9.2.1.2 GREENHOUSE GAS EMISSIONS

Sources of GHG emissions will include generation of CO_2 from a variety of combustion sources and also fugitive emission of other GHG, primarily methane (CH_4). Annual GHG emissions will be greatest during the operational period and these emissions are assessed in Section 9.2.3.5.

Release of GHG could potentially occur through melting of permafrost. Thermal impacts on permafrost are assessed in Section 9.3, and the impacts are found to be low due to the design of structures and other mitigating measures. Therefore, significant thawing of permafrost due to project activities is not predicted and hence methane emissions are not considered significant.

9.2.2 CONSTRUCTION

Atmospheric emission sources during the construction phase are summarised in Table 9.2.3 below.

Table 9.2.3: Atmospheric Emission Sources During Construction

Facility	Emission type	Sources
Well field and camp utilities	Combustion sources	Road vehicles Construction equipment Drilling rigs Flaring during well testing Boiler houses
	Fugitive/venting sources	Gas venting during gas pipeline dismantling (one-off events) Paint shops
	Dust generation	Road vehicles Earthmoving equipment/excavations
LNG Plant	Combustion sources	Road vehicles Construction equipment Mobile and static diesel power generators Boiler houses
	Dust generation	Road vehicles Earthmoving equipment/excavations Concrete batching
Airport	Combustion sources	Road vehicles Construction equipment Mobile generators
	Dust generation	Road vehicles

Table 9.2.3: Atmospheric Emission Sources During Construction		
Facility	**Emission type**	**Sources**
		Earthmoving equipment/excavations
Seaport (main)	Combustion sources	Road vehicles Construction equipment Mobile generators Shipping (dredgers) emissions
	Dust generation	Road vehicles Earthmoving equipment/excavations Cement silos
Waste facility	Combustion sources	Road vehicles Construction and landfill operation equipment Incinerator emissions (3 x KTO-50 type)
	Dust generation	Road vehicles Earthmoving equipment/excavations Waste unloading and compaction

The emission rates of key pollutants during the routine construction activities have been estimated and are summarised below.

Table 9.2.4: Atmospheric Emission Rates During Construction

Pollutant	Peak Emission (g/s) and total emission in construction period (tonne)					
	Onshore construction areas (excluding airport)[2]		Main Seaport[3]		Airport[4]	
	Peak	Annual	Peak	Annual	Peak	Annual
NO_X	10.67	499.5	4.663	95.37	1.022	2.92
SO_2	1.580	69.39	1.421	10.74	0.08244	0.283
Particulates[5]	3.175	206.9	0.6320[1]	13.73[1]	0.05045[1]	0.1096[1]
CO	23.81	561.0	4.482	75.80	2.486	2.85

[1] Calculated as 'carbon soot'.
[2] Data from Design Document 11-035.2-OOC-8.3
[3] Data from seaport OVOS 2030-4478-13-OBOC
[4] Data from airport design documentation
[5] Covers all particle sizes and hence provides a conservative comparison against PM_{10} standards

During the construction phase the primary human sensitive receptor location to the main construction sites (i.e. the seaport and LNG complex areas) is the accommodation camp at Sabetta (other satellite contractor accommodation camps are located around the Licence Area but are farther from these main construction areas). Based on the proximity to the emission sources and the scale of the emissions, air quality impacts at the Sabetta accommodation camp during construction are dominated by emissions from the LNG plant and seaport construction areas. Based on the estimated emission rates, the maximum ground level concentrations (GLC) at the Sabetta accommodation camp during the construction phase have been assessed using the

UPRZA Ekolog dispersion modeling software. The predicted GLC at the Sabetta accommodation camp are summarised in the table below. The calculation of peak impacts from the all construction sources (final column) is considered to be highly conservative due to the following factors:

1. It is conservatively assumed that peak emissions from all sources will occur simultaneously
2. The assumed background concentrations are conservative as described in Section 9.2.1.1.

Table 9.2.5: Peak Ground Level Concentrations at the Sabetta Accommodation Camp during Construction (mg/m³)

Pollutant	Project standard	Background	Maximum GLC			
			Excluding background - Due emissions from			Total incl. background
			Onshore facility construction[2]	Seaport construction[3]	Combined	
NO_2	0.2	0.056	0.02	0.1131	0.1331	0.1891
SO_2	0.5	0.011	0.004	0.0109	0.0149	0.0259
Particulates[1]	0.3[4]	0.14	0.005	0.0132[5]	0.0182	0.158
CO	5	1.8	0.1	0.06	0.16	1.96

[1] Covers all particle sizes and hence provides a conservative comparison against PM_{10} standards (see also note 4)
[2] Data from Design Document 11-035.2-OOC-8.3
[3] Data from seaport OVOS 2030-4478-13-OBOC
[4] Peak (20 minute average) standard for PM_{10}
[5] Calculated as 'carbon soot'

The predicted GLC demonstrate that during the construction period the project air quality standards will be met and that the peak contribution of construction sources is less than 50% of the Project Standards for all pollutants except NO_2. The impacts on air quality during construction are therefore conservatively assessed as **Moderate** for NO_x and **Low** for all other pollutants.

Notwithstanding this, measures to minimise air emissions during the construction phase will be implemented as follows:

- Use of modern diesel generators that meet applicable project emission standards
- Regular maintenance of stationary and mobile equipment and vehicles (vehicle emissions to be maintained in accordance with Russian Federation standards GOST R 52160-2003 and GOST 17.2.2.02-98)
- Avoid unnecessary running of engines on idle when not in use (i.e. switch engines off when not in use for prolonged periods)
- Use of low sulphur diesel
- Using closed tanks for fuels and lube oils
- Storage of volatile chemicals and loose materials in enclosed structures
- Waste incinerators will have an afterburner chamber treatment temperature of 1100 to 1200ºC ensure dioxin and furan destruction
- Ban burning of any wastes other than in dedicated incinerators
- Dust suppression in loading and unloading areas

9.2.3 COMMISSIONING AND OPERATION

Atmospheric emission sources during the commissioning and operation phases are summarised in Table 9.2.6 below.

Table 9.2.6: Atmospheric Emission Sources During Commissioning and Operation

Facility	Emission type	Sources
Well field	Combustion sources	Road vehicles Drilling rigs Horizontal flares (non-continuous) Hammer mill
	Dust generation	Road vehicles
Accommodation Camps	Combustion sources	Road vehicles Back-up diesel power plant
	Dust generation	Road vehicles
LNG Plant and Main power plant	Combustion sources	Flaring system Gas turbine compressors (2 frame 7 GT per process train) Main power plant (8 x SGT-800) process pumps and heaters
	Fugitive/venting sources	Process equipment building ventilation systems Methanol, condensate, propane and ethane storage tanks Fresh amine store Process line and flange leaks Thermal stabilization system
Airport	Combustion sources	Aircraft (landing and take-off cycle) Diesel power plant Boiler house
	Fugitive/venting sources	Fuel storage tanks De-icing fluid storage
Seaport (main)	Combustion sources	Loading machinery engines Road vehicles Vessel emissions
	Fugitive/venting sources	Loading equipment
Water treatment Plant	Combustion sources	Sludge incineration (2 incinerator units)
Waste facility	Combustion sources	Waste incinerators (3 x KTO-50.K40 units) Waste trucks and equipment
	Fugitives	Landfill gases
	Dust generation	Waste moving and cover

The emission standards for the combustion sources of primary significance during the operational phase are presented below (see the Project Standards Document in Appendix 2 for further details).

Table 9.2.7: Atmospheric Emission Standards for Key Operational Sources				
Emission source	Preliminary Yamal LNG Project Standards (mg/ Nm^3)			
	PM	SO_2	NOx	CO
Power Generation and Refrigerant Compression (> 50MWth)	N/A	N/A	51 (low NOx technology, (DLN), shall be applied)	100
Incinerators (daily)	10	N/A	200 to 400	N/A

Impacts during the commissioning and operational phases have been assessed in terms of:

1. The development of the SPZ and associated impacts at the perimeter of the accommodation areas as required under the RF regulation approvals
2. Assessment of air quality impacts around the project facilities on human health and vegetation during:
   a. Routine operations
   b. Process upset conditions.

9.2.3.1 DEVELOPMENT OF THE SPZ

The development of approved SPZs is a requirement of the Russian Federation approvals process. The size of the SPZ is set such that relevant standards for the protection human health against impacts associated with air quality emissions, noise, vibration etc. (see also the Project Standards Document) are met at the edge of the SPZ. The SPZ have been formally approved by the RF authorities and a summary of the confirmation that the relevant air quality standards are met at the edge of the SPZ for the relevant operational facilities is presented here for completeness only. Further details on the SPZ are also presented in Section 9.8.3.1.

The peak emission rates of pollutants during the commissioning and operation phases were conservatively estimated for the determination of the SPZ and these are summarised below.

Table 9.2.8: Peak Atmospheric Emission Rates During Commissioning and Operation						
Pollutant	Emissions (g/s)					
	Field wells/ camp facilities	LNG Plant	Airport	Seaport (main)	Waste facility	Total
NO_X	4.06	20.9	1.02	27.5	0.0489	53.5
SO_2	0.477	0.0232	0.0824	11.5	0.0121	12.1
Particulates	0.0170	0.0325	0.0505	1.18	0.0222	1.30

Table 9.2.8: Peak Atmospheric Emission Rates During Commissioning and Operation

Pollutant	Emissions (g/s)					
	Field wells/ camp facilities	LNG Plant	Airport	Seaport (main)	Waste facility	Total
CO	6.75	1.04	2.49	23.3	0.289	33.8

During the commissioning and operation phases the primary human sensitive receptor locations are the accommodation camp at Sabetta and the LNG workers' accommodation camp to the west of the LNG Complex. Based on the proximity to the emission sources and the scale of the emissions, air quality impacts at these camps are dominated by:

- Sabetta accommodation camp: emissions from the LNG plant and seaport facilities.
- LNG accommodation camp: emissions from the LNG plant.

Based on the estimated emission rates, the maximum ground level concentrations (GLC) at the accommodation areas during the commissioning and operation phases have been assessed using the UPRZA Ekolog dispersion modeling software. The predicted GLC at the accommodation camps are summarised in the table below.

Table 9.2.9: Peak GLC at the Accommodation Camps During Operation (mg/m^3)

Pollutant	Time average (minutes)	Project standard	Back-ground	Maximum GLC at the accommodation camps		
				LNG worker accommodation	Sabetta accommodation	
				LNG plant emissions	LNG plant emissions	Seaport (main) emissions
NO_2	20	0.2	0.056	0.086	0.074	0.081
SO_2	10	0.5	0.011	0.015	0.01	0.013
Particulates[1]	20	0.3[2]	0.14	-	-	0.0009
CO	20	5	1.8	1.9	1.8	1.8

[1] Covers all particle sizes and hence provides a conservative comparison against PM_{10} standards (see also note 2)
[2] Peak (20 minute average) standard for PM_{10}

The proposed size of the SPZ for each of the most significant emission facilities is estimated in Table 9.2.10 below. The size of the proposed SPZ for the various facilities is driven by ambient NO_2 levels and hence the maximum of the peak NO_2 levels at the edge of the SPZ are also provided in Table 9.2.10.

Table 9.2.10: Peak GLC at the edge of SPZ					
Facility	**SPZ size (m)**	**Peak GLC at edge of SPZ (mg/m^3)**			
		NO_2		**SO_2**	
		GLC (20 min)	**% of standard**	**GLC (10 min)**	**% of standard**
LNG Plant	1,000	0.168	0.84	0.03	0.06
Airport	200	0.132	0.66	0.02	0.04
Seaport (main)	500	0.085	0.417	0.0136	0.0271
Waste facility	500	0.006	0.03	Negl	0

From review of Tables 9.2.9 and 9.2.10 it can be seen that:

- The predicted air quality levels at the accommodation areas are all within project standards, although in the case of NO_2 the predicted levels including allowance for background is greater than 50% of the standard.
- The peak air quality standards are predicted to be met at the edge the SPZ for all pollutants.

9.2.3.2 ASSESSMENT OF ROUTINE OPERATIONS AIR QUALITY IMPACTS

Assessment of the air quality impacts during the operational phase has been undertaken using the ADMS software programme. The meteorological data used for the assessment are based on the last available five years' worth of meteorological data available from the Tambey weather station and is further described in Annex B.

The assessment is focused on the primary emission sources during normal operation of the LNG Complex (which, inter-alia, includes the LNG processing, storage and unloading facilities, and the main power plant). Emissions from vessels in the seaport and from aircraft at the Sabetta airport have been screened out based on international practice (UK guidance - Defra Technical Guidance LAQM.TG(09)) and the anticipated numbers of vessel and aircraft movements.

As the primary sources of emissions during normal operations are combustion of natural gas from the Tambey field, which has extremely low levels of sulphur, the assessment has focused on the emission of NO_x and CO. In developing the emissions inventory all NO_x emissions have conservatively been assumed to be released as NO_2.

The full list of emission sources is presented in Annex B, with a summary of the most significant emissions presented in Table 9.2.11 below.

Table 9.2.11: Main Emissions Sources during Normal Operations

Source	Number of units	Stack height (m)	Pollutant	Emission rate (g/s) per stack
Refrigerant Compressor GT	6	40.5	NO_x	12.75
			CO	4.28
Power plant GT (with waste heat recovery)	4	40	NO_x	3.44
			CO	0.929

The primary receptors for human health impacts during operations are assumed to be the Sabetta accommodation camp and the LNG accommodation camp. The predicted air quality impacts at these receptors are summarised in Table 9.2.12 below.

Table 9.2.12: Predicted GLC at Accommodation Camps during Normal Operations

Pollutant	Time Period	Project Standard	Sabetta Camp	LNG Camp
NO_2 (µg/m^3)	Annual average	40	0.17	0.14
NO_2 (µg/m^3)	1 hour (99.8th percentile)	200	7.70	8.51
CO (mg/m^3)	15 minute (max)	100 *	0.01	0.02
CO (mg/m^3)	8 hour (max running)	10 *	<0.01	<0.01

* Based WHO standards.

Contours plots for the NO_2 GLC are presented for both the annual average and 1 hour average (99.8th percentile) time periods in Figures 9.2.1 and 9.2.2 below[1].

[1] Note that the 'starring' effect in these isopleths is an artefact of the rounding of the wind direction to the nearest 10 degrees in the available meteorological data. As described in Annex B, this effect is not considered significant in the context of the air quality assessment.

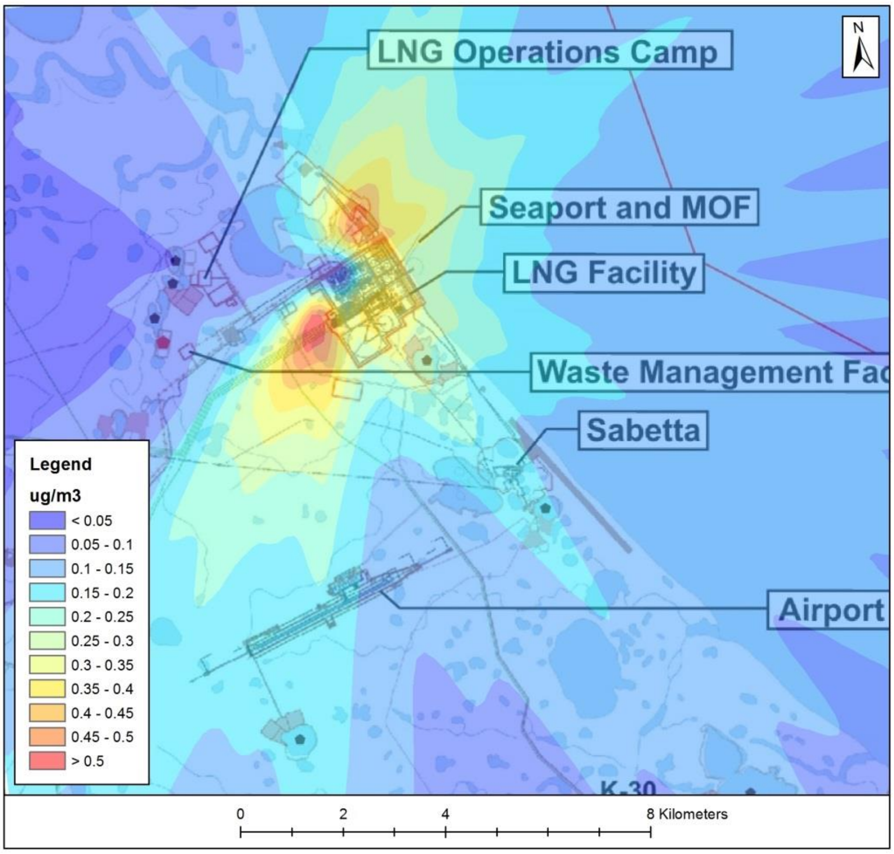

Figure 9.2.1: Predicted Annual Average NO_2 Contours During Normal Operations

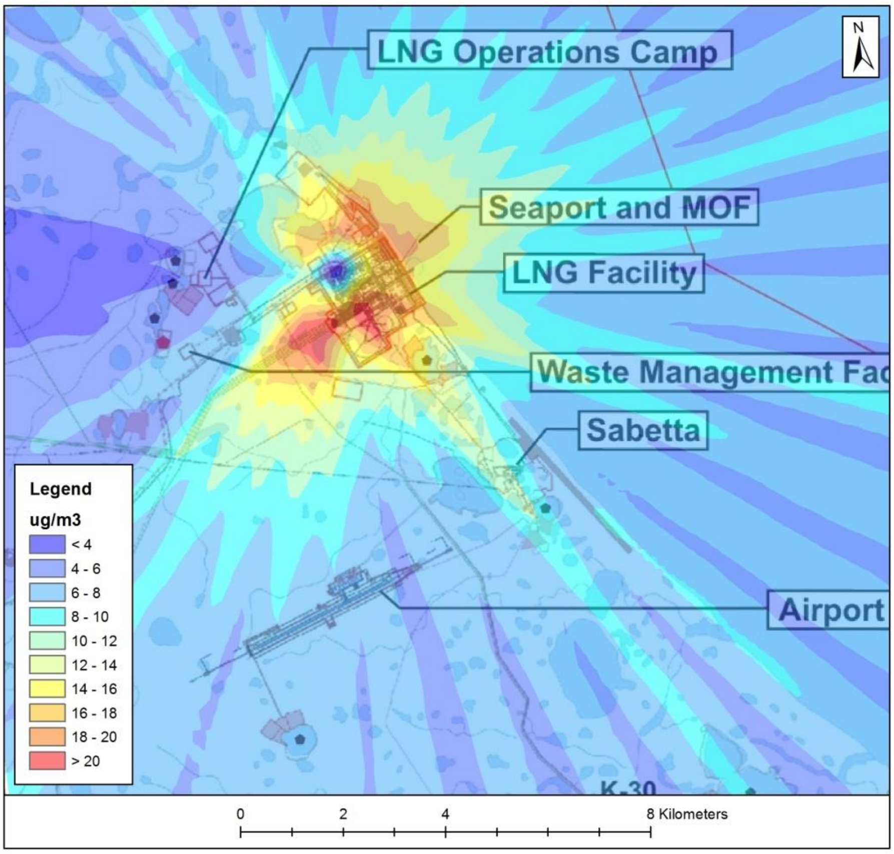

Figure 9.2.2: Predicted 99.8th Percentile 1 Hour Average NO_2 Contours During Normal Operations

The predicted GLC for both NO_2 and CO at the Sabetta and LNG accommodation camps are well within Project standards. As noted above, there is a lack of credible background air quality data and hence the predicted levels above do not include an existing background concentration. Nonetheless, given the current absence of other (non-Project) significant sources of air quality pollution in the vicinity of the Project Licence Area and the fact that predicted GLC are very much below (<<10%) the Project standards, it is concluded that the impacts on air quality for the protection of human health are **low**. In terms of cumulative air quality impacts, it is noted that the predicted GLC are well within the 25% of applicable air quality standards that is stipulated in IFC EHS guidelines to allow additional, future sustainable development in the same airshed.

As noted above, the assessment of NO_2 is based on the conservative assumption that all NO_x emissions are assumed as NO_2. This means that Figure 9.2.1 can be considered to show the predicted NO_x annual average GLC during normal operations. This plot shows that the NO_x GLC Project standard for protection of vegetation is met in all locations.

In addition the nitrogen deposition rates during normal operations have been estimated through the following two-stage process[2]:

- **Stage 1** Calculate dry deposition flux (µg/m2/s)

  The Dry Deposition Flux = Annual Mean Ground Level Concentration (µg/m3) x Dry Deposition Velocity (m/s), where the dry deposition velocity is given in Table A1 of AQTAG[2]. For NO_2 and grassland, the dy deposition velocity is assumed to be 0.0015m/s.

- **Stage 2** Calculate the annual deposition rate (kg/ha/yr)

  The Annual Deposition Rate is calculated by the multiplying the dry deposition flux by the relevant conversion factor given in Table A2 of AQTAG[2] (for NO_2 this assumed to be 96)

The predicted nitrogen deposition rates (kg/N/ha/yr) during normal operations are shown in Figure 9.2.3 below.

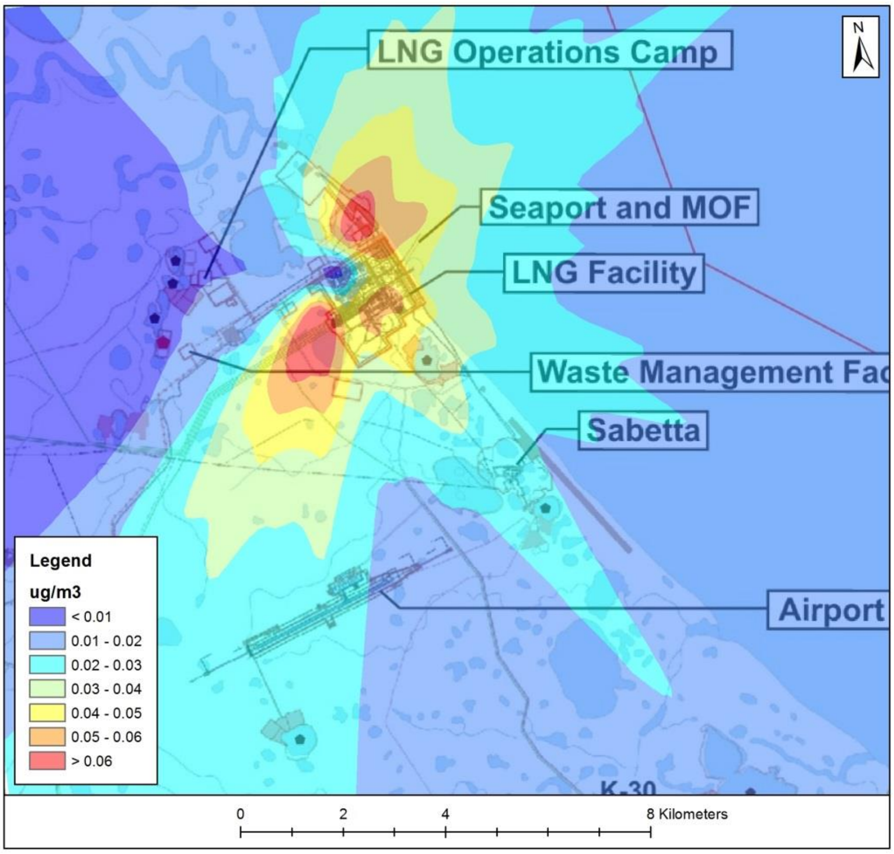

Figure 9.2.3: Predicted Nitrogen Deposition During Normal Operations

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[2] Environment Agency, 2004, AQTAG 06 Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air

Critical loads for tundra environments are assumed to be in the range of 3 to 15 kg/N/ha/yr, based on review of available literature[3,4]. Inspection of Figure 9.2.3 shows that predicted deposition rates are well below the critical load rate in all locations. Overall, the impacts on vegetation from ambient NO_x and nitrogen deposition are assessed as **negligible**.

9.2.3.3 ASSESSMENT OF INCINERATOR EMISSIONS

Emission inventories for the incinerators are provided in Annex 1 to this chapter. CO and NO_2 emissions from incinerators are included in the normal operations air quality impact assessment above. Modeling results (in µg/Nm^3) for the emission of PM_{10}, HCl and HFl are summarized in Table 9.2.13 below.

Table 9.2.13: Predicted Air Quality impacts from Incinerator emissions for PM_{10}, HCl and HFl (µg/Nm3)

Pollutant	Time average	Standard[2]	Max GLC (i.e max anywhere on the grid)	Max concentration at Sabetta Camp	Max concentration at LNG Camp
PM_{10}	24 hr	50	1.75	0.13	0.36
	Annual av	20	0.15	0.01	0.04
HCl	15 min	8000[1]	1.16	0.06	0.14
	8 hour	2000[1]	0.77	0.03	0.10
HFl	15 min	2500[1]	0.01	0.00	0.00
	8 hour	1500[1]	0.01	0.00	0.00

[1] Conservatively based on occupational health limits taken from UK guidance EH-40.
[2] See also the Project Standards Document

All the identified air quality standards are comfortably met at all locations for the assessed pollutants.

9.2.3.4 ASSESSMENT OF AIR QUALITY IMPACTS DURING ABNORMAL CONDITIONS

A range of abnormal operational scenarios was identified at the FEED stage that would result in potentially increased air emissions, and included both anticipated planned events and unplanned emergency events. In total nine scenarios have been identified which are summarised below for which full emission inventories are provided in Annex B.

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[3] Review and revision of empirical critical loads and dose-response relationships, Coordination Centre for Effects, 2010

[4] APIS indicative critical load values: Recommended values within nutrient nitrogen critical load ranges for use in air pollution impact assessments (http://www.apis.ac.uk/indicative-critical-load-values)

Table 9.2.14: Abnormal Operational Emission Scenarios			
ID	**Type**	**Title**	**Description**
Scenario 1	Unplanned	Refrigerant Compressor Trip	Refrigerant Compressor String Blowdown after trip leading to release to Dry Gas Flare.
Scenario 2	Unplanned	3 Year Cold Weather event	3 LNG train controlled shutdown - Release to Dry Gas Flare
Scenario 3	Unplanned	BOG Compressor Trip	Flaring of all BOG during unavailability of the BOG Compressors - with three LNG trains operating at design capacity during loading of an LNG carrier at the design rate.
Scenario 4	Unplanned	Depressurisation of cryogenic heat exchange and propane circuit	Scenario corresponds to simultaneous 1) Depressurisation of the Main Cryogenic Heat Exchanger and Refrigeration Emergency; and 2) Depressurisation of Propane Circuit.
Scenario 5	Planned	Planned shutdown	Planned shutdown of one LNG Train (Train 1 assumed)
Scenario 6	Planned	Offspec LNG	Cold burner emissions from offspec LNG, otherwise normal operations
Scenario 7	Planned	Demethaniser	Cold burner emissions from liquids from demethaniser drain, otherwise normal operations
Scenario 8	Planned	BOG Compressor flaring	BOG Compressor flaring, but otherwise normal operations
Scenario 9	Planned	Warm liquid burner	Warm liquid burning of general liquids, otherwise normal operations

Predicted GLC values at the primary receptors, the Sabetta and LNG accommodation camps, are summarised in Table 9.2.15.

Table 9.2.15: Predicted GLC at Accommodation Camps during Abnormal Operations (NO_2 in µg/m³ CO in mg/m³)					
Scenario	**Pollutant**	**Time Period**	**Project Standard**	**Sabetta Camp**	**LNG Camp**
1	NO_2	1 hour (99.8th percentile)	200 µg/m³	31.47	33.00
	CO	15 minute	100 mg/m³	0.37	0.65
	CO	8 hour	10 mg/m³	0.15	0.17
2	NO_2	1 hour (99.8th percentile)	200 µg/m³	34.61	35.01
	CO	15 minute	100 mg/m³	0.41	0.65
	CO	8 hour	10 mg/m³	0.17	0.18
3	NO_2	1 hour (99.8th percentile)	200 µg/m³	31.29	28.94
	CO	15 minute	100 mg/m³	0.35	0.65
	CO	8 hour	10 mg/m³	0.11	0.14

Table 9.2.15: Predicted GLC at Accommodation Camps during Abnormal Operations (NO_2 in µg/m³ CO in mg/m³)

Scenario	Pollutant	Time Period	Project Standard	Sabetta Camp	LNG Camp
4	NO_2	1 hour (99.8th percentile)	200 µg/m³	52.12	52.97
	CO	15 minute	100 mg/m³	0.67	0.67
	CO	8 hour	10 mg/m³	0.38	0.28
5	NO_2	1 hour (99.8th percentile)	200 µg/m³	33.91	30.07
	CO	15 minute	100 mg/m³	0.41	0.65
	CO	8 hour	10 mg/m³	0.14	0.15
6	NO_2	1 hour (99.8th percentile)	200 µg/m³	75.63	63.81
	CO	15 minute	100 mg/m³	1.49	2.79
	CO	8 hour	10 mg/m³	0.38	0.46
7	NO_2	1 hour (99.8th percentile)	200 µg/m³	51.67	45.68
	CO	15 minute	100 mg/m³	0.87	1.62
	CO	8 hour	10 mg/m³	0.23	0.29
8	NO_2	1 hour (99.8th percentile)	200 µg/m³	21.38	23.02
	CO	15 minute	100 mg/m³	0.15	0.14
	CO	8 hour	10 mg/m³	0.06	0.06
9	NO_2	1 hour (99.8th percentile)	200 µg/m³	33.47	28.70
	CO	15 minute	100 mg/m³	0.35	0.65
	CO	8 hour	10 mg/m³	0.10	0.13

The predicted GLC at the Sabetta and LNG accommodation camps are well within (<50% and typically very much lower) the applicable Project air quality standards. Impacts on human health from air emissions during the abnormal operations are therefore assessed as **Low**.

9.2.3.5 REGIONAL IMPACTS

Regional impacts from combustion sources can occur in relation to nitrogen deposition (which is addressed in section 9.2.3.4 above) and also acidification, primarily due to SO_2 emissions.

Gas from the Tambey Gas Condensate Field has very low (trace) levels of sulphur and there is consequently no requirement for sulphur removal as part of the gas pre-processing (see Chapter 4 for further details). This means that neither flaring of the field gas nor emissions from the acid removal unit will lead to significant SO_2 emissions. In addition, boil off gas (BOG) is used as the fuel gas for the key combustion sources at the LNG complex, namely the main power station and the LNG process compressor gas turbines, and this means that SO_2 emissions from these sources will also be minimal. While there will be sulphur emissions associated with transport sources (including aircraft, road vehicles and marine vessels) and certain stationary sources (e.g. the waste incinerators), this will represent relatively small SO_2 emissions within the regional context and are therefore not expected to contribute significantly regional acidification.

9.2.3.6 GREENHOUSE GAS EMISSIONS

During the construction phase, the primary sources of greenhouse gases are CO_2 generated from combustion sources and fugitive emissions of methane (CH_4).

The primary sources of CO_2 emissions during the operational phase of the LNG complex (including the main power plant) are summarised below (transport-associated emissions from shipping and air transport excluded).

Table 9.2.16: Annual CO_2 Emissions during the Operational Phase

Process Units	Assumed duration (hr/yr)	CO_2 emission tonne/y	Comments
Continuous Emissions			
Acid gas vent[1]	8760	512,658	Vented through Compressor Gas Turbine stack)
Compressor GT[1]	8760	1,728,186	
Wet gas purge[1]	8760	5,096	
Wet gas pilot[1]	8760	98	
Dry gas purge[1]	8760	20,386	
Dry gas pilot[1]	8760	392	
Spare flare purge[1]	8760	10,192	
Spare flare pilot[1]	8760	196	
BOG flare purge[1]	8760	48,322	
BOG flare pilot[1]	8760	392	
Power plant[2]	8760	1,867,903	
Subtotal		**2,325,918**	
Intermittent Emissions			
Emergency diesel generator[1]	100	41,850	
Warm liquid burner[1]	110	128	Fuel gas system
Cold liquid burner[1]	110	128	Fuel gas system
Dry gas flare[1]	7.99	2,812	Planned shutdown of one process train1 process train down
Cold liquid burner[1]	54	40,838	Start-ups (off-spec LNG)
Cold liquid burner[1]	48	10,531	Releases from demethaniser
Warm liquid burner[1]	96	8,464	Releases from debutanisers
HVAC backup furnace[1]	336	8,565	1 process train down
BOG flare[1]	4	475	BOG compressor trip
Subtotal		**113,791**	
Grand Total		**2,439,709**	

[1] Data from CB&I Emissions List 1757-000000-PR-LS-00008 Rev 5

[2] CB&I Preliminary Air dispersion Modelling Input Data 175700-000000-SE-LS-00029 Rev A

Total annual methane emissions during the operational period (2020 taken as base case[5]) are summarised below.

Table 9.2.17: Annual Methane Emissions during the Operational Phase	
Annual methane (CH_4) emissions (t/yr)	1,857.4
Methane Global Warming Potential[1]	25
Annual CH_4 emissions (CO_2-equivalent t/yr)	**46,435.0**

[1] IPCC Fourth Assessment Report

This gives a total annual CO_2-equivalent emission during operation of the LNG complex of 2,440kt/y. This represents approximately 0.1% of the annual total CO_2-equivalent emissions in the whole Russian Federation in 2008 of 2,355 mt/y[6]. As such greenhouse gas emissions are low in the context of overall Russian Federation emissions. However, annual emissions are above 25,000 te/yr and therefore in line with the requirements of the IFC Performance Standards, greenhouse gas emissions will be quantified by Yamal LNG annually during the operational phase.

9.2.3.7 MITIGATION CONTROLS

Air emission control and mitigation measures within the design include (see also Chapter 4):

- Use of waste heat recovery at the main power plant
- Waste incinerators will have an afterburner chamber treatment temperature of 1100 to 1200ºC ensure dioxin and furan destruction
- Vapour recovery from LNG and condensate storage tanks and load-off facilities for use as fuel gas
- Selection of key combustion equipment to meet Project emission standards as defined in Table 9.2.6 the Project Standards Document
- Use of floating roofs for bulk fuel and condensate storage tank
- Selection of Dry Low NO_x (DLN) technology for the gas turbines at the power plant and the LNG compressor trains.
- Methods to minimise fugitive air emissions:
    - Minimising the number of flanges used in pipelines, and replacing flanges with weld joints;
    - Use of high-efficiency fillings between flanges;
    - Use of glandless pumps, or, if impractical, double mechanical seals;
    - Use of high quality seals in compressors and air blowers used in handling hydrocarbons;
    - Use of high efficiency sealing material to ensure tightness of control valves;
    - Regular inspection and maintenance of gas pipelines
    - Using closed tanks for fuels and lube oils.

[5] Methane emission data taken from "Construction of facility for Gas production, conditioning and shipment of LNG and gas condensate from STGCF", 11.035.2-OOC-8.3

[6] World Bank http://data.worldbank.org/country/russian-federation?display=default

In addition, the following procedural controls will also be applied:

- Implementation of a flaring minimisation programme
- Regular maintenance of stationary and mobile equipment and vehicles (vehicle emissions to be maintained in accordance with Russian Federation standards GOST R 52160-2003 and GOST 17.2.2.02-98)
- Avoid unnecessary running of engines on idle when not in use (i.e. switch engines off when not in use for prolonged periods)
- Use of low sulphur fuel
- Ban burning of any wastes other than in dedicated incinerators
- Monitoring and control of engines on berthed vessels to minimise emissions
- Methods to minimise fugitive air emissions:
    - Use of regular hydrocarbon sampling systems based on closed cycles;
    - Using closed tanks for fuels and lube oils;
    - Storage of volatile chemicals and loose materials in enclosed structures.

9.2.4 SUMMARY

Table 9.2.18 Summary of Air Emission Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
Impacts on air quality	Humans (Sabetta accommodation camp)	Construction	• Use of modern diesel generators that meet applicable project emission standards • Regular maintenance of stationary and mobile equipment and vehicles (vehicle emissions to be maintained in accordance with Russian Federation standards GOST R 52160-2003 and GOST 17.2.2.02-98) • Avoid unnecessary running of engines on idle when not in use (i.e. switch engines off when not in use for prolonged periods) • Use of low sulphur diesel • Using closed tanks for fuels and lube oils • Storage of volatile chemicals and loose materials in enclosed structures • Waste incinerators will have an afterburner chamber treatment temperature of 1100 to 1200ºC ensure dioxin and furan destruction • Ban burning of any wastes other than in dedicated incinerators • Dust suppression in loading and unloading areas	**Moderate (NO_2 emissions)** **Low (other air quality pollutants)**

	Humans (Sabetta and LNG workers camps)	Commissioning and Operations	• Mitigation in design:
			  • Use of waste heat recovery at the main power plant
			  • Waste incinerators will have an afterburner chamber treatment temperature of 1100 to 1200ºC ensure dioxin and furan destruction
			  • Vapour recovery from LNG and condensate storage tanks and load-off facilities for use as fuel gas
			  • Selection of key combustion equipment to meet Project emission standards as defined in Table 9.2.6 the Project Standards Document
			  • Use of floating roofs for bulk fuel and condensate storage tank
			  • Selection of Dry Low NOx (DLN) technology for the gas turbines at the power plant and the LNG compressor trains.
			  • Methods to minimise fugitive air emissions:
			    ○ Installation of a system of flash gas compressors to remove steam from LNG storage tanks, load-off facilities, and re-using spent steam;
				Low

	Vegetation (lichen)	Commissioning and Operations		**Negligible**

Table 9.2.18 Summary of Air Emission Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			◦ Minimising the number of flanges used in pipelines, and replacing flanges with weld joints; ◦ Use of high-efficiency fillings between flanges; ◦ Use of glandless pumps, or, if impractical, double mechanical seals; ◦ Use of high quality seals in compressors and air blowers used in handling hydrocarbons; ◦ Use of high efficiency sealing material to ensure tightness of control valves; ◦ Using closed tanks for fuels and lube oils. • Procedural controls in operation: • Implementation of a flaring minimisation programme • Regular maintenance of stationary and mobile equipment and vehicles (vehicle emissions to be maintained in accordance with Russian Federation standards GOST R 52160-2003 and GOST 17.2.2.02-98) • Avoid unnecessary running of engines on idle when not in use (i.e. switch engines off when not in use for prolonged periods) • Use of low sulphur fuel • Ban burning of any wastes other than in dedicated incinerators • Monitoring and control of engines on berthed vessels to minimise emissions • Regular inspection and maintenance of gas pipelines • Methods to minimise fugitive air emissions: ◦ Use of regular hydrocarbon sampling systems based on closed cycles; ◦ Using closed tanks for fuels and lube oils; ◦ Storage of volatile chemicals and loose materials in enclosed structures.	

Table 9.2.18 Summary of Air Emission Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
Greenhouse gas emission	Climate Change	Commissioning and Operation	• Fugitive emissions controls (see above) • Flaring minimisation • Energy efficiency measures including: ▪ Waste heat recovery at the main power plant ▪ Vapour recover systems on LNG and condensate storage and loading facilities for use as fuel gas	**N/A**

Table 9.2.19 Summary of Air Emission Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
Air emissions	Construction	Exhaust stacks on stationary power generators	NO_x CO	Annual
Air emissions	Construction and Operation	Incinerator stacks	NO_x SO_2 Particulates Dioxins/Furans	Annual
Air emissions	Operations	Power generation plant and compression gas turbines (LNG Complex)	Inlet monitoring (gas turbine inlets): • Continuous volumetric flow meter • Sampling connection to enable definition of fuel quality Outlet Monitoring at stack: • Continuous Emission Monitoring on NOx, PM and CO_2 • Sampling ports for stack emission testing	Continuous

Table 9.2.19 Summary of Air Emission Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
Air emissions	Operations	Fired heaters at stack	Outlet monitoring at stack: • Continuous emission monitoring on NOx, PM and CO_2 Sampling ports for stack emission testing	Continuous
Air emissions	Operations	Sea port sources	Emissions from category 3 and 4 sources (as defined by "Manual on regulation and control of emissions" (Saint-Petersburg, 2005)	Category 3 sources – annual Category 4 sources – every 5 years
Flaring	Commissioning and Operation	Flare stacks	Continuous flow monitoring at flare inlet to estimate the hydrocarbon flow to atmosphere. Sampling connection to enable definition of fuel quality	Annual reporting
Air quality	Construction	Construction site boundaries and living accommodation	NO_2 CO Particulates: • Suspended solids • Inorganic dust (70-20% silicon dioxide) • Soot Total hydrocarbons Benzo(a)pyrene Additionally, SO_2 and H_2S to be monitored at Sabetta camp boundary	Quarterly at accommodation camp sites Six monthly at construction site boundaries and makeshift living quarters
Air quality	Construction	Well clusters Construction& installation pads Makeshift work sites	NO_2 CO Particulates: • Suspended solids • Inorganic dust (70-20% silicon dioxide) • Soot Total hydrocarbons	Once during construction phase

Table 9.2.19 Summary of Air Emission Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
			Benzo(a)pyrene Additionally, SO_2 and NO_x at well clusters	
Air quality	Commissioning and Operation	All SPZ Location of closest residential areas to all facilities (including life support system, Sabetta village)	Monitoring of ambient levels of: • NO_X • SO_2 • Particulates • CO • H_2S • Additionally, methanol at LNG SPZ, and benzo(a) pyrene at sea port SPZ • Meteorological parameters – wind direction and velocity, atmospheric pressure, humidity and plume behaviour.	Quarterly
Air quality	Operations	Airport work zones	NO_2 CO SO_2 Benzo(a)pyrene Glycol	Five times per quarter
Greenhouse gas emissions	Commissioning and operation	N/A	Calculation of GHG emissions from all sources via monitoring of fuel usage and fugitive emission calculations	Annual reporting

9.3 GEOLOGY, GEOMORPHOLOGY AND SOILS

9.3.1 OUTLINE OF GENERAL TYPES OF IMPACT

The general types of potential impacts on the geological environment of the South Tambey Gas-Condensate field as a result of the Project are summarised in Table 9.3.1. These are based on the classification of anthropogenic impacts on the geological environment and associated effects proposed by V.A. Korolev in 1997[7].

Table 9.3.1: Summary of potential impacts on the geological environment

Class and subclass		Impact description	Impact type	Potential sources of impact
Physical impact	Mechanical impact	Compaction	Static	Buildings, structures, power transmission lines
			Rolling Tamping	Vehicles
		Removal of rock	Drilling Digging Excavation	Bore wells Open pits Dredging works in the Gulf of Ob resulting in sea bed deepening
		Surface accumulation	Dumping Banking	Construction Temporary disposal of soil in above and below ground dumps
		Land relief formation (levelling)	Levelling Reclamation	Construction Land reclamation
		Land surface erosion	Formation of hollows	Open pits
	Thermal	Changing of Permafrost		Linear and areal facilities
Chemical impact		Pollution	Phenols, heavy metals, hydrocarbons, salinization	Transport Landfill for solid domestic and industrial waste Underground wastewater disposal facility

[7] Korolev V.A. Monitoring of geological, lithotechnical and ecogeological systems “KDU”, 2007, 416 p.

Table 9.3.1: Summary of potential impacts on the geological environment			
Class and subclass	**Impact description**	**Impact type**	**Potential sources of impact**
Physiochemical impact	Colmatation (clogging of pore space)	Physical Physiochemical	Underground wastewater disposal facility
Biological impact	Pollution	Bacteriological, microbiological	Landfill for solid domestic and industrial waste Underground wastewater disposal facility

Mechanical impacts on soils are produced by practically all production or infrastructure facilities that have foundations. Mechanical impact includes static and dynamic loads, internal structural loosening and external destruction of a formation. Erosion by water is also included in this category (e.g. channel bank scour and gulley formation).

Chemical impact primarily refers to hydrocarbon contamination, as well as the pollution of rocks and ground water by high mineral content solutions.

Thermal impact is linked with specific geocryological features of the region and is characterised by the heating of soils due to the temperatures of extracted and transported products. This can lead to changes in the conditions of permafrost soils, both at the surface and at depth.

The Project Licence Area is characterised by continuous permafrost which facilitates the extensive development of cryogenic processes. These are considered during the design of structures and assessments should be conducted of the potential impacts on permanently frozen ground.

Physiochemical impact relates to the physical and chemical process of pore clogging in underground strata as a result of wastewater injection.

Biological impacts can, for example, be associated with the introduction of microbial pollutants to underground strata as a result of wastewater injection and leachate leakage from the solid waste landfill (see also Section 9.7).

Another distinctive feature of the Project is the proposed large scale dredging works, including disposal of excavated (dredged) soil in designated water areas of the Gulf of Ob. These impacts are addressed in Section 9.4.

Details of specific impacts, the associated mitigating measures and the residual (post-mitigation) severity of these impacts are described below.

9.3.2 OUTLINE OF GENERAL MITIGATION MEASURES

In general, adverse effects on the geological environment can be minimised by taking the following measures:

- Locating wells on cluster pads,

- Application of drilling best practice to prevent drill mud from penetrating into the ground with subsequent heat impacts upon permafrost.
- Monitoring of hazardous processes in drilling and construction work to allow prompt preventative action.
- Proper management of drilling waste, including collection, storage and neutralization systems (spent drill mud, wastewater and drilling sludge), and using impermeable polymer liner for drill mud pits (see Chapter 4 for further details).
- The provision of appropriate construction material storage sites, maintaining construction sites free of litter and establishing spill prevention / clean-up protocols to prevent fuel and lube oil contamination.
- Surface drainage systems at construction sites to prevent production waste from spreading to adjacent areas, soils and ground water.
- Making sure no motor vehicle traffic occurs outside the production area and Project road network (see Section 9.4 for further details)
- Preventing industrial accidents, spills and leaks of corrosive liquids into the environment.
- Achieving uniform permafrost conditions across the entire Project construction area by means of pre-construction refrigeration and freezing through snow clearance. Ensure embankment construction works only begin once the seasonally thawed soil layer has completely frozen.

9.3.3 CONSTRUCTION PERIOD

9.3.3.1 – MECHANICAL IMPACTS

During the construction period, the primary causes of direct effects on the geological environment are likely to be related to mechanical impacts. These potentially include:

- Static load impacts - Caused by foundations and dirt stockpiling pads etc.
- Dynamic load impacts – Caused by vehicle movements.
- Drilling impacts - From the drilling of production wells and wells for wastewater disposal.
- Erosion impacts – Caused by surface water runoff forming linear erosion features (gullies) and the erosion of the banks of existing watercourses where they have been disturbed by road/pipeline crossings.
- Excavation impacts - External deterioration of a rock formation due to earthworks for foundation pits and quarries etc.

Each of these potential mechanical impacts and associated mitigating measures are discussed in turn below.

Static load impacts

Soil compaction could lead to reduced infiltration of rainfall and a resultant increase in the potential for water erosion. Compaction could also change the morphological properties of the soils and might potentially lead to localised ground thawing (discussed in more detail below). In the absence of mitigation the potential impacts are considered to be of **low** to **moderate** significance.

Soil compaction impacts would be minimised by the use of piled foundations. Adopting this method would mean that partial and temporary thawing of frozen ground would be limited to the area where the pile contacts the ground. The limited thickness of the thaw layer would allow the ground to quickly freeze around the pile.

The Project design documents also specify the use of above-ground pipelines and overhead power lines on piled foundations to minimise impact on the geological environment. If piled foundations cannot be used (e.g. in the upper tank farm for oil products), then facilities will be equipped with thermal protection to ensure the stability of the permafrost zone. With the adoption of these mitigating measures the potential impacts are considered to be of **low** significance.

Dynamic load impacts

The construction and use of roads has the potential to damage the soil cover because of the initial disturbance necessary for construction and the subsequent passage of vehicles. If unmitigated, this is could represent a **moderate** impact.

The Project design incorporates mitigating measures to reduce the impact of dynamic load. These measures include restriction of unscheduled traffic over frozen soil and the use of road transport for construction purposes only in winter. The quantity of vehicles and equipment on roads and construction sites will be limited as far as is reasonable.

For prevention of subsidence and wetlands formation at areas where a road intersects a pipeline, corrugated 1500mm diameter casing of the pipeline will be installed prior to the construction of the road over the pipeline.

Corrugated 2.0-2.5m diameter culverts will be imbedded in road embankments where necessary to allow passage for smaller watercourses. Metal bridges will be constructed at crossings over permanent watercourses.

Residual impacts from dynamic loads would be **low** with mitigating measures in place.

Drilling impacts

Well drilling results in internal loosening of the rock formation structure. The impact itself comes in the form of elastic vibrations on rock strata and the penetration of drill mud into rocks via fissures and pores. The drill mud may clog the fissures and pores (hence affecting groundwater flow) and affect the chemistry of ground water. These impacts would be localised but of a long-term duration, as residues of drilling mud would remain in the rocks.

The effects would take place underground, at considerable depth and within strata that do not constitute sensitive receptors. Therefore, environmental impacts are considered to be **negligible** and do not require specific mitigation.

Erosion impacts

Rainfall and snowmelt runoff could create linear erosion features in areas where vegetation has been removed and the ground disturbed. This could create gullies with potentially unstable sides and result in the transport of eroded soil into existing watercourses. In the absence of mitigation the potential impact is considered to be **moderate/high.**

Mitigation would comprise minimising the area of disturbed land and the use of temporary surface water management systems in construction areas. These will include (where appropriate) surface runoff collection channels, retention ponds, silt fencing and silt traps. These measures would reduce potential impacts to a **low** significance.

9.3.3.2 CHEMICAL IMPACTS

Contamination of shallow near-surface soils could potentially occur by the infiltration of products and drilling waste into ground. This could be due to:

- Lack of waterproofing barriers on mud pits, and their holding capacity not matching the actual quantities of mud stored in them,
- Process liquid and lube oil leaks and spills, and
- Accidental oil and petrochemical, wastewater and other waste spills as a result of violations of storage reservoir lining rules, fuel and lube oil spills.

Potential chemical contamination of shallow soil and ground water in areas adjacent to construction sites will be short-term and localised in scale. In the absence of mitigation the potential impacts are assessed to be of **moderate** significance. Mitigation will be achieved by adherence to relevant regulatory standards and the adoption of protocols during the construction period to minimise spillages (see Section 9.4 for further details). With these measures in place, the significance of residual impacts would be reduced to a **low** level.

9.3.3.3 THERMAL IMPACTS

Thermal impacts on the geological environment during the construction period could be brought about by disturbance of the soil and vegetation cover. Thermal impacts could also potentially occur as a result of changes in the snow accumulation regime and changes in the surface and underground runoff regimes. Disturbance of soil and vegetation cover and the snow regime could affect the thermal balance of the permafrost, which in turn could trigger thermokarst, thermal erosion, frost blowout and permafrost degradation. Changed surface and ground water flows would affect the permafrost thermal regime to a lesser degree, affecting it more in terms of flooding, more active slope erosion processes and erosion of soil depressions caused by human activities. These impacts could potentially be of **moderate** to **high** significance.

To conserve the thermophysical properties of the soil, the Project road design incorporates a 0.3m (1.6m at the airport) thick dry sand course at the base of each road with ground grips to ensure stabilisation.

With the adoption of mitigating measures, residual impacts would be of **low** significance. More details on the prevention of impacts upon permafrost are presented in Section 9.3.5.3.

9.3.4 REINSTATEMENT OF DISTURBED AREAS

A reinstatement plan will be developed at the end of construction, that will include the definition of reinstatement methods, timescales and success criteria. In general terms, reinstatement will involve two phases (mechanical and biological rehabilitation) as follows:

Mechanical rehabilitation:

- Removal of construction debris and unused materials;
- Grading of disturbed land areas;
- Reinforcement of slopes and banks with a peat/sand mixture.

Biological remediation:

- Reinforcement of un-built areas and passages with peat and sand mixture;
- Planting and seeding in mechanically remediated areas.

9.3.5 OPERATIONAL PERIOD

9.3.5.1 MECHANICAL IMPACTS

Mechanical impacts on underground horizons during gas field operations will include changes in internal formation pressure, changes in hydrodynamic and hydrochemical ground water regimes and gradual depletion of gas reserves. During operations, hydrocarbon strata will undergo the following direct changes:

- Extracted hydrocarbons in the reservoir will be replaced by water or gas.
- The hydrodynamic and thermodynamic conditions of the reservoir will change due to hydrocarbon extraction.

In addition, it is possible that fluids could migrate between previously unconnected strata via the annulus of a well. This would only occur in instances where the annular space between the inside of a well and its casing has not been properly sealed.

During operation there may also be static loads on the geological environment from engineering construction foundations. This may accelerate cryogenic and erosion processes, form depressions and cause waterlogging. Mechanical impacts during gas field operations may carry on after their completion, especially if cryogenic processes have been intensified as a result of the operations.

Adverse impacts on the geological environment during gas and condensate extraction is estimated to be long-term, of high magnitude and of a regional scale.

However, the changes in the properties of the hydrocarbon bearing strata will occur at great depth and within a low sensitivity receptor. The impacts will therefore be of **negligible** significance and will not require specific mitigation.

The preferential migration of fluids via the annulus of wells could theoretically lead to contaminants reaching shallow sub-surface strata that are connected to the surface water system. Impacts could potentially be of **low** to **moderate** significance, but can be effectively mitigated by well construction in accordance with good industry practice. With the adoption of such practices, the residual impacts will therefore be **negligible**.

The mitigation of impacts from static loads will be achieved by the actions described above for the construction phase. Potential impacts before mitigation would be of a **low** to **moderate** significance, and post mitigation residual impacts are predicted to be of a **low** significance.

9.3.5.2 CHEMICAL IMPACTS

Chemical impacts on the geological environment during the operational period include potential leakages from fuel and lubricant storage facilities, condensate spills and releases of well testing waste and other wastewater. Potential impacts from these are considered to be of **moderate** to **high** significance.

The Project design will provide construction of earth bunding around tanks; the capacity of bunds around hydrocarbon fuel (diesel, kerosene and gasoline) tanks will be at least 110% of the nominal volume of the largest tank within the bund. Diesel storage tanks will have waterproof bunding and an impervious screen. Fired heaters will be installed on a concrete tray for the collection of precipitation and accidental leakage. Concrete curbing will be provided around tanks for storage of lubricants, methanol, and diesel fuel. The site surface will be solidly sealed. Residual impacts would be of **low** significance following the adoption of mitigation.

Soil contamination as a result of pipeline rupture could potentially incur impacts of a **moderate** to **high** significance. Mitigation would be provided by the provision of electrically driven shut-off valves. Stop valves would be equipped with remotely controlled automatic shutting devices. The residual significance of impact after mitigation is considered to be **low** (see also Section 9.12).

Leachate leakage from the solid waste landfill during the frost-free period could potentially result in **moderate** to **high** impacts on soil quality. Mitigation will be achieved by the construction of a low permeability membrane at the base of each landfill cell. Residual post-mitigation impacts would be **low**. (See also Sections 9.5 and 9.7.)

Final disposal options for the treated wastewater including waste drilling mud (and its rheological properties) are currently under consideration. The preferred option is that the wastewater will be injected into the Marresalinsky subsurface horizon using deep well injection technology, although design solutions are currently being considered to confirm this (see Chapters 4 and 6 for further details).

The following supporting documentation has been received by Yamal LNG:

- Positive expert conclusion # 062.12-3C dated 09/26/2012 West-Siberian department of FBU “GKZ” of Ministry of Natural Resources and Environment of the Russian Federation for the project on geological study of subsurface resources “Geological investigations for justification of disposal of solid and liquid drilling waste, industrial and sanitary wastewater in subsurface at the area of South Tambey Licence area”
- Amendment to the licence SLKh 15365 for use of subsurface resources in order to performing geological survey for assessment of capability for industrial and sanitary wastewater disposal at South Tambey Licence area.

The Marresalinsky formation is an aquifer of around 500m thickness that lies approximately 900m below the surface (further details are given in Chapter 7). The aquifer is overlain by approximately 600m of low permeability clay and sandy clay deposits and underlain by approximately 300m of low permeability argillite-clay of the Yarong suite.

The Marresalinsky aquifer is not currently utilised for groundwater abstraction. The great depth of the aquifer and the naturally poor quality of groundwater that typically occurs in deep aquifers means that future abstraction is unlikely. The aquifer is therefore not considered to be a sensitive receptor. Furthermore, the low permeability deposits above and below the aquifer would isolate injected waste water within the designated formation and prevent cross-flow and the infiltration of waste water into adjacent geological formations. Therefore, if used for injection of wastewater, the potential for adverse impacts is considered to be **negligible** and no additional mitigation is required.

9.3.5.3 THERMAL IMPACTS

General

Sources of direct thermal impact include all infrastructure constructed within the Project Licence Area.

As described for the construction stage, the thermal impacts of Project infrastructure on permafrost might lead to the raising of soil temperature and the acceleration of cryogenic processes. Without mitigation impacts are predicted to be **moderate**.

A number of methods are proposed to reduce thermal impacts on soils:

- Construction of above-ground facilities on piles.
- Ventilation of underfloor spaces.
- Seasonally and permanently operated refrigerating plants (thermal stabilisers).
- Thermal shields (includes combination of filled soil and insulation material).

Ventilated underfloor spaces can be open, with ventilated air holes in the building basement, or closed. The underfloor space surface would slope towards outside skirting or drains which allow unhindered drainage.

Seasonally operated refrigerating plants will be used as thermal stabilisers. Thermal stabilisers consist of an above ground condensing section and a buried evaporator. Seasonally activated refrigerating plants will be used to refrigerate permafrost soils in summer.

The purpose of thermal shields is to reduce the flow of heat from a building into the frozen soil. Thermal shields are characterised by good water and heat insulating properties and can be laid directly in the ground.

The specific mitigation measures proposed to reduce thermal impacts at individual project assets are summarised below. The adoption of these measures would reduce the level of predicted impact to **low**.

Construction/Rotation Camp

- The tank farm and buildings' sites in Sabetta are filled with sand material.
- Buildings and structures will have ventilated underfloor space.
- Pipe platforms and racks will be erected on piled foundations raised above the ground surface.
- Construction of overhead services and utility lines.
- Soil thermal stabilization measures in Sabetta (boiler plant, power supply centre, heated parking, fire station) and the Upper Tank Farm would include heat insulation under

structures and the construction of two independent horizontal passive tubular thermal stabilisation systems[8].

Well pads

- Well pads are filled with sand material.
- The design of the flare pit base includes heat insulation slabs, sand cushioning (packing), soil compacted with crushed rock and the provision of bunds around pits.
- The application of drilling best practice to prevent drill mud from penetrating into the ground with subsequent heat impacts upon permafrost. These include:
  - Wells will be spaced not less than two times the radius of the expected estimated thawing halo. In this case the distance between wells is determined as 30m;
  - Drilling of permafrost will be carried out using polymer-clay drilling mud with pseudo-plastic properties which reduce heat transfer and erosion effects;
  - Drilling will be carried out using solutions with temperature up to 10°C (not higher than 10°C);
  - Use of a BHA (bottom-hole assembly) that has a high mechanical speed and headway per drill bit (turbine drilling method) which reduces the time that the drilling equipment is in contact with permafrost;
  - Full filling of caverns with grout, with grout flow up to wellhead;
  - All borehole casing which is set in permafrost will be of an adequate strength to ensure the integrity of the casing during refreezing;
  - Using arctic concretes (cements) and compounds/additives with low thermal conductivity coefficients

SDW Landfill

- It is planned to lay heat insulation material (“Teplopleks”) at the base of the pit flooring sections.

LNG Plant

- Conservation of permafrost by adopting snow clearance measures in winter.
- Continuous/solid filling of the built-up area.
- Construction of structures on piled foundations with ventilated spaces.

Airport

- Conservation of permafrost by adopting snow clearance measures in winter.
- Reinforcement of the runway embankment with two layers of geotextile and the construction of a drainage mat for removal of ground (thaw) water from paved surface bedding.
- Construction of a ventilated underground space (basement) in the office and passenger building and in the building for maintenance teams.

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[8] Uses ambient cold air for cooling during winter time and in summer a condenser is equipped by nozzle that removes the heat from the condenser when temperature of air is above zero °C.

- Soil thermal stabilization measures include heat insulation under structures and the construction of two independent horizontal passive tubular thermal stabilisation systems.

9.3.6 MONITORING

Surveys and studies that have been carried out across the Project Licence Area have revealed areas where hazardous geological processes are likely to develop if triggered by natural or anthropogenic factors. In the absence of mitigation these could potentially have significant effects on land degradation and the safety of oil field facilities.

Monitoring of geological processes will allow the actual effects of construction and land remediation operations on the geological environment to be identified. Monitoring will also confirm the effectiveness of mitigation and identify any areas where mitigation measures require modification to remain effective.

The main hazardous geological processes that will be subjected to monitoring are:

- Linear erosion.
- Impacts upon permafrost.

A key monitoring approach to assess the above processes will be monitoring of the thermal regime within the permafrost.

Monitoring the residual impacts upon geology of other processes (such as the bed/bank erosion of watercourses and the formation of waterlogged areas) is described in Section 9.4.

Consideration will also be given in future to the use of aerial/satellite remote sensing techniques.

9.3.7 SUMMARY

A summary of the predicted impacts, proposed mitigation measures and residual impacts are summarised in Table 9.3.2.

The proposed monitoring program to confirm the efficacy of the mitigating measures is summarised in Table 9.3.3.

9.3.8 SUMMARY

Table 9.3.2: Summary of Geology, Geomorphology & Soils Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
Mechanical impacts	Soil	Construction and operation	• Use of piled foundations wherever practicable. • Use of above-ground pipelines and overhead power lines on piled foundations • Limit vehicular traffic to existing winter roads connecting the Sabetta camp with drilling sites. • Quantity of vehicles and equipment on roads and construction sites will be limited as far as is reasonable. • Culverts will be imbedded in road embankments where necessary to allow passage for smaller watercourses. • Disturbed areas will be kept to a minimum during construction • Use of temporary surface water management / silt retention during construction. • Development and implementation of a post construction reinstatement plan	Low
Direct drilling impacts	Deep underground strata	Construction	Introduction of drill mud - Low sensitivity receptor and impacts are of negligible significance. No mitigation required.	Negligible
Chemical impacts	Deep underground strata	Construction and operation	Injection of wastewater into deep geological strata - Low sensitivity receptor. No mitigation required.	Negligible
Chemical impacts	Soil	Construction	• Adherence to relevant regulatory standards • Adoption of protocols during the construction period to minimise spillages. • Provision of liner to mud pits • Bunding of fuel storage tanks • Provision of low permeability liner to SDW landfill	Low
Thermal impacts	Permafrost	Construction and operation	• Conservation of permafrost by adopting snow clearance measures in winter • 0.3m thick dry sand course installed and fixed at the base of each road. • Construction of above-ground facilities on piles;	Low

Table 9.3.2: Summary of Geology, Geomorphology & Soils Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			• Ventilation of underfloor spaces; • Seasonally operated refrigerating plants (thermal stabilisers) • Thermal shields (includes combination of filled soil and insulation material).	
Physiochemical impact	Deep underground strata	Construction and operation	Injection of wastewater into deep geological strata - Low sensitivity receptor. No mitigation required.	Negligible
Chemical impact	Soils	Operation	• Low permeability liner at SDW landfill. • Electrically driven shut-off valves to close pipeline in event of rupture • Earth bunding around tanks. Diesel storage tanks will have concrete bunding and impervious screen. • Fired heaters will be installed on a concrete tray for collection of precipitation and accidental leakage. • Concrete curbing will be provided around tanks for storage of lubricants, methanol, and diesel fuel. The site surface will be impermeable.	Low
Chemical impact	Shallow underground strata	Operation	• Well construction in accordance with good industry practice to ensure that well annulus is sealed.	Low

Table 9.3.3: Summary of Geology, Geomorphology & Soils Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
Thermal impact (soil frost heaving)	Construction and operation	Thermometer wells located in areas of maximum potential effects of temperature	Temperature conditions	Twice per year (summer and winter

Table 9.3.3: Summary of Geology, Geomorphology & Soils Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
Thermal impact (thermokarst)	Construction and operation	Within the area of engineering structures	Flat surfaced (flowless) permafrost soil composition and proportion of ice; Temperature conditions in lakes; Changes in size of existing thermokarst lakes; Size of contemporary embryonic thermokarst forms; Thermokarst affected area (%); Affected area per unit land (m^2); Lake growth rate (thermal abrasion).	Twice per year in snow free periods.
Long term changes in linear erosion and permafrost	Operation	Project Licence Area	Consideration to be given to remote sensing	To be determined following construction monitoring above

9.4 SURFACE WATER

9.4.1 INTRODUCTION

This section addresses impacts to surface waters during the construction and operation phases of the Project and discusses mitigation and monitoring measures to be implemented.

For impacts to hydrogeological systems (groundwater) refer to Section 9.5 and for impacts associated with water abstraction refer to Section 9.6.

Existing baseline studies undertaken in the region (see Chapter 7) indicate that the hydrographic network of the Project Area of Influence belongs to the Kara Sea catchment and surface watercourses mainly comprise small and mid-size rivers. In addition to rivers, there are many lakes, most of which are located in river floodplains, in estuaries and near-estuarine areas. Lakes occupy up to 25% of Yamal river basins, in some cases up to 38%. The marine environment within the Project Area of Influence comprises the Gulf of Ob which connects to the Kara Sea in the north.

Freshwater (lakes and rivers) and marine surface water bodies are a vulnerable element of natural ecosystems. In the course of the construction and operation of the Project facilities, adverse impacts to surface water bodies may be caused as receivers of treated wastewater. In addition, surface water bodies will be affected by engineering operations underwater and on the banks of waterbodies. Impacts may manifest as changes in the hydrological regime and pollution of the aquatic environment.

9.4.2 CONSTRUCTION PHASE IMPACTS

Construction of the Yamal LNG Project includes the development of South Tambey Gas Condensate field (well drilling, construction of well clusters and linear infrastructure including gas pipelines, roadways, access roads and power transmission lines) in addition to the construction of an LNG Plant, a seaport, an airport, and worker accommodation camps (see Chapter 4 for further details).

During construction activities, impacts to surface water bodies may be caused by the following activities:

- drilling of wells;
- ground surface levelling for the placement of site and linear facilities;
- wastewater discharges (sanitary, stormwater, snowmelt and hydrotest water);
- operations under water and on the banks of water bodies at crossings by linear structures;
- Construction of the SIDW Landfill;
- Construction of the seaport and associated dredging activities.

Water abstraction (e.g. for sanitation, industrial/construction processes, fire suppression and hydrotesting) may also affect surface waters and this is assessed further in Section 9.6.

9.4.2.1 GENERAL SPILL RISKS

General measures to minimise washout of pollutants by storm/meltwater from construction sites to surface water bodies the following measures will be implemented:

- Regular examination of construction machinery for satisfactory condition maintenance;
- Provision of drip trays beneath mobile plant;
- Refuelling of construction machinery will be performed directly from tankers at dedicated areas with concrete surface and water proofing;
- Secondary containment for preventing of infiltration at storage areas of hazardous materials (like glues, paintings and others);
- Secondary containment (bunding) of plots for fuel storage, vehicles parking area, filing stations and sites of loose materials and chemicals storage;
- Bunding of work areas and surface levelling at drill units area to send water flow (e.g. from washing of equipment, storm and melt water) to waste water collector;
- Protective bunding of settling pits in temporary storage of fuel areas, vehicles and construction machinery parking areas, filling stations and areas of loose materials and chemicals storage, for further collecting and clarifying of storm water prior to their transportation to waste water treatment plant at Sabetta;
- Usage of impermeable polyfilm underneath storage containers for fuel, spent fuel and lubricants; hoist towers and drill winches, boilers, diesel power generators and reservoir for collecting of storm and melt water;
- Use of impermeable septic tanks for temporary storage of sanitary waste water.

With the application of these general controls, spill risks to waterbodies are assessed as **Low**. Further facility-specific spill risks are assessed in turn below.

9.4.2.2 WELL DRILLING

Sites planned for the drilling of exploratory wells (well pads) are fully or partially located within the boundaries of water protection zones established for surface water bodies as follows (see also Figure 9.4.1)[9]:

- Site # 152-R is located on the left hand bank of the Nyakharvangotayakha River at distances of 70 m to 200 m from the water's edge and 520 m from the bank of the Gulf of Ob.
- Site # 155-R is located on the right hand bank of the Venuymuyeyakha River, 2.0 m from the water's edge, i.e., the drill site area lies entirely within the 200 m wide water protection zone established for this river.
- Site # 157-R is located on the right hand bank of a nameless creek with a 50 m wide water protection zone.

Water for drilling operations will be imported from external sources (see Section 9.6 for further details). Untreated drilling wastewater or other types of wastewater from well drilling sites will not be discharged directly to surface water bodies. Surface water bodies may be

[9] It is permitted to operate commercial and other facilities within water protection zones provided that they are equipped with devices protecting water bodies against water pollution, contamination and depletion (RF Water Code, Article 65).

affected by the runoff of contaminated melt/stormwater from drilling/construction sites. Without mitigation measures in place, well pads with fuel stores and filling stations located in water protection zones present a potential risk of hydrocarbon contamination of freshwater bodies due to accidental spills.

In addition to oil products and suspended solids, storm/melt water runoff from well drilling sites may contain chemical substances that are added in the course of well drilling.

The key potential causes of contamination impacts from drilling operations to surface water bodies are as follows:

- absence of appropriate lining of technical (equipment and storage) sites;
- lack of an efficient waste collection/waste recycling system;
- violation of management rules for operations associated with loading, transport, unloading and storage of bulk materials and chemical reagents;
- intensive traffic movement throughout drilling and construction sites and on the adjacent territories; and
- occurrence of an emergency incident (e.g. leak or spillage).

In addition, fluvial processes cause intensive wash-out on the Venuymuyeyakha River near to Site # 155-R. Further wash-out of the river could therefore jeopardise this well.

During well drilling operations the unmitigated adverse impacts to surface water bodies are generally assessed as **Moderate**. However, in the event of an uncontrolled gas condensate/formation spill, particularly at sites in the immediate vicinity of water bodies (e.g. Site # 155-R), the impact may be more significant.

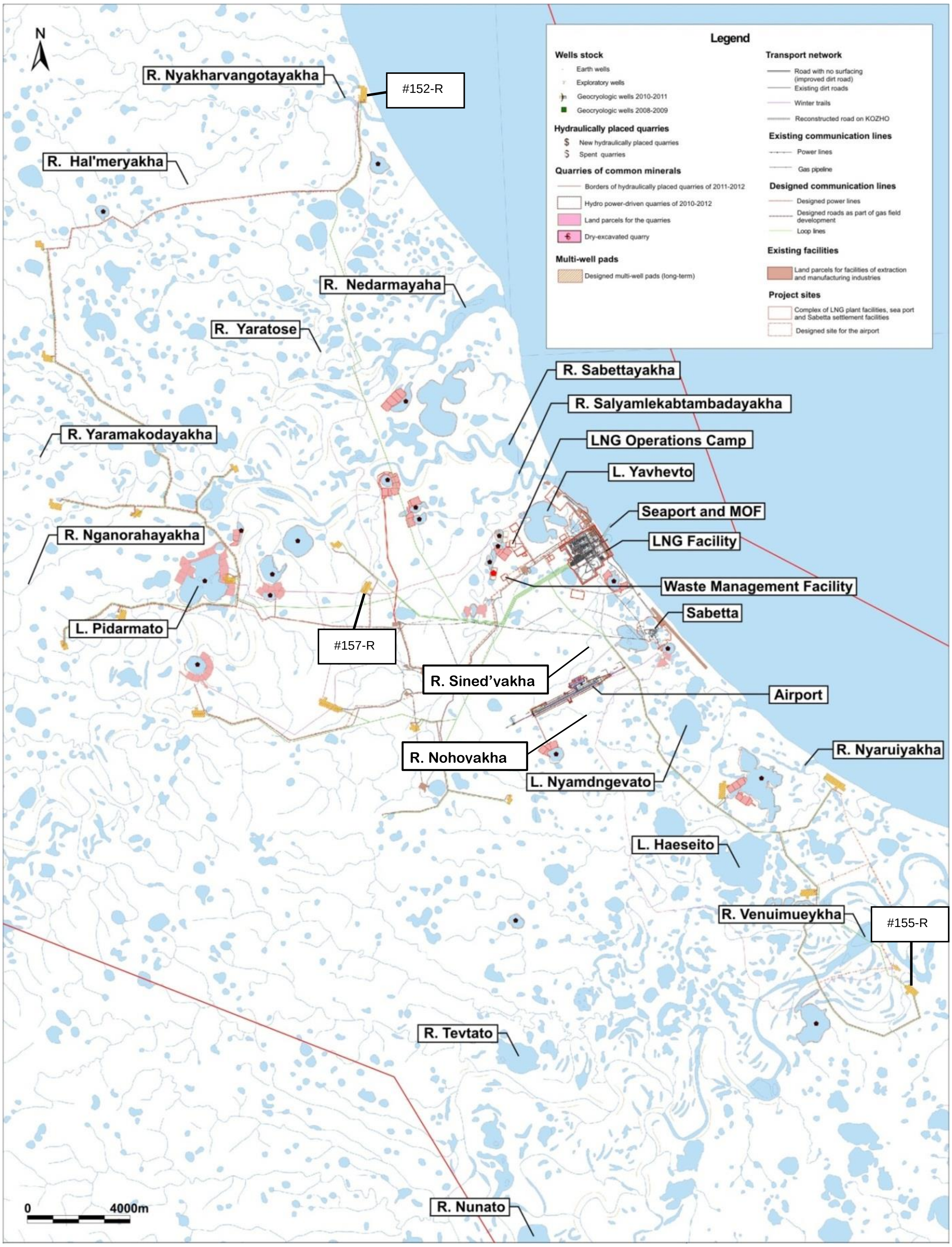

Figure 9.4.1: Exploratory Well Pad Locations

To prevent contamination of surface waters, the following mitigation and monitoring measures will be implemented:

- engineered erosion control measures applied to protection well pads in near vicinity of rivers (this applies to Site # 115-R);
- reduction of drilling mud volume (excess) through mud recycling (see Chapter 4 for further details);
- undertaking inspection tests of drilling fluids (chemical reagents, materials) to verify their compliance with requirements specified by technical documentation;
- fuel store sites, parking lots for vehicles and construction machinery, refuelling sites and sites designated for storage of bulk materials/reagents will have secondary containment such as hard pavement, bunds, settling tanks/ponds for collection and clarification of stormwater with a view to its subsequent treatment and use or removal;
- bunding working zones and sloping of ground surfaces under drilling rig blocks in order to direct any spills (e.g. from equipment washing operations, stormwater and melt water) toward a wastewater collection pit;
- construction of impermeable polyethylene lining beneath fuel storage tanks, spent fuel/lubricants storage tanks, derrick-drawworks units, boiler-houses, diesel power generators and stormwater/melt water accumulator tanks;
- lining of sites to be occupied by sewage accumulator tanks;
- use of dedicated containers for collecting solid food waste, garbage, and oil-contaminated rags;
- lining and bunding of a horizontal flare pit designated for the technical “annealing” (heat process) of wells;
- collection of drill flush (e.g. in case of a pipe leak when hoisting equipment and connection to a closed loop circulation system);
- collection of drilling waste mud in special tanks; and
- washing drilling rig equipment in winter using minimal water volumes and with discharge to an accumulator tank in summer.
- Minimise drilling fluids usage through treatment and recycling (see Chapter 4 for details);
- Secondary containment (bunding) of sites of loose materials and chemicals storage;
- Impermeable lining of areas where tanks for collecting sanitary water will be located.

Following the implementation of mitigation and monitoring measures outlined above, the residual impact to surface waters is considered to be **Low**.

9.4.2.3 GROUND SURFACE LEVELLING

Preparatory works necessary for the construction of site facilities (e.g. the LNG Plant, camp accommodation, airport, etc.) include levelling and filling with imported soil. This will result in the disturbance of top soil layers, changes in terrain topography, and subsequently may cause:

- deterioration of natural hydrological conditions of surface watercourses and flow redistribution with time;

- occurrence and activation of hazardous fluvial morphological processes in rivers and erosion of waterside bank areas;
- changes in permafrost conditions due to disturbance of vegetation cover integrity, and
- potential contamination of water bodies with fuel & lubricants and pollution of river beds and floodplains with construction debris.

As part of the construction preparation works for the LNG Plant, it is planned to carry out drainage works (water abstraction and discharge to and from lakes) and to fill sites with soils. The total volume of abstracted water during ground levelling will amount to 241,120 m^3. Water will be discharged via flexible hoses to the Gulf of Ob. Small lakes and streams in the LNG Plant and airport runway areas will be filled in with soil. This has the potential to result in loss of habitat (see Section 9.9) and also discharge of water to adjacent waterbodies.

The airport and its auxiliary sites will be located within water protection zones of surface water bodies[10] (namely, the Nokhoyakha River (the right tributary to the Sined'yakha River – see Figure 9.4.1) and the Gulf of Ob). Mechanical ground works during construction could potentially trigger adverse fluvial processes, formation of flooding and erosion zones, activation of thermokarst and thermal erosion and other hydrological processes.

Without additional mitigation, the impacts of ground surface levelling works may result in **Moderate** impacts on surface waters. To mitigate these impacts during construction works, the following environmental mitigation and monitoring measures will be implemented:

- observance and monitoring of working zone boundaries;
- prohibition of transport traffic outside of temporary and permanent access roads;
- prohibition of washing of vehicles and machinery outside of specially equipped and contained sites;
- bunding technical sites and lining with "Bentomat AS-100" geosynthetic liner;
- bunding multiple well platforms (2 m in height, 0.5 m in width and with a bund slope of 1:1.5);
- lining of slurry pits and other technical pits;
- equipping work areas, temporary buildings and structures with containers for the collection of domestic and industrial waste;
- timely removal of industrial and domestic waste to landfill or recycling facility (see Section 9.7); and
- collection of sanitary wastewater and melt/stormwater to be directed to treatment facilities in the Sabetta accommodation camp.

Other specific mitigation controls for the protection of surfaces waters to be implemented during the construction of the airport include:

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[10] It is permitted to operate commercial and other facilities within water protection zones provided that they are equipped with devices protecting water bodies against water pollution, contamination and depletion (RF Water Code, Article 65).

- Performance of site preparation works in the winter period only (to minimise runoff)
- Removal of snow and ice to suitable remote areas (to prevent runoff during melt periods) prior to preparation works
- Construction of an artificial embankment with reinforced slopes reducing flood risks (see also Section 9.12).

The severity of residual impacts to surface water bodies from ground levelling activities will be **Low**.

9.4.2.4 DISCHARGE OF WASTEWATER

Figure 9.4.2 below shows the water consumption and disposal routes during construction phase.

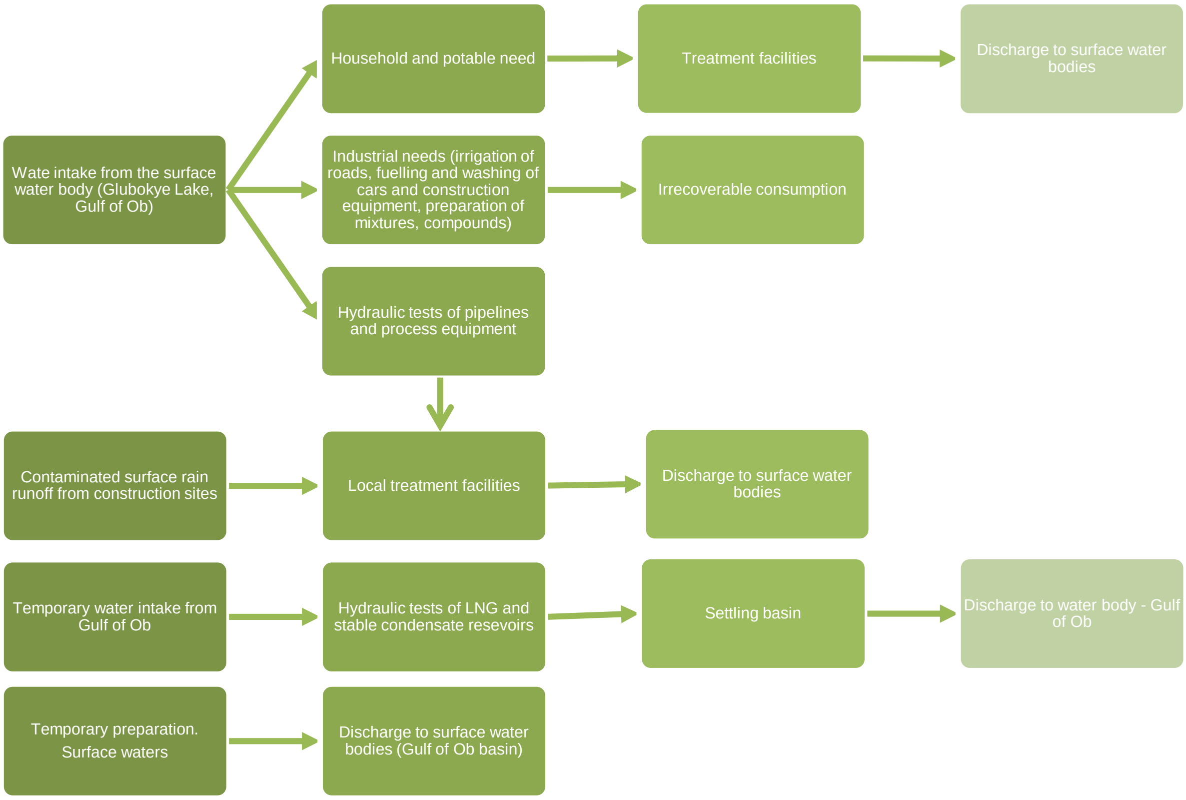


Figure 9.4.2: Water consumption and disposal routes during construction phase

Wastewater discharge standards for the Project are defined in the Project Standards document (see Appendix 2) and specific regulatory limits (Maximum Permissible Discharges (MPD)) for surface water bodies are set in the regulatory documentation. The discharge of wastewaters is described below for the construction phase of the individual Project facilities, except for hydrotest wastewater which is described in a separate sub-section.

Well fields and Sabetta accommodation camp

There is a common sewerage system in the Sabetta accommodation camp designated for the collection of sanitary and process wastewater. Treated wastewater is then discharged to the marsh/bog areas. The capacity of the existing wastewater treatment facilities is insufficient for servicing the proposed new facilities and the treatment capacity will be expanded as construction proceeds.

The total volume of wastewater per well construction will equate to approximately 2,750 m^3, of which 1,100 m^3 will be sanitary wastewater and 1,455 m^3 will be re-used process wastewater. Irretrievable water losses as a consequence of drilling mud filtration into formations, plugging solution preparation, boiler-house steam generation, etc.is estimated to be approximately 3,600 m^3.

The total volume of wastewater to be generated in the course of drilling exploratory wells (including drilling, testing, conservation and abandonment) is broadly equal to the water requirement and amounts to approximately 3,500 m^3 per well over the whole period of works.

Drilling waste (cuttings and fluids) generated in the course of drilling operations will be fed to a treatment unit whereupon it will be re-used (see also Chapter 4). Treatment of process water will be performed through a circulating drilling mud treatment system. Treated mud wastewater will be temporary collected in metal containers of the treatment facility and then used for preparation of drilling mud.

A drainage system will be installed for the removal of construction wastewater (e.g. preparation of building materials including mortars) and melt/stormwater from drilling sites. Wastewater/stormwater will be fed to buried impermeable catchment trays prior to settling and filtering before discharge to an existing impermeable reservoir with a capacity of 16 m^3. As the wastewater/stormwater accumulates in the reservoir, it will be pumped and transported by tankers to existing treatment facilities installed in the Sabetta accommodation camp. Liquid generated in basin will be used for technical purposes (e.g. washing equipment)[11] For production wells [12] storm/melted water from drilling sites will be routed to the mud pit.

Amenity and accommodation camps for the construction personnel will be equipped with septic tanks to contain sanitary waste prior to treatment at the Sabetta accommodation camp facility. Toilets will be disinfected with bleaching powder, sodium hypochlorite or other appropriate disinfectants at regular intervals.

LNG Plant

During construction of the LNG Plant and its infrastructure, workers will be primarily accommodated in the Sabetta accommodation camp complex which is currently equipped with effluent discharge systems (see section above) (some construction workers will also be accommodated in temporary satellite contractor accommodation camps).

Sanitary wastewater from LNG Plant construction sites will be temporarily stored in sealed steel tanks prior to removal for treatment at the Sabetta camp. The volume of wastewater

[11] Design documentation # 049-РП-032/12 “Construction of sidetracks on exploration wells # 152-R, # 155-R, # 157-R of South-Tambey gas field”. Book 2. Section 8. The list of measures for environmental protection. OAO “Yamal LNG”, OOO “KrasnoyarskNIPINeftegas”, 2012.

[12] Group project for construction of production wells 3700 m deep for facilities VI (layers ТП 5 ÷ТП 12), VII (layers ТП 13 -ТП 14-15), VIII (layers ТП17 ÷ТП 19) in South-Tambey gas field”. Design documentation. Section 6 “Construction management plan”. 70/11/-YLNG-346-Э-ПОС.

will be roughly equal to the volume of water consumed (480 m^3/day of sanitary water, and 200 m^3/day for construction processes).

Construction machinery and vehicles will be washed at designated locations within the contractor's compound, where recirculation systems with oil skimmers will be installed.

Storm/melt water runoff is dependent on the season and runoff from construction areas may be contaminated with suspended solids and oil products. This type of wastewater will be collected from construction site surfaces via a drainage network and fed in to accumulator tanks. The tanks will in turn be emptied by suction trucks to the treatment facility at the Sabetta accommodation camp.

Main Seaport

Sanitary wastewater generated on shore during seaport construction will be collected in impermeable septic tanks prior to removal to the treatment facilities at the Sabetta accommodation camp.

Sanitary wastewater and oil-contaminated water from ships will be removed by special bunkering vessels under specific contractual agreements. The total volume of oil-contaminated water over the period of construction operations (2012 and 2013) is calculated to be 2,100 m^3 from construction of the seaport marine area and 360 m^3 from dredging vessels during construction of navigation channel (for the whole period).

Airport

During construction of the airport, wastewater removal will be performed in the same manner as for other construction sites. Wastewater will be contained in tanks prior to transport for treatment at the Sabetta accommodation camp facility.

Waste facilities

Sanitary facilities at the landfill site will include a mobile heated washroom facility connected to a septic tank to enable biological treatment of sewage.

Impact Assessment

Process and domestic wastewaters will be treated to meet Project standards prior to discharge to the receiving bog environment and will therefore not result in significant impacts on the marsh/bog water quality. Following this treatment, the residual impact of the wastewater discharge is therefore assessed as **Low**.

9.4.2.5 HYDROTESTING

During construction and pre-commissioning operations, wastewater will be generated in the course of hydrotesting of the LNG Plant equipment and its auxiliary facilities (e.g. LNG and condensate tanks, process equipment and pipelines). Hydrotesting operations will be performed sequentially to conserve water resources. After testing, used hydrotest water will be pumped in to high capacity tanks. The maximum water consumption will take place in the process of testing the LNG Plant tanks. The total calculated volume of required hydrotest water is approximately 10,000 m^3, with a usage rate of 116 l/s based on one LNG tank being filled and emptied over 16 days. The water will be pumped from the Gulf of Ob at the designated surface water intake facility. The suction pipeline will be equipped with a fish protection device, a pump with an electric motor drive or a diesel-engine drive and quick-release pressure pipelines around 300m in length and 300mm diameter.

Wastewater generated in the course of LNG and condensate tank hydrotesting will be routed to a temporary 10,000m^3/day capacity settling basin (for the separation of suspended solids from the water) prior to discharge to the Gulf of Ob. Settled out solids from the settling basin will be disposed of to the SIDW landfill after dewatering and thermal treatment.

Wastewater to be generated in the course of pipeline and process equipment hydrotesting is estimated at 1.5 m^3 to 25 m^3 per testing procedure and will be settled in the settling basin prior to discharge into the Gulf of Ob.

No chemical additives will be required for the hydrotest water (hydrotesting will be undertaken during the warm season in order to remove the need for antifreeze).

Following treatment the residual impact of the hydrotest wastewater to surface waters will be **Low** given that discharge waters will meet prescribed criteria.

A diagram showing the layout for the temporary water intake and settlement pit is shown in Figure 9.4.3.

Figure 9.4.3: Arrangement of temporary water intake and settling basin during hydrotesting

9.4.2.6 LINEAR STRUCTURE CROSSINGS

The construction and transport activities for linear crossings over surface waters can potentially lead to damage to river/lake banks and beds, and flood lands as well as contamination of the aquatic environment.

Linear structures relevant to the Project include a gas pipeline system, roadways and power transmission lines. These are discussed below.

Gas pipeline system

The Project includes the construction of an aboveground gas pipeline network required to carry products between the well pads and the LNG Plant. Gas is also to be supplied to the Sabetta accommodation camp from active wells Nos. 21 (a main well) and 106 (a standby well).

Gas pipeline routes will cross several surface water bodies (see Table 9.4.1) and will be installed on freestanding metal supports.

Table 9.4.1: Crossings of Water Bodies by Gas Pipelines

Route location	**Water body**		
	Name	**Width during low water period, m**	**Depth during low water period, m**
Gas pipeline from drilling well # 21 to the Sabetta accommodation camp			
PK11+50	Unnamed creek	4.0	0.4
PK30+6	Salyamlekabtambada-Yakha River	7.0	0.35
PK76+27,0	Unnamed creek	4.0	0.74
PK80+17,4	Sined'yakha River	4.0	0.8
PK101+36	Unnamed lake	91.0	0.4
PK103+60 PK104+5,50	Unnamed lake	6.0 41.0	0.4
Gas pipeline from drilling well # 106 to cutting-in point of well #21 - Sabetta camp gas pipeline			
PK2+29,25	Unnamed creek	30.0	0.7
PK29+61,63	Unnamed creek	0.3	0.30

Construction and assembly operations may disturb top soil layers on the banks of surface water bodies, potentially resulting in soil erosion. In addition, temporary construction sites may generate unregulated migration of contaminants (sediments, hydrocarbons etc.) through land runoff to surface waters it not properly controlled.

Roads & Bridges

Prior to the construction of the gas pipelines, temporary roads will be constructed along the gas pipeline routes to allow for the movement of construction plant and machinery. To facilitate the crossing of small streams, it is planned to strengthen the ice layer with wood and ice over a 3.5 m width. The Project also includes the construction of permanent roads to connect well pads with store sites and the Sabetta accommodation camp. Roads may impact land drainage and hence have the potential to lead to temporary flooding.

Adverse impacts to surface waters during the construction of roads may be caused by uncontrolled melt/stormwater runoff contaminated with suspended solids and petroleum products, as well as stormwater runoff from temporary construction sites, parking areas and refuelling stations.

In order to avoid impacts in the water channels single-span bridges will be constructed across all rivers except there the span exceeds approximately 50m. In total 37 bridges will be constructed (8 of which will require a central support) and 18 metal culverts.

Table 9.4.2 lists the bridges that require central supports.

Table 9.4.2: Bridge surface water crossings requiring central supports (greater 590m span)

Water body	Route staking point	Span (m)
LNG Plant Access Road		
Sined'yakha River	PK 14+21	49.87
Well Pad 25 Access Road		
Vanuyeyakha River	PK 170+80	372.81
Unnamed stream	PK 150+73	71.96
Nyarukha River	PK 67+27	94.05
Well Pad 39 Access Road		
Nedarmayakha River	PK 117+22	82.96
Sabettayakha River	PK 52+74	171.23
Nyaharvangotayakha River	PK 388+50	93.96
Yaratose River	PK 240+03	49.87

Power transmission lines

An overhead 6kV power transmission line will be installed to provide power supply to the Sabetta Upper Fuel & Lubricants Store, water abstraction facilities and the Sabetta accommodation camp. To mitigate potential adverse impact to the environment, construction operations are to be performed in the winter season to minimise disturbance of top-soil layers of watercourse banks and surface water bodies. Table 9.4.3 lists the power line intersection points over key surface water bodies.

Table 9.4.3: Intersection of the Power Transmission Lines over surface water bodies			
Route staking point	**Water body**		
	Name	**Width in mean water period, m**	**Depth in mean water period, m**
Power transmission line 6 kW Sabetta village – Upper fuel and Lubricant Store Input № 1. Facility-6 kW site Portable Electric power Plant-2500 – PK11 +55.43			
from PK 1+48.19 till PK 3+71.23	Lake	223	N/A
from PK 8 +22.58 till PK 8+84.77	Lake	63	N/A
Power transmission line 6 kW Sabetta village – Upper fuel and Lubricant Store Input № 2 Facility-6 kW site Portable Electric power Plant-2500			
from PK 1+40.22 till PK 3+68.39	Lake	228	N/A
from PK 8 +05.96 till PK 8+69.17	Lake	63	N/A
from PK 16+23.35 till PK 17+67.04	Lake	144	N/A
from PK 24+18.71 till PK 25+81.18	Lake	163	N/A
from PK 34+22,03 till PK 34+56,39	Lake	35	N/A
from PK 41+81.86 till PK 42+17.54	Lake	36	N/A
from PK 55+77.60 till PK 55+95.02	Lake	18	N/A
from PK 78+16.80 till PK 78+82.80	Lake	66	N/A
from PK 38+82.06 till PK 38+92.54	Sined'yakha River	9.7	0.4
from PK 39+29.04 till PK 39+65.25	Sined'yakha River	9.7	0.4
Tap to the base of workers power transmission line 6 kW Sabetta village – Upper fuel and Lubricant Store Input № 2			
c PK 4+33.24 till PK 4+38.26	Stream	10.0	0.5
Power transmission line 6 kW Sabetta village – Upper fuel and Lubricant Store Input № 1. tap to the base of workers, berth			
c PK 11+68.10 till PK 13+03.11	Lake	135	0.4
c PK 19+53.93 till PK 21+24.61	Lake	171	0.5
from PK 50+33.87 till PK 50+75.65	Lake	42	0.5
from PK 73+53.28 till PK 73+96.32	Lake	43	0.3
from PK 34+12.58 till PK 34+23.76	Sined'yakha River	9.7	0.4
from PK 34+93.50 till PK 35+05.38	Sined'yakha River	9.7	0.4
N/A – Not Available			

Impact Assessment

Construction machinery traffic and earthworks may affect natural surface water runoff as a result of soil compaction and the formation of local drainage systems on construction sites. This adverse impact will be **Low** within construction site boundaries.

Erosion of the bed and banks of watercourses might occur due to any local realignment of water channels at road/pipeline crossings. During operation there may also be static loads on the geological environment from engineering construction foundations. These may accelerate cryogenic and erosion processes, form depressions and cause waterlogging. Details of these processes, including the associated potential impacts and mitigation, are provided in Section 9.3.

To mitigate adverse impacts on the environment, the following mitigation measures are proposed for gas lines, roads, bridges and power lines:

- Construction and piling operations will be carried out during the low water period in winter;
- Foundations will be constructed by using piling methods allowing for frozen soil layers under foundations and preventing disturbance of existing land runoff processes (piling will be undertaken using auger piling methods wherever ground conditions allow);
- Where culverts are used for river/stream crossings the location, length and diameter of pipes are determined by a calculated rate of water flow to prevent flooding of adjacent land;
- When installing culverts, temporary by-pass roads will be used and removed once the pipes are in place;
- road embankments will be reinforced by geo-grids filled with crushed stone and peat;
- sediment controls measures including silt fencing will be used during earthworks in the vicinity of surface waterbodies where necessary;
- Bridge supports will not be constructed within river beds; and
- Construction sites (for temporary accommodation camp and machinery) for bridges will be located on the left-hand bank of the Sined’yakha River and on the right-hand bank of the Salyamlekabtambada-Yakha River.

Monitoring measures during the construction of linear structure crossings of surface waterbodies include:

- Visual inspections of river and lake beds, banks and flood plains at crossings and near aerial crossings;
- Sampling of waters and sediment to determine the hydrochemical condition;
- Sampling to determine the hydrobiological state of water and fish resources;
- Observation of bank protection and bank slopes; and
- Lakes and rivers located within a construction site or construction site area of influence, and their water protection zones are subject to the following monitoring requirements (MPR of Russia 's Order No. 30 of 06.02.2008):
  - Monitoring parameters will include: odor, transparency, color, temperature, pH, dry residue, COD, BOD, suspended solids, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, sulfates, chlorides, iron, copper, phosphates, synthetic surfactants, petrochemicals, phenols, dissolved oxygen, as well as conductivity and hardness.

Sanitary-epidemiological water studies (total coliform bacteria, thermotolerant coliform bacteria, coliphages, enterococcus, pathogenic microflora) must be in accordance with SanPiN 2.1.5.980-00 'Hygienic requirements to surface water protection'; and

- The monitoring frequency will be determined in design approval documents. However, it should commence before construction begins, continue during water area/crossing operations, and through to completion of the construction works and during the first summertime low water period.

Following the implementation of the mitigation and monitoring measures listed above, the risk of sediment and contamination inflow into the surface waterbodies is expected to be minimised and the residual impacts from the construction of linear structures is assessed as **Low**.

9.4.2.7 LANDFILL

The SIDW landfill will be constructed on the edge of the Salyamlekabtambadyakha River valley, east of the river and beyond water protection zones (WPZ) (see Table 9.4.4). Further details are provided in section 9.7.

Table 9.4.4: Distances from the Landfill Site to the Nearest Surface Water Bodies

Name of the nearest water body	WPZ width, m	SPZ width, m	Minimal distance to SIDW Landfill, km
Nameless lake # 1	50	50	0.672
Nameless lake # 2	50	50	0.280
Nameless lake # 3	50	50	0.607
Nameless lake # 4	50	50	0.379
Nameless lake # 5	50	50	0.298
Nameless lake # 6	50	50	0.332

A floodplain and the Sabettayakha River are situated 350 m and 4.06 km respectively, from the proposed landfill. There is also a thermokarst lake (with a surface area of 0.04 km^2) situated east of the landfill site. The soil at the proposed location of the landfill comprises sand. The edges of the landfill site are also flooded and the south-western part of the site has a dried lake bed.

The hydrological regime of the local area will be affected by the construction of the landfill which will result in changes to the natural topography and localised disturbance of the natural landscape (microrelief, surface water runoff and the current hydrological regime).

To prevent surface water contamination, the following mitigation and monitoring measures will be implemented during the landfill construction (for designed mitigation measures during operation, see Sections 9.4.3 and 9.7):

- regular inspections of construction machinery to ensure they are in good working order;

- refuel construction machinery directly from a refuelling truck at specially designated sites with hard paving and impermeable lining;
- use of secondary containment to prevent release of hazardous substances at storage areas (e.g. adhesives, paints and other materials);
- undertake the main construction operations and earthworks in the winter season; and
- use of watertight septic tanks for the temporary storage of liquid sanitary waste on location until removal to the treatment facilities at the Sabetta accommodation camp.

The residual impacts on surface waters during the construction of the landfill will be **Low** to **Moderate.**

9.4.2.8 SEAPORT

The construction of the MOF and main seaport may lead to potential impacts on the marine environment primarily through dredging of the seaport, approach channel and navigational channel. Potential impacts associated with dredging activities relate to:

- Effects of suspended sediments on the column and sedimentation effects on the seabed at both the dredged areas and the dredge spoil disposal areas.
- Potential effects of seawater characteristics in the upper reaches of the Gulf of Ob from removal of sand bars in the navigational channel.
- Temporary safety exclusion zones around operating dredging and support vessels (see Chapter 10 for assessment of associated social-economic impacts).

An overview of the dredging activities and the potential effects on the marine environment are described below in turn. The effects of suspended sediment and sedimentation on marine flora and fauna are assessed in Section 9.10. Noise impacts associated with dredging are assessed in Section 9.8

Overview of Construction Dredging Activities

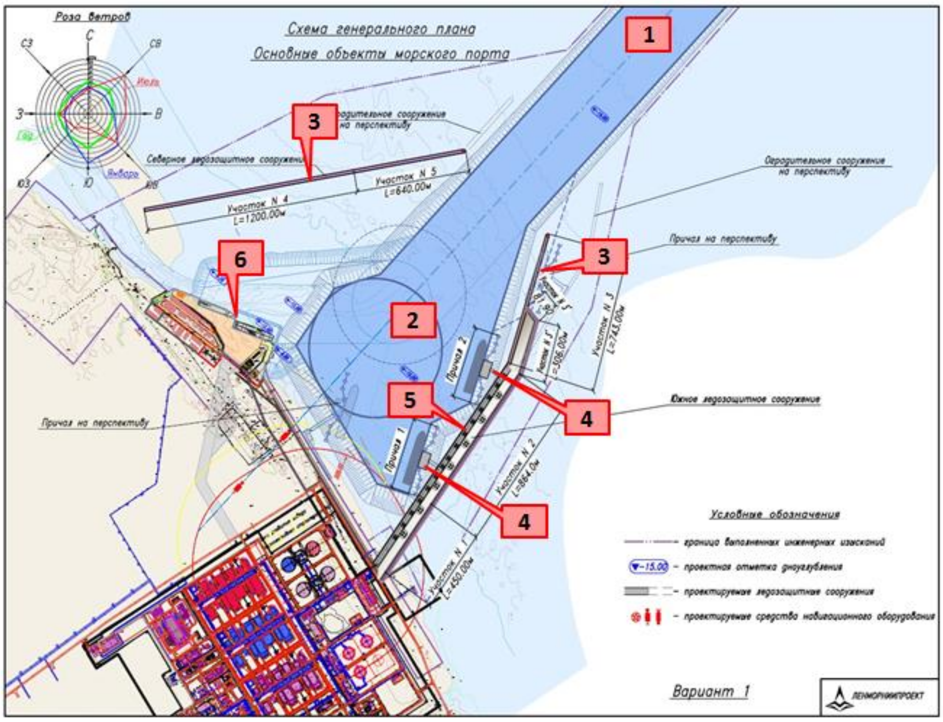
Dredging is required in the following areas as part of seaport construction:

- **Seaport turning circle and approach channel (see Figure 9.4.4)**

  Construction of the seaport basin (turning and manoeuvring areas) and approach channel will be performed from 2014 to 2016 by additional dredging of an existing turning area and approach channel. The width and length of dredged part of approach channel are 495m and 5,656m respectively. The diameter of the turning area is 600m. Dredging activities will be performed using dredging equipment appropriate for the coastal wave environment as follows:

  - stationary suction dredge
  - large trailing suction hopper dredgers (TSHD) with draught of 9.1-10 m;
  - medium TSHDs with draught of 5.5-9.1m

  The total volume of extracted sediment during dredging activities (not including sediment accumulation) will be 23.438 million m^3. Soils in the seaport and approach channel area are composed of: silts; high-plastic, semi-solid or stiff loam; sands; and sandy clay.



Key
1. **Approach channel;**
2. **Turning circle;**
3. Ice protection area;
4. Offloading berths;
5. Offloading LNG trestle;
6. Modules offloading facilities

Figure 9.4.4: Seaport facilities, including approach channel and turning circle

- **Navigational channel (see Figure 9.4.5)**

  The navigation channel is 48.9 km in length and 306m wide and is planned for construction between 2013 and 2016 using five large TSHDs as follows:

  - three TSHDs with a hold capacity 11,650 m^3 and draught at full load of 9.1m;
  - two TSHDs with a hold capacity 14,000 m^3 and draught at full load of 10.0m.

  The total volume of extracted soil during dredging activities in the navigation channel, taking into account sediment accumulation, will be 46.4 million m^3. Soils in the navigational channel are composed of clayey silt.

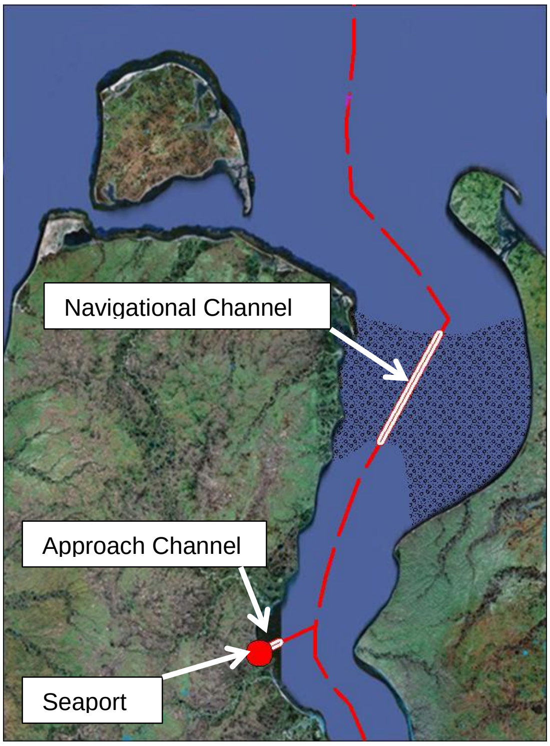


Figure 9.4.5: Approach and navigational channel in the Gulf of Ob

Dredging activities in all areas will be performed from early August until mid-October during each year of construction dredging. During these periods dredging activities will be undertaken around-the-clock, 7 days per week. Preliminary depth measurements will be carried out prior to such activities.

Disposal of extracted soil during navigation channel construction is planned at two offshore sites (see Figure 9.4.6):

- A northern plot of 1,210 ha the centre of which is located 32.65km from the middle of the navigation channel
- A southern plots of 4,452 ha the centre of which is located 22.6km from the middle of the navigation channel

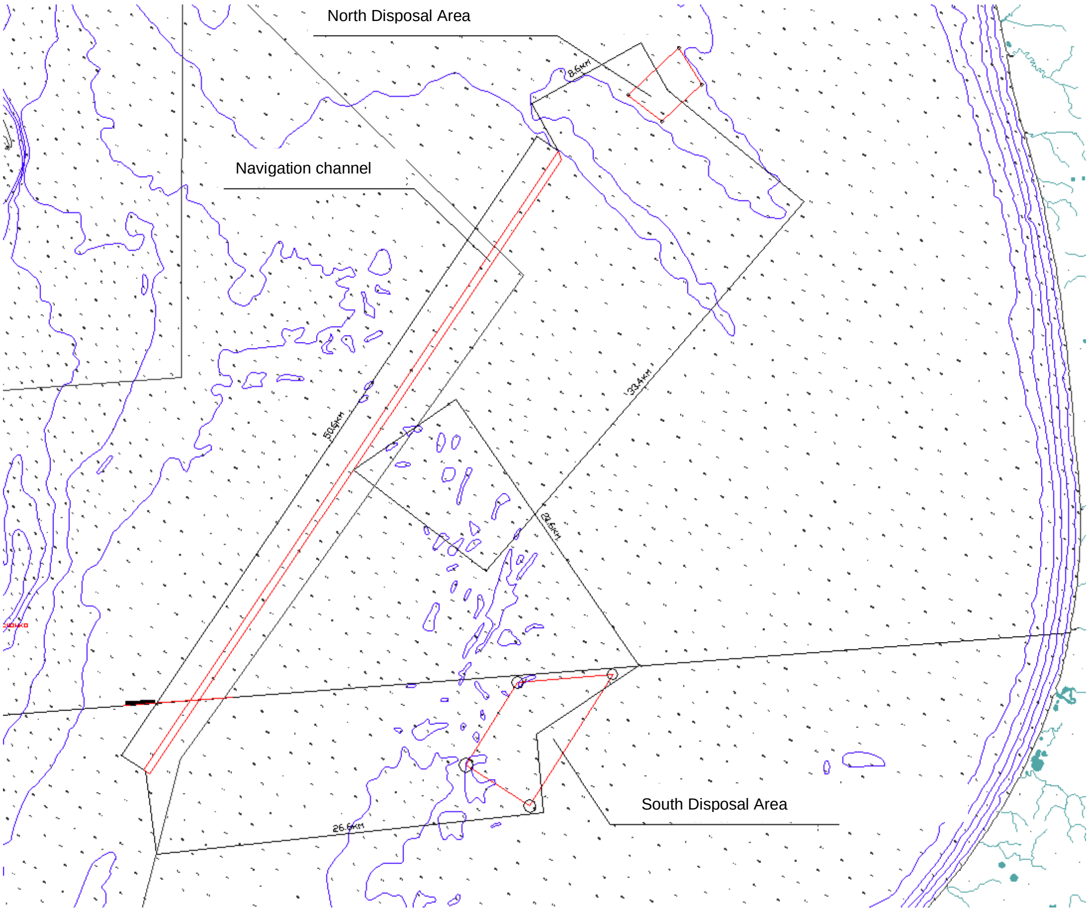


Figure 9.4.6: Location of spoil disposal areas for navigation channel dredging

Disposal of extracted spoil from the seaport and approach channel construction will be performed at an offshore plot 13.5km to the east of the center of seaport area (see Figure 9.4.7), which is a natural depression.

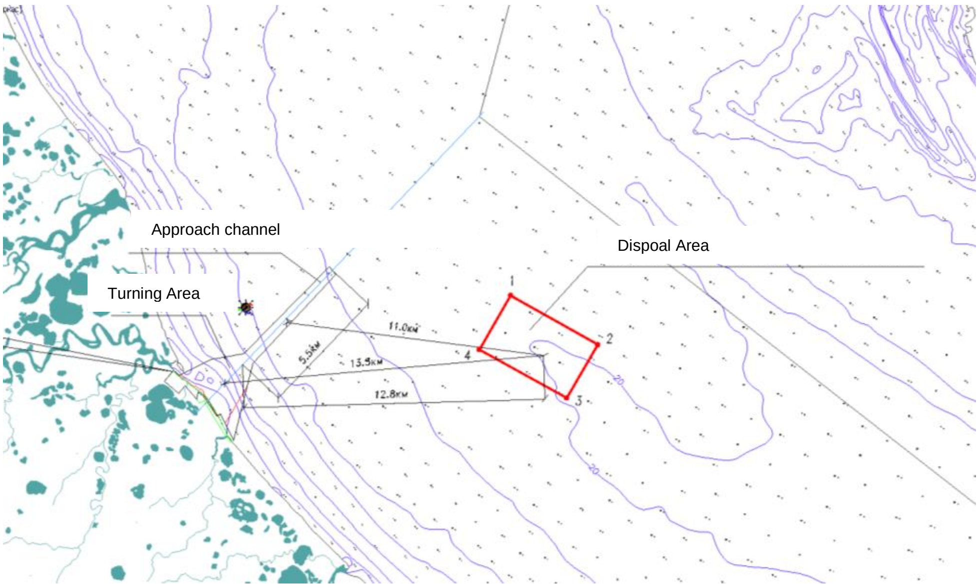


Figure 9.4.7: Location of spoil disposal area for seaport dredging

Coordinate and water depth data for all the dredge spoil disposal sites is provided at the Table 9.4.5 below.

Table 9.4.5: Coordinates of Dredge Spoil Disposal Sites			
Point No	**Latitude, N**	**Longitude, E**	**Depth, m**
Northern plot			
1	72° 33' 02.0"	74° 14' 46.2"	16.6
2	72° 34' 35.1"	74° 21'24.1"	16.4
3	72° 33' 10.3"	74° 23' 47.1"	16.2
4	72° 3Г 57.4"	74° 18' 33.9"	16.5
Southern plot			
1	72° 11'54.2"	73° 55' 26.4"	10.0
2	72° 11'55.5"	74° 06' 50.0"	10.2
3	72° 07'21.6"	73° 55' 39.4"	10.6
4	72° 09' 02.8"	73° 48' 27.8"	9.8
Plot of soil dumping from sea port water area			
1	71° 18' 36.3"	72° 26' 26.6"	19.2
2	71° 17' 21.4"	72° 32' 26.6"	18.8
3	71° 16' 10.6"	72° 30' 01.3"	20.5
4	71° 17' 23.7"	72° 24' 00.1"	18.8

It is planned that the volume of dredge spoil from the navigation channel will be similar every year of the construction period of 2013-2016. The dredging process using TSHDs involves the following stages: dredging (loading), transportation (voyage) and unloading (disposal). Dredging is carried out by suction pipes set along the vessel hull. Extracted material is loosened and gathered in the hold by a snapper at the end of the suction pipe. Once the hold is full, the suction pipe and snapper are lifted on deck, the TSHD sails to the disposal plot at a speed of 5 to 15 knots and discharges loaded material.

The use of TSHD in the shallow seaport area is not possible due to the size of the draught (7m BS[13]). Therefore, dredging activities in the shallow water area of sands and silts will first be performed (in 2014) to a depth of 5m depth (BS) by high-productive suction dredges. Spoil removal will be undertaken through a floating pipeline to self-propelled scows, which then transports the spoil to the disposal plot.

The next phase of dredging in the seaport area will be performed by two backhoe dredges with back digger and spoil loading to self-propelled scows. The backhole dredges will remove only the top sandy deposits. Further dredging to a depth of 7m (BS) will then be

[13] Referenced to the tidal datum of the Baltic Sea (BS)

performed by cutter-dredger. In addition, during 2014, dredging of the trestle construction area (to the depth of 8.5 m BS) and the approach channel in the areas >9m deep BS will be partially carried out. It is planned to perform mechanical loosening of the top permafrost layer (to the depth of 7 m BS) in the second part of the 2014 dredging period using backhoe dredges with back digger and loading of loosened permafrost to the hold of self-propelled scows. The total amount of spoil extracted from seaport and approach channel area in 2014 will be 5.7 million m^3.

During 2015 dredging of the shallow seaport area (at depths from 7 to 9m BS) and shallow approach channel areas will initially be performed using medium-sized TSHDs and will then be continued using four large TSHDs. The total amount of spoil transported during the 2015 dredging period from the seaport and approach channel will be 6.6 million m^3, including an estimated 0.162 million m^3 of additional sediment from interseasonal accumulation.

During 2016 dredging of the seaport area will be completed by five large TSHDs. Extracted sediment will mostly comprise silts, high-plastic loams, sands and clay sands. Dredging of areas comprising semisolid and stiff loam will be performed by backhoe dredges with back digger. After loosening of permafrost rock from a depth 7 to 15.2 m BS at the western part of the seaport area, it is planned to remove frozen sands using backhoe dredge with loading to scows. During the same period 8.5m depth BS of soil will be removed by backhoe dredge near the wall of the trestle. The total amount of spoil transported to the dumping plots during the 2016 dredging period will be approx. 9.5 million m^3.

Suspended Sediments

Suspended sediment plumes will be generated during dredging activities. Baseline studies (see Chapter 7) have shown that the marine sediments in the Gulf of Ob have low levels of contamination, and hence the primary potential impacts of concern from suspension of sediments relate to the physical levels of total suspended sediments (TTS) in the plume and sedimentation on the seabed.

Suspended sediment plumes will drift according to the direction and speed of the prevailing currents. Constant, tidal and wind currents are observed in the Gulf of Ob. Constant currents form from river inflows and head northward at speeds in the range of 0.5 to 0.7 knots; their speed decreases from spring to autumn. Tidal currents are semi-diurnal. The general direction of high tidal currents is to the south (for 5 hours), and low tidal is to the north (for 7 hours). Wind currents speed depends on the speed, direction and duration of the wind. High tidal currents of 0.1 to 0.2 knots and wind currents are observed in the northern part of the Gulf of Ob. The maximum speed of high tidal currents is observed along the western shore from the Hesal cape to the Saboloyakha river mouth and along the eastern shore Shokalsky island and Storm cape. The influence of tidal currents decreases by the middle of the Gulf of Ob.

Modelling of suspended sediment dispersion in the marine environment during dredging and disposal activities has been performed on behalf of Yamal LNG using the certified mathematical model “AKS-ECO Shelf”, designed by the computation centre of the Russian Academy of Sciences and Ecocenter MTEA (Environmental compliance certificate of RF Natural Resources Ministry – SER(1492)-Б-30/OC-63).

The model predictions take into account current parameters that were obtained during research at nearby hydrological stations. The proportion of sediment that is suspended (from the overall spoil volume) is calculated taking into account standard indexes for hydro-mechanical dredging type and different sediment types[14].

The list of parameters used in the model to calculate the dispersion of suspended sediment and hence the impact on the marine environment includes:

- weight of extracted and dumped soil (tons)
- weight of soil transforming into suspended solids (tons)
- area of disturbed bottom surface (m^2)

The impact on the marine environment is then assessed through consideration of the modelling results in terms of:

- the maximum distance from the source to the area borders with concentrations above maximum permissible concentration (MPC – 10 mg/l)
- the duration for which the suspended sediment plume exceeds the MPC (hour)
- the area of sedimentation impacts and the maximum distance from the source to the where sedimentation thicknesses exceed design values.

Associated impacts on marine flora and fauna from dredging are assessed in Section 9.10.

Tables 9.4.6 and 9.4.7 provide predicted distances from the extraction point at which different suspended sediment concentration levels (1, 10, 20, 50 and 100 mg/l) are reached for different dredging activities. Table 9.4.8 provides the predicted duration of suspended sedimentation concentration plumes resulting from dredging activities. Tables 9.4.9 and 9.4.10 provide the distances from the dredging area to isolines for sedimentation thickness layers on the seabed (thickness levels of 1, 10, 20, 50 and 100mm).

Table 9.4.6: Distance from dredging activities in the navigation channel to the position of threshold limit isoline, m

Threshold limit of suspended sediment in water, mg/l	**≥ 100**	**≥ 50**	**≥ 20**	**≥ 10 (MPC)**	**≥ 1**
Dredging	8,960.3	8,982.7	9,005.0	9,027.3	9,060.9
Disposal at the northern plot	6,510.5	6,564.7	6,633.1	6,663.7	6,740.3
Disposal at the southern plot	8,338.6	8,363.1	8,387.5	8,406.8	8,460.8

[14] As listed in RF standard document "Payment calculation procedure for pollution of marine environment and surface bodies, that are federal property of RF during performing activities related to extraction and transportation of bottom soils, exploration of non-mine materials from underwater open pit and disposal of soils at underwater dumps"

Table 9.4.7: Distance from dredging activities in the seaport and approach channel to position of threshold limit isoline, m					
Threshold limit of suspended sediment in water, mg/l	**≥ 100**	**≥ 50**	**≥ 20**	**≥ 10 (MPC)**	**≥ 1**
Activities in 2014					
Dredging	699.0	1,518.9	2,481.6	3,547.0	5,869.1
Disposal	1,083.2	1,378.6	1,986.1	2,354.4	2,623.8
Activities in 2015					
Dredging	699,0	1,518.9	2,481.6	3,547.0	5,869.1
Disposal	2,623.2	2,657.6	2,696.4	2,723.7	2,796.3
Activities in 2016					
Dredging	5,933.9	5,972.2	6,011.7	6,035.4	6,090.9
Disposal	2,541.1	2,569.8	2,607.6	2,630.1	2,697.8

Table 9.4.8: Duration of plume existence during dredging and dumping activities, hour					
Threshold limit of suspended sediment in water, mg/l	**≥ 100**	**≥ 50**	**≥ 20**	**≥ 10 (MPC)**	**≥ 1**
Activities at the navigation channel (every year for 2013-2016)					
Dredging	321	321	321	321	321
Northern dumping plot	35	48	53	53	54
Southern dumping plot	212	212	212	212	212
Activities at the sea port water area and approach channel					
2014					
Dredging	241	276	279	279	280
Dumping	102	186	252	266	272
2015					

Table 9.4.8: Duration of plume existence during dredging and dumping activities, hour					
Threshold limit of suspended sediment in water, mg/l	**≥ 100**	**≥ 50**	**≥ 20**	**≥ 10 (MPC)**	**≥ 1**
Dredging	241	276	279	279	280
Dumping	208	226	259	297	320
2016					
Dredging	391	391	391	391	392
Dumping	129	144	176	211	273

Table 9.4.9: Maximum distance (m) from navigation channel dredging activity to sedimentation thickness levels					
Sedimentation thickness (mm)	**≥ 100**	**≥ 50**	**≥ 20**	**≥ 10**	**≥ 1**
Dredging	0	25	315	698	2,676
Disposal (north area)	163	385	879	1,346	3,215
Disposal (south area)	42	512	1,114	2,001	6,932

Table 9.4.10: Maximum distance (m) from seaport and approach channel dredging activity to sedimentation thickness levels					
Sedimentation thickness (mm)	**≥ 100**	**≥ 50**	**≥ 20**	**≥ 10**	**≥ 1**
2014					
Dredging	0	36	196	376	858
Disposal	10	49	166	384	1 031
2015					
Dredging	0	36	196	376	858
Disposal	396	805	1,120	2,031	2,272
2016					

Dredging	265	488	978	1,494	4,019
Disposal	152	489	631	965	1,678

It follows from Tables 9.4.6 and 9.4.7 that the distance between the dredging activity location and the MPC isoline ranges from 700 to 9,000m. At the same time the duration of the suspended sediment plume with concentrations between 10-100 mg/l during dredging at the seaport will be from 240 to 390 hours, and during dredging of the navigation channel up to 320 hours. Taking into account the size and duration of the plume, the duration of the dredging activity (at least 75 days of around-the-clock activity per dredging season), but also considering the fact that the northern part of the Gulf of Ob is not used for other water supply needs (domestic), impact on marine waters from dredging is estimated to be **moderate**.

The following measurements will be implemented to minimize the impact on the marine environment during performing dredging activities at the Gulf of Ob, although the residual impacts are still assessed as **moderate**:

- perform loading of TSHDs without any overflow of technical water over the side;
- perform unloading of scows and TSHDs at the dumping point only after their complete stop;
- to bring the dredge bucket down to the water at the hold of scow as close as possible to avoid spillage of sludge;
- the dredge bucket should be 75 % full to prevent spillage of spoil back to water
- perform chemical and analytical monitoring of water quality at the Gulf of Ob before, during and after dredging activities;
- perform constant control of underwater activities, including recording of coordinates and volumes of all dredging and dumping activities.

Sand bar removal

Intensive interaction of warm freshwater from river runoff and the cold salt water of the Kara Sea is observed in the Gulf of Ob. These water types mix and form a diffuse border (salt wedge). Major influences on the dynamics of the Gulf of Ob include freshwater income (553 km^3 per year) and tides, as well as storm surges and wind circulation.

Dredging activities for the navigation channel have the potential to influence the salinity of water in the Gulf of Ob due to the removal of sand bars. Mathematical modeling has been performed to assess this potential impact using a 3D model for hydro dynamical and thermohaline processes, including information on the relief of the navigation channel. Separate modeling studies were undertaken by OOO “Eco-Express-Service” and AANII on behalf of Yamal LNG. The modelling results were assessed by SRO non-commercial partnership “Ecological International Community of Auditors” (OOO “PROEKSON” (2013)) on request of OAO “LENMORNIIPROJECT”.

The modelling area is located from 72º45' N (east - Tyurisalya cape, west - Halyapala Gulf) to 71 º17' S (east – Honarasalya cape, west – river mouth of Sabettayakha river) and is shown in Figure 9.4.8.

Figure 9.4.8: Salinity modelling study area

The model takes into account currents, level fluctuations, water salinity and temperature. Impacts from storm surges and tides, current variability and salinity variability at the northern border are included, as well as freshwater income from the south. The variability of parameters over different temporal scales (daily, tidal, synoptical, season, annual, decadal etc.) was factored into the modelling. The model calculations show results for scenarios both with and without the construction of the navigation channel. Comparison results predict that changes to current areas are minor and that within 3km from the navigation channel salinity levels may differ up to 2 ‰. It is predicted that salinity may even decrease at some points due to the formation of local zones of flow convergence-divergence and vertical exchange increase.

The main conclusions of Ecological International Community of Auditors report are provided below:

1. Prior long-term monitoring shows that salinity, temperature and other water parameters of the Gulf of Ob depend on meteorological conditions, variations in currents and other natural factors, that may change not only seasonally but also over periods of a several days.

2. Modelling performed by OOO “Eco-Express-Service” based on data obtained by Lapin S.A. during field work in 2010 show the impact of channel construction and operation on water salinity at the Gulf of Ob to be low.

3. Modelling performed by AANII based on long-term research shows that salinity is predicted to change by less than 2 ‰ in the case of storm surges.

Based the findings of these studies, the impact of dredging of the navigational channel on thermohaline processes of the Gulf of Ob is assessed to be **Low**.

9.4.2.9 WORKER ACCOMMODATION CAMPS

During construction of worker accommodation camps there is the potential for adverse impacts upon surface water from:

- Spills of fuel/oil from construction machinery;
- Spills during refuelling of construction machinery;
- Leaks from fuel/oil storage areas;
- Spills of hazardous materials (paints, solvents etc.);
- Uncontrolled release of sanitary waste water.

In the absence of mitigation, the potential adverse impacts of constructing worker accommodation camps are assessed to be **moderate**.

The potential impacts upon surface water will be reduced by employing the following mitigation measures:

- Regular examination of construction machinery to ensure satisfactory condition and maintenance;
- Provision of drip trays beneath mobile plant;
- Refuelling of construction machinery will be performed directly from tankers at dedicated areas with a concrete surface and water proofing;
- Secondary containment for preventing infiltration at hazardous material storage areas (including waste oils/lubricants);
- Secondary containment (bunding) at fuel/oil storage areas, vehicle parking areas and filing stations;
- Use of impermeable septic tanks for temporary storage of sanitary waste water.

With the adoption of the above mitigation measures the potential adverse impact of accommodation camp construction is assessed to be **low**.

It should be noted that the above assessment relates to the construction of worker accommodation camps, during the construction phase. However, these camps will also be operating (i.e. being used to house workers) during the construction phase of the Project. The ‘operational’ impacts (albeit taking place during the Project construction phase) are assessed in Section 9.4.3.

9.4.3 OPERATIONAL PHASE IMPACTS

This section discusses the impacts to surface waters during the operational phase of the Project.

Upon the completion of the construction phase, certain sources of impacts to surface water bodies will be eliminated (e.g. wastewater discharge from the Sabetta accommodation camp to the Bezymyannoye bog, ground levelling, river/lake bank disturbance by construction of linear infrastructure). In addition, the existing fuel and lubricants store located within the coastal area of the Gulf of Ob will be decommissioned.

During the operational phase of the Project, impacts to surface water bodies will be caused predominantly by the following operations:

- wastewater discharges (including sanitary, stormwater, brine water from the desalination plant, snowmelt and process water); and
- operations in water (sea port) and on the banks of water bodies at crossing points by linear infrastructure.

Impacts associated with water abstraction for sanitary, processing, fire suppression and other needs are assessed in Section 9.6.

9.4.3.1 WASTEWATER DISCHARGE (NORMAL OPERATIONS)

A summary of wastewater discharge sources, treatment facilities, discharge locations and discharge volumes during the operational phase is provided in Table 9.4.11.

Table 9.4.11: Summary of waste water discharges during the operation period

Facility	Type/source of waste water	Volume of waste water excl. storm water (m^3 per day)	Volume of storm water (m^3 per day)	Treatment facility	Discharge location	Total waste water volume excl. storm water (m^3 per day)	Total volume of storm water (m^3 per day)	Total (m^3 per day)	Total (m^3 per year)
LNG Plant and Camp	Sanitary water	661	N/A	Local waste water treatment facility at the LNG site	Deep disposal well	3,756	9,580	13,336	4,867,640
	Process water, salt concentrate from desalination unit and potential contaminated storm water	3,095	9,580						
Well fields and Sabetta camp	Sanitary waste water	725	N/A	Local waste water treatment facility	Gulf of Ob (common outfall)	1,048	350	1,398	510,270
	Process water and potentially contaminated storm water	323	350	Local waste water treatment facility					
	Brine from desalination plant	Included in abovementioned figures	N/A	Desalination unit					
Upper fuel store	Sanitary water	0.16	N/A	Sewage treatment facility at Sabetta camp	See Sabetta above	48.16	304.22	352.38	12,8618.7
	Process water and potentially contaminated storm water	48	304.22	Local waste water treatment facility	Nameless local lake				

Table 9.4.11: Summary of waste water discharges during the operation period

Facility	Type/source of waste water	Volume of waste water excl. storm water (m^3 per day)	Volume of storm water (m^3 per day)	Treatment facility	Discharge location	Total waste water volume excl. storm water (m^3 per day)	Total volume of storm water (m^3 per day)	Total (m^3 per day)	Total (m^3 per year)
Waste management facility	Sanitary water	0.2	N/A	Sewage treatment facility at Sabetta camp (sanitary water unit of the plant)	Deep disposal well	1,608..2	2,311	3,919.2	1,430,508
	Runoff water (relatively clean)	Not applicable	2311	Production runoff water treatment unit with a landfill filtrate cleaner unit					
	Contaminated runoff water (landfill filtrate)	1590	Not applicable						
	Production runoff water (contaminated water)	18	Not applicable						
Airport	Sanitary water	25	N/A	Sewage treatment facility at Sabetta camp	See Sabetta above	33	103.7	136.7	49,895.5
	De-icing runoff	8	N/A	Collection tanks prior to disposal to the treatment facility at Sabetta camp	See Sabetta above				
	Other potentially contaminated storm water	N/A	103.7	Local waste water treatment facility	Re-used on site				

Table 9.4.11: Summary of waste water discharges during the operation period

Facility	Type/source of waste water	Volume of waste water excl. storm water (m³ per day)	Volume of storm water (m³ per day)	Treatment facility	Discharge location	Total waste water volume excl. storm water (m³ per day)	Total volume of storm water (m³ per day)	Total (m³ per day)	Total (m³ per year)
Seaport	Sanitary water	57.03	N/A	Sewage treatment facility at Sabetta camp	See Sabetta above	87	21	108	39,420
	Cleaning water (e.g. resulting from cleaning oil booms)	23.36	N/A						
	Other potentially contaminated runoff	N/A	21.39	Local waste water treatment facility	Gulf of Ob (seaport berth)				
	Bilge water	6.67	N/A	For harbor vessels bilge water during the operation period specific treatment facilities are envisaged which are part of the seaport. Bilge water of the vessels which home port is other than Sabetta must be treated at their home ports facilities.	Sanitary waste water treatment facility at Sabetta seaport is to be discharged into Gulf of Ob.				
					Total (m³ per day)	**6,580**	**12,670**	**19,250**	**7,026,352**

Further details on these discharges are provided for each facility in turn below. As a general point, in order to ensure the operability of water treatment facilities in the cold climatic conditions prevalent in the licence area, the following methods will be implemented:

- Trace heating will be provided on water pipes
- Biological treatment units will be located in heated housing as necessary

It is also noted that disinfection in the wastewater treatment plant will be undertaken through UV treatment.

Well fields and worker accommodation camps

Process effluents and melt/stormwater from operational drilling well sites No. 21 (24.26 m^3 / day) and No. 106 (23.74 m^3 /day) will be collected in specially lined pits with a holding capacity of 16 m^3 and 32 m^3 respectively. Once full, the effluent will be pumped and transported by tanker to a wastewater treatment facility at the Upper Fuel & Lubricants Store area. Effluents from other production well pads will be removed by suction tanker to the treatment facilities at the Sabetta accommodation camp. Waste drilling mud in the case of loss of rheological properties will be transported to wastewater treatment plant of LNG plant and then will be injected in subsurface horizon with treated wastewater.

The following sewage and drainage systems will be constructed at the Sabetta camp:

- Sewage and wastewater treatment facilities, total capacity of 1,000 m^3/day, for sanitary wastewater and process wastewater (this will comprising four lines with a capacity of 250 m^3 each and will be delivered in the form of assembled block-structured modules);
- A drainage system for the collection of melt water and stormwater from the Sabetta accommodation camp with further treatment at stormwater treatment facilities, total capacity of 150 m^3/day.

Once these sewage effluent treatment facilities in the Sabetta accommodation camp are commissioned, the existing treated wastewater outlet to the Bezymiannoye bog will be closed down.

The sanitary wastewater chemical composition will comply with Project Standards (see the Project Standards Document).

Sewage will be subject to complete biological treatment and treated waters will meet the Project Standards defined in Appendix 2. Treated and disinfected (by UV treatment) wastewater is to be discharged to the Gulf of Ob via a common outfall at a distance of 650 m from the shore.

Storm water and melt water will be collected via open gutters that feed to drainage reservoirs and the stormwater treatment facilities.

Treated effluents will be fed via a designated delivery pipeline for discharge to the Gulf of Ob via the common outlet. Saline solutions from water treatment facilities will be also discharged via the common outlet; the dilution with other waste waters will mitigate any potential localised raised salinity impacts at the discharge point. The outlet head is designed to ensure mixing of treated wastewater with the waters of the Gulf of Ob. The outlet will be the common outfall located at a distance of 650m (see above) from the shore in order to avoid coast side contamination in the event of wind-induced currents and surfs.

The total volume of effluents to be discharged to the Gulf of Ob is shown in Table 9.4.11calculated as 1,387 m^3/day. The concentration of pollutants in wastewater at the outlet is provided in Table 9.4.12.

Table 9.4.12: Indicators of Wastewater Quality at the Outlet to the Gulf of Ob

Components	Unit	Concentration at the wastewater outlet	MPC for water bodies of fishery significance	Project Standards (at edge of mixing zone)
Suspended solids	mg/l	2.35	+ 0.25 – fresh water 10 –seawater	SS background + 0.25
Oil products	mg/l	0.04	0.05	0.05
Chromaticity	degree	15.68	20	Not established
Ammonia ions	mg/l	0.25	0.5	0.5
Nitrate ions	mg/l	1.97	40	40
Nitrite ions	mg/l	0.04	0.08	0.08
Permanganate oxidizability	mgO_2/l	3.92 *	Not established	Not established
Total iron	mg/l	0.24	0.05	0.1
Manganese	mg/l	0.08	0.05	Not established
Copper	mg/l	0.008	0.005	0.001
Chloride-ions	mg/l	984.37	300 – fresh water 11900 (12-18‰) – sea water	300
Sulphate-ions	mg/l	181.46	100 – fresh water 3500 (12-18‰) – sea water	100
Strontium	mg/l	< 1.0	4.14	Not established
Fluoride-ions	mg/l	1.18	0,05	Not established
Sodium	mg/l	156.77	120	120
Magnesium	mg/l	201.6	40	Not established
Odor	point	0.2	Not established	Not established
pH	pH	5.88	6.5 to 8.5	Not established
Phenol	mg/l	0.01	0.001	0.5
Cyanides	mg/l	0.02	0.05	Not established
Dry residue	mg/l	2,743.52	1,000	Not established
Zinc	mg/l	3.92	0.05	0.01

Table 9.4.12: Indicators of Wastewater Quality at the Outlet to the Gulf of Ob

Components	Unit	Concentration at the wastewater outlet	MPC for water bodies of fishery significance	Project Standards (at edge of mixing zone)
Lead	mg/l	0.01	0.01	0.006
Cadmium	mg/l	< 0.001	0.01	0.05
Arsenic	mg/l	< 0.05	0.01	Not established
Chromium (III)	mg/l	< 0.01	0.07	Not established
Boron	mg/l	0.1	0.5	Not established
Mercury	mg/l	< 0.0005	0.0001	0.0001 (below Detection Limit)
BOD_5	mgO_2/l	3.0	2	3
COD	mgO_2/l	20.0	15	15
Aluminium	Mg/l	0.0016	0.04	Not established
Total hardness	Mg/equiv./l	13.0 *		Not established
Surfactants	mg/l	0.11	0.11	Not established
Wastewater stream temperature	^oC	13 to 17	^oC +5	**

* wastewater quality norms according to SanPiN 2.1.5.2582-10

** End of pipe effluent temperature not to be more than 5^0 above receiving water body temperature. Absolute temperature receiving water body not to increase above 20^0C in summer and 5^0C for salmonid waters and not more than 28^0C in summer and 8^0C in winter for other waters.

It should be noted that discharge concentration at the discharge point provided in Table 9.4.12 are not directly comparable with the MPC and Project Standards, which are set at the edge of the mixing zone. The common outfall in the Gulf of Ob at a distance of 600 m from the shoreline through a deep-water dispersing outlet ensuring rapid dilution of wastewater in the Gulf of Ob directly at the outlet point. In most cases the concentrations at the discharge point are already below the edge of mixing zone standards. In the few cases where this is not the case, the discharge point concentrations are less than a factor of 10 above the edge of mixing zone standards, and hence will rapid dilute to meet MPC/Project Standards within the immediate mixing zone.

In order to ensure adequate mixing from the common outlet to the Gulf of Ob, and specifically to avoid the risk of build-up of pollutant concentrations in the seaport area, the outfall is to be located 650m from the shore. In addition, water quality monitoring will be undertaken at both the outlet discharge location (see Table 9.4.16) and in the seaport area (see Table 9.10.7).

Pursuant to the regulatory document SanPiN2.2.1/2.1.1.1200-03, a tentative size for sanitary protection zoning for sewage effluent treatment facilities is 150 m and for surface water treatment facilities, 20m (see also Section 9.8.3.1).

LNG Plant

The maximum calculated volume of wastewater to be generated in the summer season from the LNG Plant and its associated infrastructure is approximately 3,756 m^3/day, including 661 m^3/day of sanitary wastewater and 3,095 m^3/day of process wastewater (including wastewater contaminated with chemical substances). The volume of melt/stormwater will amount to 9,580 m^3/day (see also Table 9.4.11).

There will be separate drainage/sewer systems at sites to be occupied by the LNG Plant and its associated infrastructure. This includes the following:

- Sanitary sewer system: Wastewater from sanitation equipment installed in amenity rooms at the LNG accommodation camp will be sent to sewage effluent treatment facilities for biological treatment. Sanitary wastewater from a canteen (to be constructed in accommodation camp) will be pre-treated by a fat interceptor (rate 54 m^3/hour). The projected interceptor performance efficiency is 40% to 70% for suspended solids and 50% to 80% for fat and oils.
- Technical water drainage system: This system is designed to accept wastewater generated in the course of processes at inlet facilities (e.g. wastewater from the methanol regeneration plant and methanol-containing wastewater) and from the condensate storage tank site. The wastewater will be sent to process wastewater/stormwater accumulator tanks and from there to the waste water treatment facility.
- Process wastewater/stormwater drainage system: This system will accept process wastewater from washing and hydrotesting of process equipment, contaminated stormwater/melt water from bunded technical sites and effluents from outer/internal fire suppression modules. This wastewater will be sent to process wastewater/stormwater accumulator tanks and from there to the waste water treatment facility.

Stormwater from the wastewater treatment facilities site will be discharged to the process wastewater/stormwater drainage system. A complex of wastewater treatment facilities (WTF) capable of accepting and treating all types of effluents from the LNG Plant and its infrastructure facilities will be constructed comprising:

- four sanitary wastewater storage tanks with a capacity of 200 m^3 each;
- block-structured module with a capacity of 800 m^3/day designated for sanitary wastewater treatment (a mechanised grate, a sand trap and a biological treatment block);
- three accumulator tanks with a capacity of 5,000 m^3 each for accumulation of process wastewater/stormwater;
- block-structured module with a capacity of 6,000 m^3 designated for treatment of process wastewater and stormwater (settling, flocculation, flotation, filtration);
- three treated wastewater storage tanks with a capacity of 5,000 m^3 each;
- pump station and;
- networks.

The biological treatment block will consist of two treatment lines with a capacity of 400 m^3/day each. Each line will comprise a primary settling tank, a sectional aeration tank and a secondary settling tank. After treatment, wastewater will be sent to a fine treatment block (e.g. three pressure filters with carbon sorbent) and further to a UV-disinfection plant.

A process wastewater/stormwater treatment plant is designed to ensure compliance of these effluents with sanitary norms. This plant consists of a mechanical treatment unit, a pressure flotation unit, a fine treatment and after-treatment unit, a disinfection unit and a sludge dewatering unit. Treated sanitary, process wastewater and stormwater will be mixed and prepared for -injection to deep formation[15]. See Section 9.5 for further information.

Seaport

There will be three drainage systems at the territory of the seaport: Domestic waste water from buildings and facilities of the main seaport (41.33 m^3/day / 14479.65 m^3/ year) and from the area of early phase seaport facilities (MOF) (15.7 m^3/day / 5670 m^3/ year). These waters will be collected from a sanitary drainage system and pumped to water treatment facilities of LNG plant.

Industrial waste water from main sea port facilities will be discharged via drains to a drainage pump station and further to an accumulator tank (with capacity of 18 m^3) and finally to treatment facility at the MOF fuel berth. Industrial waste water includes:

- waste water from washing of details unit at oil spill response complex building
- waste water from washing of booms (after oil spill response)
- bilge water from vessels and oil-carrier

Industrial waste waters have the following concentrations:

- suspended matters – 500 mg/l
- oil products – 1000 mg/l.

Treatment of these waters is performed at a settlement and skimming unit with capacity 2 m^3/hour (44 m^3/day). The unit operates continuously and automatically. Treated water is used for washing of filters and discharged into storm water drainage system.

Stormwater from the territory of main sea port facilities will be collected to a block-structured treatment facility with capacity of 20 m^3/hour and sent to the central waste water treatment facility at the MOF fuel berth. The wastewater treatment complex will comprise mechanical treatment (gravity thickening), electric coagulation, duplicative gravity thickening, filtration and ultraviolet disinfection.

Treated water with concentrations that do not exceed MPC set for fishery water bodies (Table 9.4.13) will be discharged into seaport water area. An underwater effluent discharge outlet will be constructed at berth.

[15] Feasibility studies for deep well injection are ongoing – see Chapter 4 for further details

Table 9.4.13: Efficiency of Industrial Stormwater Treatment Facility Performance				
Contaminants	**Concentration, mg/l**			
	Maximum concentration prior to treatment	**After gravity thickening**	**After mechanical filters**	**After sorption filters**
Suspended matters	700	140	15	5
Oil products	50	10	1,0	0,05
COD	200	80	56	30
BOD_5	40	18	12	3

There will also be a drainage system to collect heating water from pipelines and water supply in case of spillages from leaks or during maintenance. The temperature of waters will be lower prior to discharge in cooling pits.

To mitigate the impacts of operational phase waste water discharge to the Gulf of Ob, the following measures will be implemented:

- Treatment of potentially contaminated industrial, storm/melt and drainage waters from the seaport at a treatment facility designed to meet fishery requirements on MPC (Maximum Permissible Concentrations);
- Automation of cargo loading and unloading process to help avoid spills and spillages;
- The fuel berth will be equipped with automatic loading-unloading systems for oil products (cranes, equipped with emergency release system in case of unexpected tanker movement);
- Seaport maintenance will be performed by special service vessels for collecting of wastes, waste water and assistance in filling;
- Compliance with "Regulations on registration of oil relating operations, oil products and other substances, their mixtures, generated at vessels that may be harmful for health or marine environment" RD 31.04.17-97;
- Compliance with all regulating standard documents regarding safety of vessel navigation conditions;
- Usage of tankers with double hulls;
- Vessels to be equipped according requirements of International Association of Lighthouse Authorities;
- Alignment of navigation equipment specification with Head department of navigation and oceanography of RF;
- Coordination of routes, shipping areas and anchoring position in the area of Project responsibility.

The residual impact on the marine environment is evaluated to be **low** due to:

- Installation of an integrated waste water system for water discharged into seaport marine area;

- low water consumption.

For harbor vessels, bilge water during the operation period will be sent to specific treatment facilities planned as part of a seaport. Bilge water of vessels whose home port is other than Sabetta must be treated at their home ports facilities.

The waste water treatment facility at Sabetta seaport is to be discharged into Gulf of Ob. According to MARPOL73/78 Convention bilge water having hydrocarbon concentration of 15mg per litre after treatment are allowed to be discharged into the sea.

LNG carriers and condensate tankers will have segregated ballast tanks in order to minimise contamination of ballast waters. To minimise the risks associated with invasive species ballast waters exchange will be undertaken at the depth more than 1000m (.i.e. outside of the Gulf of Ob) as required under RF regulations.

The following measures will be implemented to prevent pollution of marine environment:

- usage of tankers with segregated ballast;
- no reparation or cleaning of ballast tanks at the territory of the sea port;
- control of vessel ballast waters according “Manual on regulation and control of vessels with ballast water and management of it to decrease transportation of harmful aquatic organisms and pathogens” (resolution A.868 (20) 2007)
- exchange of ballast water at sea depths of 1,000m (in the Kara sea)
- full compliance with RF legislation requirements and MARPOL73/78

The impact on marine environment of ballast waters is evaluated to be **low**.

Airport

Airport generated effluents will be removed via sewer and stormwater drainage systems. The volume of wastewater will be equal to the volume of consumed water and will amount to 25 m^3/day. Sanitary wastewater will be sent to accumulator tanks prior to wastewater treatment facilities at the Sabetta accommodation camp.

Surface runoff from potentially contaminated area (namely the vehicle washing, fuel storage, fuel servicing station and boiler house) areas will collected via drainage systems to holding tanks. Wastewater from vehicle washing operations will be treated at a block-structured treatment plant with a capacity of 1.5 m^3/hour. The plant will consist of a settling tank with a thin-layer coalescing module, an oil sorption boom and a sorbent filter. This plant will also receive melt/stormwater from the other potentially contaminated areas identified above.

Treated wastewater (suspended matters < 10 mg/l, oil products < 0.05 mg/l) will be reused for washing vehicles. A reused water system will be fed via a fire water pipeline. Non-contaminated stormwater from other airport areas will be discharged via gutters and ditches by gravity.

Wastewater from an aircraft de-icing site will be contained in two accumulator tanks with a capacity of 15 m^3 each. These wastewater will be mixed with storm/melted and sanitary wastewater and transported to Sabetta treatment facilities by dedicated pipeline (according to new project “Extension of Sabetta settlement”); the wastewater treatment system is designed to treat wastewater containing de-icing liquid pollutants.

Stormwater runoff from other areas of the airport will drain by gravity via drainage launders to ground.

Waste Facilities

Sanitary wastewater/process wastewater sewerage systems will be in operation at the landfill site. The volume of sanitary wastewater to be generated will be equal to the volume of consumed water and will amount to 25 m^3/day (1,606 m3/year). Sanitary wastewater will be contained in a septic tank prior to transport for treatment at the sewage treatment facility at the Sabetta camp.

Process wastewater will be generated at disinfection sites and in the course of steaming and sanitation of containers and garbage trucks. Process wastewater will be contained in tanks and will be re-used for watering waste layers to prevent fire incident during warm seasons.

Upper Fuel & Lubricants Store

Sanitary wastewaters (0.16 m^3/day) will be sent to an underground storage tank with a capacity of 5 m^3 installed on the Upper Fuel & Lubricants Store area, from where effluents will be regularly transported to effluent treatment facilities at the Sabetta accommodation camp.

A drainage system is planned to be constructed on the storage site to collect process surface effluents and stormwater with a total volume of 48 m^3/day (including effluents from technological sites with the containment bunding – 11.57 m^3/day, diked areas – 36.43 m^3/day) and melt/stormwater of 304.22 m^3/day (stormwater runoff from roads, pavements and building roofs). Melt/stormwater will be treated at a treatment facility with a capacity of 200 m^3/day. Treatment facilities will be capable of treating effluents with oil and other impurities.

Treated process wastewater and melt/stormwater from the Upper Fuel Store Facility (see Table 9.4.14) will be discharged to a nameless lake (which is does not fall under the official Russian Federation category of a water body of fishery significance). This lake is situated in the vicinity of the Upper Fuel Store.

Table 9.4.14: Chemical Composition of Treated Effluents at Nameless Lake Outlet

Contaminants	Concentrations prior to treatment, mg/l	Concentrations after treatment, mg/l	Efficiency of treatment operation, %
Suspended solids	400 to 600	3	99.5
Oil products	50 to 100	0.05	99.95

Pursuant to the regulatory document SanPiN2.2.1/2.1.1.1200-03, the tentative size of sanitary protection zone for the effluent treatment facility on the Store territory is 20 m.

The following mitigation measures will be implemented to minimise the impact to the Nameless Lake:

- Integrated treatment of storm/meltwater and technical water from the Upper Fuel Storage. (Storm and technological water from drilling sites 21 and 106 will be also treated at this treatment facility).
- Water discharged into the Nameless Lake will meet all requirements of the PSD.

Impact Assessment

The discharge of treated sanitary wastewater, process wastewater and stormwater from the Sabetta accommodation camp and other facilities to the Gulf of Ob will not significantly affect the chemical composition of the water.

Project wastewater treatment facilities are designed to ensure that discharges to surface waters comply with relevant Project Standards. The impact of discharges from the treatment facilities is therefore assessed as **Low**.

Impacts of wastewater discharges to injection wells are described in Section 9.5.

The waste water treatment facility is designed to withstand and function normally in the Project's climate conditions. All operating controls will be located within temperature controlled areas.

9.4.3.2 ACCIDENTAL DISCHARGES

In addition to wastewater discharges from the dedicated wastewater treatment plant, other sources of impacts from wastewater discharge to surface waters during the Project's operational phase include:

- unregulated surface water runoff from industrial sites, raw material storage sites and waste storage sites;
- contaminated water runoff from roads;
- accidental spillage of process liquids at industrial sites;
- leakage of harmful substances from tanks, pipelines or other equipment; and
- leakage along pipeline routes, especially in locations of watercourse crossings.

To mitigate contaminated stormwater runoff beyond the boundaries of industrial sites, the following measures will be implemented:

- bunding of well clusters around the periphery of 1 m in height, 0.5 m in width and bund slope of 1:1.5;
- construction of linings made of "Bentomat" geosynthetic sodium bentonite-based liners manufactured by the CETCO Company;
- protection of embankments inundated by waves through the application of different pitching techniques specific to a water body's hydrological regime (e.g. grass sowing in accordance with ECOS technology, use of "PRUDON-494" cellular geogrids with their subsequent filling with sand and crushed stone, etc.);
- lining of fuel store sites by applying sodium bentonite-based geotextile materials (geosynthetic needle-punched bentonite liners "Bentomat");
- bunding of bulk fuel storage tanks to provide at least 110% capacity of the largest tank within the bund;
- placement of chemicals and storage of bulk materials within sheltered containment;
- surface water discharge from well cluster sites to a drainage system connected to wastewater treatment facilities at the Sabetta accommodation camp; and

- waste water from an aircraft de-icing site will be accumulated in two tanks with a capacity of 15 m^3 each. Annual aircraft wastewater volumes are calculated as 48.6 m^3/year and will be transported to the wastewater treatment plant at Sabetta.

To mitigate impacts to surface water bodies from pipeline contamination in the event of an accidental spillage or a leak at crossing locations, it is proposed to equip pipelines with emergency valves. For specific crossings over the Salyamlekabtambada-Yakha and Sined'yakha rivers, the gas pipelines will be have gas valve units with vent stacks.

To mitigate impacts to surface water bodies from operational roads and bridges, the following measures will be implemented:

- water removal from the bridge roadway beyond a water protection zone via cross (20 ‰) and longitudinal (5 ‰) slopes and through a drainage barrier along the flooring edge;
- construction of drainage gutters in 7 m intervals along the roadway to disperse surface water runoff; and
- regular cleaning of roadways, bridges and adjacent territories.

With the application of the above mitigation controls, the impact/risk of accidental spills and potentially contaminated surface water run-off are assessed as **Low**.

LNG Plant

The LNG Plant is categorised as a hazardous industrial facility given that explosive and combustible substances (e.g. natural gas, methanol, gas condensate and petroleum products) will be present. Without mitigation, a hydrocarbon spillage incident has the potential to be highly mobile, migrating to adjacent territories and surface water bodies.

Emergency incidents may also occur at the LNG Plant that pose a risk to surface waters as a result of violations of technical codes e.g. the LNG or condensate shipping procedure, and external natural factors.

Emergency prevention/emergency response actions at designed facilities are described in Section 9.13**.**

Seaport

The Gulf of Ob will accommodate the movement of petroleum products, fuels & lubricants via loading/unloading at the proposed fuel berth. Each berth will be equipped with five cranes, among them three cranes will be used for the movement of liquid products.

To protect the marine environment during the operation of the seaport as associated vessels, the following mitigation and monitoring measures will be implemented:

- fuel unloading processes will be completely automated. A tanker with petroleum products will be unloaded via two automated cranes equipped with a secondary release system in the event of unexpected movement of a tanker;
- a fire-control (emergency) motor-operated valve with local and remote control will be installed at each filling line at a distance of 30 m from a crane. Valves will come into action within 120 seconds;
- ships will be serviced by dedicated service vessels for the collection of waste, wastewater and to aid refuelling);

- collection of ballast water will be possible for vessels shipping LNG and will be collected outside the sea port. Impacts associated with invasive species are assessed in Section 9.10.

In accordance with applicable guidance, all bilge water and sludge will be discharged to port reception facilities for further treatment except where ships are equipped with certified oily water separators (OWS), which may discharge treated water to sea in accordance with MARPOL 73/78 provisions. The permitted oil limit will be 0.05mg/l (most stringent Russian standard).

There is no designed discharge of waste water from vessels into the sea port water area or the Gulf of Ob.

SIDW Landfill

Potential impacts from leachate from the SIDW landfill are addressed in Section 9.7.

9.4.3.3 MAINTENANCE DREDGING

During the operational phase, maintenance dredging will potentially be undertaken by the seaport operator (Rosmorport) at the seaport and the approach channel as natural sedimentation processes occur over time. Sedimentation processes are summarised in Chapter 7 and indicate that both sedimentation and erosion processes occur in the approach and navigation channels, and sedimentation levels in the navigation channel have been assessed as less approximately 40cm per year. Requirements for the frequency of maintenance dredging will be monitored during the operation of the seaport.

The impacts of maintenance dredging will be similar to those assessed for the construction period (see Section 9.4.2.8). Impacts are expected to the short duration after each dredging activity and no enhanced cumulative impacts are therefore expected. With the application of the same mitigation measures described for the construction phase, residual impacts on marine waters associated with maintenance dredging are assessed as **moderate**. (Associated impacts on marine flora and fauna are assessed in section 9.10.)

9.4.4 SUMMARY

Table 9.4.15: Summary of Surface Water Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual impact
Well drilling – impacts to surface waters	Local water courses and water bodies: ▪ Nyakharvangotayakha River (Drill Site # 152-R) ▪ Venuymuyeyakha River (Site # 155-R) ▪ A nameless creek (Site # 157-R)	Construction	• Engineered erosion control measures applied to protection well pads in near vicinity of rivers (this applies to all well pads, including Site # 115-R); • Reduction of drilling mud volume (excess) through mud recycling; • Testing of drilling fluids (chemical reagents, materials) to verify compliance with requirements specified by technical documentation; • Secondary containment of fuel store sites, parking lots for vehicles and construction machinery, refuelling sites and sites designated for storage of bulk materials/reagents, such as hard pavement, bunds and settling tanks/ponds; • Bunding of working zones and sloping of ground surfaces to direct any spills towards a wastewater collection pit; • Construction of impermeable polyethylene lining beneath fuel storage tanks, spent fuel/lubricants storage tanks, derrick-drawworks units, boiler-houses, diesel power generators and stormwater/melt water accumulator tanks; • Lining of sites to be occupied by sewage accumulator tanks; • Dedicated containers for collecting solid food waste, garbage, and oily rags; • Lining and bunding of a horizontal flare pit designated for the technical “annealing” (heat process) of wells; • Collection of drill flush (e.g. in case of a pipe leak when hoisting equipment and connection to a closed loop circulation system); • Collection of drilling waste mud in special tanks; and • Washing drilling rig equipment using “open” steam in winter and minimal water volumes with discharge to an accumulator tank in summer.	Moderate reduced to **Low**

Table 9.4.15: Summary of Surface Water Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual impact
			• Minimise drilling fluids usage through treatment and recycling (see Chapter 4 for details); • Secondary containment (bunding) of sites of loose materials and chemicals storage; • Impermeable lining of areas where tanks for collecting sanitary water will be located.	

Ground surface levelling – disturbance to topography, fluvial processes and surface water contamination	Surface water bodies near construction sites of designed facilities (LNG plant, airport and auxiliary sites, camp, seaport, well pads), including Gulf of Ob and Nokhoyakha River	Construction	• Observance (monitoring) of working zone boundaries;
			• Prohibition of construction traffic outside of temporary and permanent access roads;
			• Prohibition of vehicle and machinery washing outside of specially equipped and contained areas;
			• Bunding of technical sites and lining with geosynthetic “BENTOMAT AS-100”;
			• Bunding of multiple well platforms (bund height 2 m; width 0.5 m; slope 1:1.5);
			• Lining of slurry pits and other technical pits;
			• Equip work areas and temporary buildings/structures with containers for collection of domestic and industrial wastes;
			• Timely removal of above wastes to landfill or recycling facility;
			• Direct sanitary wastewater and melt/storm water to treatment facilities at Sabetta accommodation camp.
			• Specific controls at the airport include:
			   ○ Performance of site preparation works in the winter period only (to minimise runoff)
			   ○ Removal of snow and ice to suitable remote areas (to prevent runoff during melt periods) prior to preparation works
				Moderate reduced to **Low**

Table 9.4.15: Summary of Surface Water Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual impact
Wastewater discharge – change in water quality	Fresh water bodies (lakes, bogs etc.)	Construction	• Sanitary waste water generated during well drilling, construction of LNG plant, main sea port, airport and landfill will be treated at existing waste water treatment plant at Sabetta prior to discharge to the bog; • Stormwater and wastewater from well construction is settled and filtered being pumped to treatment facilities at the Sabetta accommodation camp; • Quality of discharged water will satisfy all Project design standards.	**Low**
	Gulf of Ob		• There will be no discharge of waste water from vessels into the Gulf of Ob. Sanitary waste water and oil-containing bilge water from vessels, used during construction and delivery of cargo, will be collected by special bunker vessels according concluded contracts or transported to ports of registration and treated there.	**Low**
	Gulf of Ob, via common outfall	Operation	• Sewage and drainage facilities constructed at Sabetta camp will treat sanitary and process wastewater, melt water and potentially contaminated storm water. • Discharged wastewater quality will not exceed the sanitary norms established for water bodies of fishery significance and will meet all requirements of PSD (Project Standards Document); • Discharge outlet head designed to ensure mixing of treated wastewater with receiving waters; • Outlet located at a distance of 650 m from the shore in order to avoid coastal contamination; • Saline solutions will be diluted with other waste waters to mitigate the potential for localised raised salinity impacts at the discharge point.	**Low**
	Gulf of Ob, via seaport berth		• Low water consumption; • Installation of an integrated waste water system for water discharged into seaport marine area;	**Low**

Table 9.4.15: Summary of Surface Water Impacts and Mitigation Control				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual impact**
			• Treatment of potentially contaminated industrial, storm/melt and drainage waters from the seaport at a treatment facility designed to meet fishery requirements on MPC (Maximum Permissible Concentrations);. • Automation of cargo loading and unloading process to help avoid spills and spillages; • The fuel berth will be equipped with automatic loading-unloading systems for oil products (cranes, equipped with emergency release system in case of unexpected tanker movement); • Seaport maintenance will be performed by special service vessels for collecting of wastes, waste water and assistance in filling. • Compliance with “Regulations on registration of oil relating operations, oil products and other substances, their mixtures, generated at vessels that may be harmful for health or marine environment” RD 31.04.17-97.	
	Surface water bodies in the vicinity of the Upper Fuel Store		• Integrated treatment of storm/meltwater and technical water from the Upper Fuel Storage. (Storm and technological water from drilling sites 21 and 106 will be also treated at this treatment facility). • Water discharged into the surface water bodies will meet all requirements of the PSD.	**Low**

Table 9.4.15: Summary of Surface Water Impacts and Mitigation Control				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual impact**
Accidental discharges (run off, accidental releases)	Surface water bodies in vicinity of construction sites	Construction	To minimise washout of pollutants by storm/meltwater from construction sites to surface water bodies the following measures will be implemented: • Regular examination of construction machinery for satisfactory condition maintenance; • Refuelling of construction machinery will be performed directly from tankers at dedicated areas with concrete surface and water proofing; • Secondary containment for preventing of infiltration at storage areas of hazardous materials (like glues, paintings and others); • Secondary containment (bunding) of plots for fuel storage, vehicles parking area, filing stations and sites of loose materials and chemicals storage; • Bunding of work areas and surface levelling at drill units area to send water flow (e.g. from washing of equipment, storm and melt water) to waste water collector; • Protective bunding of settling pits in temporary storage of fuel areas, vehicles and construction machinery parking areas, filling stations and areas of loose materials and chemicals storage, for further collecting and clarifying of storm water prior to their transportation to waste water treatment plant at Sabetta; • Usage of impermeable polyfilm underneath storage containers for fuel, spent fuel and lubricants; hoist towers and drill winches, boilers, diesel power generators and reservoir for collecting of storm and melt water; • Use of impermeable septic tanks for temporary storage of sanitary waste water.	**Low**

Table 9.4.15: Summary of Surface Water Impacts and Mitigation Control				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual impact**
	Surface water bodies in vicinity of industrial area	Operation	• Bunding of well clusters; • Usage of geosynthetic liners (e.g. BENTOMAT); • Shoreline protection using different reinforcement methods according hydrological regime of certain water bodies; • Lining of fuel storage areas; • Bunding of bulk fuel storage tanks to provide at least 110% capacity of the largest tank within the bund; • Undercover storage of chemicals and bulk materials; • Injection of treated drilling wastewater and waste drilling mud (in case of rheological properties loss) in subsurface horizons with treated wastewater Surface water drainage from well clusters discharged to wastewater treatment facilities at Sabetta accommodation camp.	**Low**
	Gulf of Ob		• Fuel unloading processes will be completely automated. A tanker with petroleum products will be unloaded via two automated cranes equipped with a secondary release system in the event of unexpected movement of a tanker; • Installation of fire-control (emergency) motor-operated valve with local and remote control at each filling line at a distance of 30 m from a crane. Valves will come into action within 120 seconds; • Ships will be serviced by dedicated service vessels for the collection of waste, wastewater and to aid refuelling; Wastes and wastewater may also be transported to ports of registration and treated there • Automation of cargo loading and unloading process helps to avoid spills and spillages; • Fuel berth will be equipped with automatic loading-unloading system of oil products (cranes, equipped with emergency release system in case of	**Low**

Table 9.4.15: Summary of Surface Water Impacts and Mitigation Control				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual impact**
			unexpected tanker movement); • Compliance with all regulating standard documents regarding safety of vessel navigation conditions; • Usage of tankers with double hulls; • Vessels to be equipped according requirements of International Association of Lighthouse Authorities; • Alignment of navigation equipment specification with Head department of navigation and oceanography of RF; • Coordination of routes, shipping areas and anchoring position in the area of Project responsibility.	
Hydrotesting	Gulf of Ob	Construction	• No chemical additives will be required for the hydrotest water (hydrotesting will be undertaken during the warm season in order to remove the need for antifreeze). • Hydrotest water generated in the course of LNG and condensate tank hydrotesting will be routed to a temporary settling basin prior to discharge to the Gulf of Ob. Settled out solids from the settling basin will be disposed of to the SIDW landfill after dewatering. • Hydrotest to be generated in the course of pipeline and process equipment hydrotesting will be settled in the settling basin. Suspended solids content will need to meet the applicable 1000mg/l criteria prior to discharge to the treatment facility.	**Low**
	Fish and marine fauna		• Suction pipeline used for abstraction of hydrotest water will be fitted with fish protection device. See chapters 9.10 Fauna and 9.6 Water Abstraction.	**Low**

Table 9.4.15: Summary of Surface Water Impacts and Mitigation Control				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual impact**
Linear structure crossings – damage and contamination of the aquatic environment	Surface water bodies (rivers, lakes, flood lands) in the vicinity of gas, power, road & bridge crossings	Construction	• Construction and piling operations will be carried out during the low water period; • Foundations will be constructed using piling methods allowing for frozen soil layers under foundations and preventing disturbance of existing land runoff processes (auger piling will be utilised in all cases where technically feasible); • Where culverts are used for river/stream crossings the location, length and diameter of pipes are determined by a calculated rate of water flow to prevent flooding of adjacent land; • Temporary by-pass roads will be removed once culvert pipes are in place; • Road embankments will be reinforced by geo-grids filled with crushed stone and peat; • Sediment controls measures including silt fencing will be used during earthworks in the vicinity of surface waterbodies where necessary; • Bridge supports will not be constructed within river beds; and • Bridge construction sites (for temporary accommodation camp and machinery) will be located on the left-hand bank of the Sined'yakha River and on the right-hand bank of the Salyamlekabtambada-Yakha River.	Low, remaining Low
		Operation	*Culverts through water courses:* • Pipelines will be equipped with emergency valves; • Gas pipelines crossings the Salyamlekabtambada-Yakha and Sined'yakha Rivers will be equipped with gas valve units with vent stacks. *Road-bridge crossings of water courses:* • Construction of carriageway with drainage gutters at intervals of 7m to disperse surface water runoff; • Regular cleaning of roads, bridges and adjacent territories;	**Low**

Table 9.4.15: Summary of Surface Water Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual impact
			• Water diversion from the bridge roadway and beyond WPZ using cross (20‰) and longitudinal (5‰) slopes and through a drainage barrier along the flooring edge.	
Landfill construction – surface water contamination	Salyamlekabtambad-Yakha River valley Sabettayakha River Nearby thermokarst lake	Construction	• Regular inspections of construction machinery to ensure they are in good working order; • Refuel construction machinery directly from a refuelling truck at specially designated sites with hard paving and impermeable lining; • Use of secondary containment to prevent release of hazardous substances at storage areas (e.g. adhesives, paints and other materials); • Undertake the main construction operations and earthworks in the winter season; and • Use of watertight septic tanks for the temporary storage of liquid sanitary waste on location until removal to the treatment facilities at the Sabetta accommodation camp.	**Low-Moderate**
	Nearby surface waterbodies	Operation	• Mitigation measures to minimise operational impacts are shown in Section 9.7.	

Table 9.4.15: Summary of Surface Water Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual impact
Dredging activities	Gulf of Ob	Construction and operation	• Perform loading of trailing suction hopper dredgers (TSHDs) using environmental and cost-effective technologies; • to perform unloading of scows and TSHDs at dumping point after their complete stop; • Bring dredge bucket down to the water at the hold of scow as close as possible to avoid spillage of sludge; • Dredge bucket should be 75 % full to prevent spillage of soil back to water; • Perform chemical and analytical monitoring of water quality at the Gulf of Ob before, during and after dredging activities; • Perform constant control of underwater activities;	Moderate remaining **Moderate**
Ballast water	Gulf of Ob	Construction and operation	• Usage of LNG and condensate tankers with segregated ballast; • No reparation or cleaning of ballast tanks at the territory of the sea port; • Control of vessel ballast waters according “Manual on regulation and control of vessels with ballast water and management of it to decrease transportation of harmful aquatic organisms and pathogens” (resolution A.868 (20) 2007); • Exchange of ballast water at sea depths of 1,000m (in the Kara sea); • Full compliance with RF legislation requirements and MARPOL73/78.	
		Operation	• Collection of ballast water will be possible for vessels shipping LNG and will be collected outside the sea port.	

Table 9.4.16: Summary of Surface Water Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
Well drilling	Construction	Gas field Fuel stores, parking lots, refuelling sites, storage sites, bunds, tanks, settling ponds. Two monitoring stations per cluster	Drill fluids (chemical reagents)	Weekly
			Visual observations	Daily
			Surface water and sediment for chemical parameters including TSS and total hydrocarbons	Baseline (prior to drilling) and annual until completion of drilling
Ground surface levelling for Facilities	Construction	Working zone boundaries	Visual observations	Daily
Waste water discharge from facilities and sites – Existing Treatment Facilities	Construction	Network of drainage pipes at construction area. Operating waste water treatment facility at Sabetta Outlet of water from Sabetta into the Nameless bog	Suspended solids and oil products	Monthly during warm period of the year
			Chemical and organoleptic parameters: • Odour, transparency, colour, temperature, pH, dry residue, COD, BODtot, suspended solids, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, sulphates, chloride, iron, copper, phosphates, synthetic surfactants, petroleum hydrocarbons, methane, phenol and dissolved oxygen.	Quarterly
			Sanitary-epidemiological water	Quarterly

Table 9.4.16: Summary of Surface Water Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
			studies: total coliform bacteria, thermotolerant coliform bacteria, coliphages, enterococcus, pathogenic microflora.	
Waste water discharge from facilities and sites – New Treatment Facilities	Construction & Operation	• Network of drainage pipes. • New treatment facilities at Sabetta • Treatment facilities at the Upper Fuel Storage • Outlet of treated water from integrated treatment facility at Sabetta and sea port into the Gulf of Ob • Outlet of water from the Upper Fuel Storage into the Nameless Lake • Treatment facilities for melt / stormwater from potentially contaminated areas at the airport • Monitoring points at discharge outlet, upstream (500m) and downstream (500m) of the discharge outlet.	Range of parameters to comply with MPC for water bodies of fishery significance. The sanitary wastewater will comply with SNiP 2.04.03-85 (BOD – 370 mg/l, suspended solids – 320 mg/l, nitrogen ammonia – 39.5 mg/l, phosphates – 16.5 mg/l, chlorides – 44.3 mg/l, and surfactants – 12.3 mg/l). Receiving waterbodies to be analysed for: odour, transparency, colour, temperature, pH, dry residue, COD, BODtot, suspended solids, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, sulphates, chlorides, iron, copper, phosphates, synthetic surfactants, petroleum hydrocarbons, methane, phenol and dissolved oxygen.	Monthly during warm period the year
			Sanitary-epidemiological water studies: total coliform bacteria, thermotolerant coliform bacteria, coliphages, enterococcus,	Quarterly

Table 9.4.16: Summary of Surface Water Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
			pathogenic microflora.	
Hydrotest waste water	Construction	Point of discharge	Parameters of discharged water and water receiving body: • Suspended solids • Petrochemicals • Phenols • Dissolved oxygen • pH	Waste water – prior to discharge, Receiving water – prior to and following discharge
Dredging	Construction	Gulf of Ob – 19 stations in the dredging work area (sampling points as per water sampling)	Hydrological factors: current velocity and direction, water temperature vertical profile, water salinity vertical profile, water transparency and water turbidity vertical profile. During dredging and storage of dredged material, monitor suspended solids in natural waters (vertical turbidity distribution) as well as the following hydrochemical parameters: temperature, odour, colour, dissolved oxygen, % dissolved oxygen saturation, pH, Eh, biochemical oxygen demand (BOD5), chemical oxygen demand (COD), chlorides, sulphates, salinity, dry residue, total petroleum hydrocarbons, metals (copper, zinc, nickel, lead, cadmium, cobalt, mercury, chromium, arsenic, manganese, iron total), suspended	Every year during dredging activities: • Once prior to start of dredging • Twice during dredging • Once upon completion of dredging
	Operational (on demand)	Sampling point locations are defined every year depending on the dredging area		

Table 9.4.16: Summary of Surface Water Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
			solids, biogenic elements (total phosphorus, total nitrogen, nitrites, nitrates, ammonium ion, phosphates), phenols, benzo(a)pyrene, PCBs (selectively), organochlorine pesticides (selectively). Monitoring of bottom sediments for: • Physical and mechanical properties: granulometric structure, loss of ignition, dry unit weight. • Chemical parameters: petroleum hydrocarbons (total), heavy metals (mercury, copper, zinc, chromium, nickel, lead, cadmium) and arsenic, benzo(a)pyrene, PCBs and OCP. • Radiological characteristics • Sanitary-epidemiological parameters: total coliform bacteria, E.coli, coliphages, enterococci and staphylococci. Use of sediment traps for analysis of physical, mechanical and chemical parameters.	
Linear infrastructure crossings (pipes,	Construction & Operation	During construction – Each monitoring station at each crossing to include 3 checkpoints: 1) maximum	• Visual inspections of water body beds, banks and floodplains. • Current velocities and water	During construction period – once. prior to construction works;

Table 9.4.16: Summary of Surface Water Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
roads and power lines)		possible impact; 2) 100-200m downstream; 3) background-upstream or outside construction area of influence.	levels. • Parameters of natural water: o Suspended solids o Petrochemicals o Phenols o Dissolved oxygen o pH • Hydrochemical monitoring for a range of parameters including: odour, transparency, colour, temperature, pH, dry residue, COD, BOD, suspended solids, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, sulphates, chlorides, iron, copper, phosphates, synthetic surfactants, petroleum hydrocarbons, phenols, dissolved oxygen, conductivity and hardness. • Sanitary-epidemiological water studies (total coliform bacteria, thermotolerant coliform bacteria, coliphages, enterococcus, pathogenic microflora) must be undertaken in accordance with SanPiN 2.1.5.980-00 'Hygienic requirements to surface water protection'.	during construction; after completing construction. During operation – every year at summer period of low water level.

Table 9.4.16: Summary of Surface Water Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
Seaport	Construction & Operation	Gulf of Ob	Physical impact measurement stations at the SPZ boundary of the sea port.	Quarterly during navigation period
Landfill	Operation of the landfill facility	Edge of the Salyampekabtambad-Yakha River valley Surface water monitoring points within landfill SPZ: (1) Nameless lake, 290m NE of landfill boundary (2) Nameless lake, 195m NW of landfill (3) Nameless stream, 375m SW (4 and 5) Nameless stream, 500m S (6) Nameless stream, 500m N.	Leachate – ammonia (nitrates and nitrites) Chemical parameters of filtration and groundwater runoff: Leachate – ammonia (nitrates and nitrites)	Weekly during spring (after snow recession) and summer
			Sanitary and epidemiological parameters: total coliform bacteria, E. coli, coliphages, enterococci and staphylococci, pathogenic microflora.	Once during summer
Waterlogging and flooding	Operation of all facilities	All project facilities	• Total area covered by the process (m2); • Growth/reduction rate of waterlogged (flooded) areas compared to previous monitoring period; • Waterlogged (flooded) area growth rate (cm/year); • Groundwater levels within	Once after construction

Table 9.4.16: Summary of Surface Water Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
			waterlogged area distance from pipeline, (m); • Impact on top soil and vegetation; • Process frequency (feature/year).	

9.5 GROUNDWATER

9.5.1 INTRODUCTION

The water-bearing groundwater strata of the Yamal Peninsula are subject to special protection. The analysis of hydrogeological conditions within the Project Licence Area is indicative of a low level of protection of the upper aquifer which is confined to modern lacustrine-paludial deposits. Deeper aquifers are shielded by permafrost rocks and they are reasonably protected from migration of contaminants from the ground surface.

9.5.2 CONSTRUCTION

During the construction phase the most potentially significant sources of impacts on groundwater relate to:

- Potential chemical/hydrocarbon spills and potentially contaminated runoff waters during construction activities and from storage areas;
- Well drilling;
- Leachate from the Project Solid, Industrial and Domestic Waste (SIDW) landfill.

Impacts associated with landfill leachate are assessed in Section 9.7 and are not discussed further in this section.

Impacts associated with chemical/hydrocarbon spill risks and potentially contaminated runoff waters may lead to significant impacts on the groundwater environment unless suitably mitigated. Mitigation controls to be implemented during construction include:

- carrying out of all operations only within boundaries of land plots allocated for construction works;
- hard paving (resistant to hydrocarbons) of parking lots for vehicles and machinery, refuelling sites, and fuel storage sites;
- provision secondary containment and bunding for all liquid chemical and hydrocarbon storage and bulk loading areas;
- use of drip trays under mobile equipment during re-fuelling;
- collection of storm water/surface water runoffs and sanitary wastewater in special water-proof tanks with further transportation of effluents to treatment facilities in the Sabetta accommodation camp (see Section 9.4 for further details).

Further facility-specific spill control measures are identified in Section 9.4. In addition, a full suite of pollution prevention measures will be described in Project Environmental and Social Management Plans (see Chapter 14 for further details). With the adoption of these mitigation controls, residual risks to groundwater from spills are assessed as **Low**.

Well drilling poses a potentially significant source of adverse impact on water-bearing strata from loss of drill fluids during either drilling or drill fluid re-injection. These risks will be mitigated through:

- casing of the well
- monitoring of the drill mud (quality and pressure)

- minimisation of drilling mud volumes through multi-stage treatment and re-use (see also Section 9.7 for further details).

The application of the above measures will both reduce the likelihood of drill fluid loss occurring to **Possible** and also the potential volumes that may be lost, hence reducing the severity of any loss to **Moderate**. Overall, the residual risk to groundwater from well drilling is therefore assessed as **Low**.

9.5.3 COMMISSIONING AND OPERATION

Potential impacts to groundwater during the commissioning and operation phases include:

- Potential chemical/hydrocarbon spills and potentially contaminated runoff waters from process and storage areas;
- Well drilling;
- Leachate from the Project Solid, Industrial and Domestic (SIDW) landfill;
- Injection of wastewater into deep formations.

The impacts and risks associated with the above activities are similar to those during the construction phase and hence mitigation controls and assessed impact/risk levels are the same. The exception is injection of wastewater into deep formation, which will only occur during the operational phase.

Injection of wastewater relates to wastewater generated from the operation of the LNG Plant as well as waste drilling mud in case of rheological properties loss, domestic and sewage waters. The wastewater is first treated and will then be injected into the Maressalinsk deep water-bearing complex (aquifer).

The following supporting documentation has been received by Yamal LNG:

- Positive expert conclusion # 062.12-3C dated 09/26/2012 West-Siberian department of FBU “GKZ” of Ministry of Natural Resources and Environment of the Russian Federation for the project on geological study of subsurface resources “Geological investigations for justification of disposal of solid and liquid drilling waste, industrial and sanitary wastewater in subsurface at the area of South Tambey Licence area”

- Amendment to the licence SLKh 15365 for use of subsurface resources in order to performing geological survey for assessment of capability for industrial and sanitary wastewater disposal at South Tambey Licence area.

A wastewater injection well will be located in the vicinity of the WWTP near the LNG site. The feasibility of waste water injection (well location and design) has been assessed to ensure that:

- the depth of water-bearing strata is the most acceptable for injection operations in terms of preliminary engineering economic considerations;
- the water-bearing complex is of no practical value for abstraction of potable water or mineral medicinal groundwater; and
- the lithological structure and filtration-capacity properties of the water-bearing strata are favorable for receiving the injection of sizable amounts of effluents into deep formation.

Based on the application of the mitigation controls and considering the pre-treatment of wastewater prior to injection, the environmental impacts of wastewater injection are assessed to be **Low**.

9.5.4 SUMMARY

Table 9.5.1: Summary of Groundwater Impacts and Mitigation Control

Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
Chemical/hydrocarbon spills to groundwater	Groundwater	Construction and operation	Mitigation controls to be implemented during construction include: • carrying out of all operations only within boundaries of land plots allocated for construction works; • hard paving (resistant to hydrocarbons) of parking lots for vehicles and machinery, refuelling sites, and fuel storage sites; • provision secondary containment and bunding for all liquid chemical and hydrocarbon storage and bulk loading areas; • use of drip trays under mobile equipment during re-fuelling; • collection of storm water/surface water runoffs and sanitary wastewater in special water-proof tanks with further transportation of effluents to treatment facilities in the Sabetta accommodation camp (see Section 9.4 for further details). • Further facility-specific spill control measures are identified in Section 9.4. In addition, a full suite of pollution prevention measures will be described in Project Environmental and Social Management Plans (see Chapter 14).	**Low**
Loss of drill fluids to groundwater strata	Groundwater	Construction and operation (drilling and drill fluid re-injection)	These risks will be mitigated through: • casing of the well • monitoring of the drill mud (quality and pressure) • minimisation of drilling mud volumes through multi-stage treatment and re-use (see also Section 9.7 for further details).	**Low**

Table 9.5.1: Summary of Groundwater Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
Injection of waste water to groundwater strata	Groundwater	Operation	These risks will be mitigated through: • pre-treatment of wastewater prior to injection • Selection of the well location and design to ensure that: - the depth of water-bearing strata is the most acceptable for re-injection operations in terms of preliminary engineering economic considerations, - the water-bearing complex of no practical value for abstraction of potable water or mineral medicinal groundwater, - the lithological structure and filtration-capacity properties of water-bearing strata are favorable for receiving the injection of sizable amounts of effluents into deep formation.	**Low** (further evaluation will be undertaken following completion of the injection well design.)
Leachate from landfill	Groundwater	Operation of the landfill	See Section 9.7	See Section 9.7

Table 9.5.2 Summary of Groundwater Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
Landfill leachate	Operation of the landfill	See Section 9.7	See Section 9.7	See Section 9.7
Groundwater from wastewater injection wells	Operations (Operation of wastewater injection	Aquifer intended for wastewater injection, within calculated radius of influence.	pH, hydrocarbons, alkalinity (as $CaCO_3$), biochemical oxygen demand, chemical oxygen demand, arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, manganese, tin, zinc, phosphate, phenols, cyanide (free and total), sodium, potassium,	Once per year.

Table 9.5.2 Summary of Groundwater Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
	wells)		calcium, magnesium, electrical conductivity, chloride, sulphate and iron.	

9.6 WATER SUPPLY

9.6.1 INTRODUCTION

This section discusses the impacts of the Project's water supply needs. Water intake at the initial stage of construction will be performed from an existing source in the Sabetta settlement (Glubokoye Lake), which is situated at a distance of 300 m from the west shore of the Gulf of Ob and adjacent to the Sabetta accommodation camp (the camp is at the perimeter of the lake's water protection zone). The surface water area of the lake is 113,270 m^2 and the lake volume is approximately 178,270 m^3. The chemical composition of the water does not currently comply with SanPiN 2.1.4.107-01 regulatory requirements and water can be used for drinking only after appropriate treatment.

An aboveground water abstraction facility, with a capacity to abstract 296.5 m^3/day, was constructed in the southern part of the lake in 2003. There is an existing agreement for water abstraction up to 212,330 m^3/year. The volume of abstracted water is metered. Abstracted water is treated at an ozone treatment installation with the capacity of 240 m^3/day.

After this initial period, abstraction from the Glubokoye will cease and water will then be abstracted from an artificial pond ('Pit 202') near Sabetta (a water abstraction license was obtained in 2013 to abstraction up to for 154,000m^3 per year from Pit 202). Water from Pit 202 will be treated at the existing ozone treatment installation. Satellite contractor camps will be supplied with water for potable, sanitary and technical needs from Pit 202.

All water abstraction locations are fitted with fish protection devices. Water will be transported from Sabetta to construction sites by road tankers (which will be heated in winter).

In the future, to coincide with operations phase water demands (domestic water and production fire-fighting water demand), the construction of a unit for surface water intake from the Gulf of Ob is envisaged as a source of water supply for the Project that will comprise:

- water treatment facilities, including a 2,500 m^3/day capacity water treatment plant;
- water supply pump station;
- a 8,000 m^3/hour capacity fire water pump station with fire water reserve tanks;
- separate water supply systems for domestic and drinking water, for plant and fire water, independent firewater supply system.

The water intake portals will be equipped with a fish protecting device to prevent entrainment of fish and shellfish. A water treatment system, inclusive of filtration, coagulation processes and a desalination unit is also planned.

Additional water abstraction licenses have been in 2013 for the artificial Pit 212 that may be used if necessary (a licence to abstract up to 44 000 m^3 per year was granted in 2013, with allowance for increase in future)

There is no existing water supply in place at the Upper Fuel Storage site.

9.6.2 CONSTRUCTION

9.6.2.1 WELL FIELDS AND SABETTA ACCOMMODATION CAMP

As it is noted above, during the construction period the water supply for the Sabetta camp is provided using the existing system from the Lake Glubokoye. However, as the number of staff will be significantly increased, it is planned to expand the accommodation camp and other critical infrastructure based on demand to provide the accommodation for 5200 people. In order to organize uninterrupted water supply of staff living in the camp, hydrological and hydrochemical surveys were carried out to select additional sources for the accommodation camp water supply. In addition to Pits 202 and 212 mentioned above, the following other potential water sources have been identified:

- Artificial Pit 201 - previously abandoned quarry No.201 with water volume of 637.67 m^3 (water agreement pending);
- Artificial Pit 218 - previously abandoned quarry No.218 with water volume of 183.32 m3 (water agreement pending).

When developing the South Tambey gas condensate field and constructing accommodation camps, construction workers will be supplied with imported bottled potable water. The imported water quality will comply with relevant Project Standards (see the Project Standards document in Appendix 2). Satellite contractor camps will be supplied with water for potable, sanitary and technical needs from Glubokoye lake. Water will be transported from Sabetta to construction sites by road tankers (which will be heated in winter).

Process water for construction activities, drilling operations, hydrotesting, etc. will initially be supplied from the existing water abstraction facility at Lake Glubokoye (see above) and unnamed lake 202. Alternative additional water supply sources and fire water sources will be as follows:

- for well 152-R – a lake situated at a distance of 50 m eastward of a design site (latitude 71°25'35" North, longitude 71°50'58" East); the lake is about 2 m deep, its surface water area is 8,000 m^3.
- for well 157-R – a lake situated at a distance of 1 km south of a design site (latitude 71°12'19" North, longitude 71°46'56" East); the lake is more than 2 m deep; its surface water area is 150,000 m^3.
- A small lake to the east of the Sabetta.

All water abstraction facilities are fully permitted and are equipped with fish protection devices (a metal net with a mesh of 2 mm in diameter). Water is abstracted once or twice a day (depending on necessity). The volume of abstracted water will be recorded in a dedicated logbook.

Water to be used in the course of well drilling operations will be consumed for:

- washing fluid preparation;
- cement;
- washing vibrating screens work areas; and
- cooling drilling-rig drives and hydraulic brakes.

The duration of well construction operations is provided in Table 9.6.1.

Table 9.6.1 Well Construction Duration

Well cluster number	Duration of construction operations (hour)
7	188
25	94
30	94

Table 9.6.1 Well Construction Duration	
Well cluster number	**Duration of construction operations (hour)**
39	283
43	94
44	377
45	94
46	283
47	377

The total water requirement over the whole period of one well construction will amount to approximately 5,700 m^3, of which approximately 4,350 m^3 will be for process needs (including boiler-house operation), 1,150 m^3 for sanitary and drinking needs, and 200 m^3 for fire water reserve.

Fire water will be stored in four storage tanks with the capacity of 50 m^3 each and will be located at each well drilling site.

9.6.2.2 LNG PLANT

During construction of the LNG Plant and its infrastructure, workers will be accommodated in the existing Sabetta camp which is equipped with water supply and effluent discharge systems (see section above).

Water will be consumed for potable, sanitary, process and fire suppression needs, as well as for testing of pipelines and tanks. Drinking water will be delivered in bottles on the basis of 25 l/day for one person[16]. The volume of sanitary water required is approximately 480 m^3/day. A volume of 300 m^3/day water will be needed for construction processes.

In the initial stages of pre-commissioning, water for hydrotesting of LNG Plant tanks and pipelines will be sourced via the existing water abstraction facility at the Sabetta accommodation camp. When pre-commissioning the LNG Plant, water will be supplied from temporary water supply/wastewater discharge systems, including:

- temporary facility for water abstraction from the Gulf of Ob;
- temporary water pump station; and
- a quick-disconnect pipeline network.

Hydrotesting operations will be performed sequentially. After testing, water will be loaded into tanks. The volume of water to be consumed during LNG Plant tank hydro testing will be approximately 10,000 m^3. It is expected that one LNG tank will be loaded and unloaded over a 16-day period.

[16] Plastic bottles will be recycled similar to other plastic waste or, if suitable recycling rouitesare not available, will be disposed of to SIDW landfill.

The optimal capacity of temporary mobile water abstraction facilities (a truck-mounted pump station) is 10,000 m^3/day (116 l/s). The pump station will be equipped with a suction pipeline fitted with a fish protection device, a pump with an electric motor drive or a diesel-engine drive and quick-disconnect pressure pipelines 300 m in length.

9.6.2.3 SEAPORT

Sanitary water for worker facilities at the seaport will be delivered by tanker from Sabetta. A volume of 2.23 m^3/day will be required. Water for ships to be involved in construction operations will be supplied by bunkering vessels on a contractual basis. Necessary firewater reserves will be abstracted directly from the Gulf of Ob. Potable water will be delivered through imported bottled water.

9.6.2.4 AIRPORT

During construction of the airport, water supply and wastewater removal will be performed in the same manner as for other construction sites. Water will be imported from external sources and wastewater will be contained in tanks prior to transport for treatment at the Sabetta accommodation camp facility.

9.6.2.5 WASTE FACILITIES

During construction of the landfill, water will be supplied for drinking, sanitation and hydro testing. As per other construction site, drinking water will be delivered in bottles on the basis of 25 l/day for one person. The total volume of water required for the whole period of landfill construction is calculated at 706.34 m^3.

9.6.2.6 IMPACT ASSESSMENT

Water abstraction during the construction phase will be from existing abstraction sources (Lake Glubokoye), and abstraction rates will remain within existing permit limits. In addition, continuous monitoring of the water level in Glubokoye lake is undertaken in order to prevent excess drawdown of the lake. As such impacts on the recharge of Lake Glubokoye will remain unchanged from existing activities and are assessed as **Negligible**. Impacts related to water abstraction from other water supply sources mentioned in section 9.6.2.1 will be assessed as part of the “Extension of Sabetta accommodation camp of Yamal LNG” project as it is developed.

In order to mitigate potential abstraction impacts on aquatic fauna, all abstraction points will utilise fish protection systems. With the application of these controls, and on the basis that the water is abstracted from artificial pits (former quarries) of low ecological value, impacts on aquatic fauna will be highly localised and of low severity and are therefore assessed to be of **Low** significance.

9.6.3 COMMISSIONING AND OPERATION

9.6.3.1 DESALINATION PLANT

During the operational phase water for sanitation and processing will be supplied from a water abstraction facility located on the Gulf of Ob. The water abstraction facility is designed to operate in a cold climate and will comprise a submerged two-section type design. The volume and rate of water abstracted will be metered. Water abstraction pipe heads will be equipped with protection devices to prevent harm to fish species and other aquatic organisms.

Raw water treatment for potable needs will be undertaken at treatment facilities with a capacity of 5,000 m^3/day (3,000 m^3/day for needs of the LNG Plant and 2,000 m^3/day for accommodation camps – see below). Treated water will be stored in tanks, from where water will be delivered to workers.

Water treatment facilities will comprise two interchangeable lines that operate in parallel with a capacity of up to 1,500 $m^{3/}$day for process water and fire water supply and 500 m^3/day for sanitary water and potable water supply. Each line consists of three block-structured modules. These modules provide physical and chemical treatment, desalination, and potable water production. All pipelines rest on supports to protect against freezing and to protect the permafrost. After physical and chemical treatment, water will be reserved for fire suppression systems at LNG Plant industrial sites, inlet facilities and stable condensate store.

After desalination, water will be used in the process water/fire water supply system for LNG Plant's sites and infrastructure facilities (including an electrical power plant and other units). Treated water from the third module will be used for potable water supply to accommodation camps for construction people and plant operators, the LNG Plant and other consumers as necessary.

Pursuant to SanPiN 2.1.4.1110-02 regulatory requirements, a sanitary protection zone must be established for water abstraction facilities. The width of the first sanitary belt is 100 m in all directions along the water abstraction area and along the adjacent shore from the water line during the summer-autumn low water level. The second sanitary belt boundary runs at a distance of 3 km on both sides and at a distance of 500m from the water line under the normal water level. Boundaries of the 2nd and 3rd sanitary belts along the shore coincide with a water protection zone of the sea of 500 m wide from the high tide line where economic or other activities are restricted. A diagram of the sanitary protection zone is shown in Figure 9.6.1.

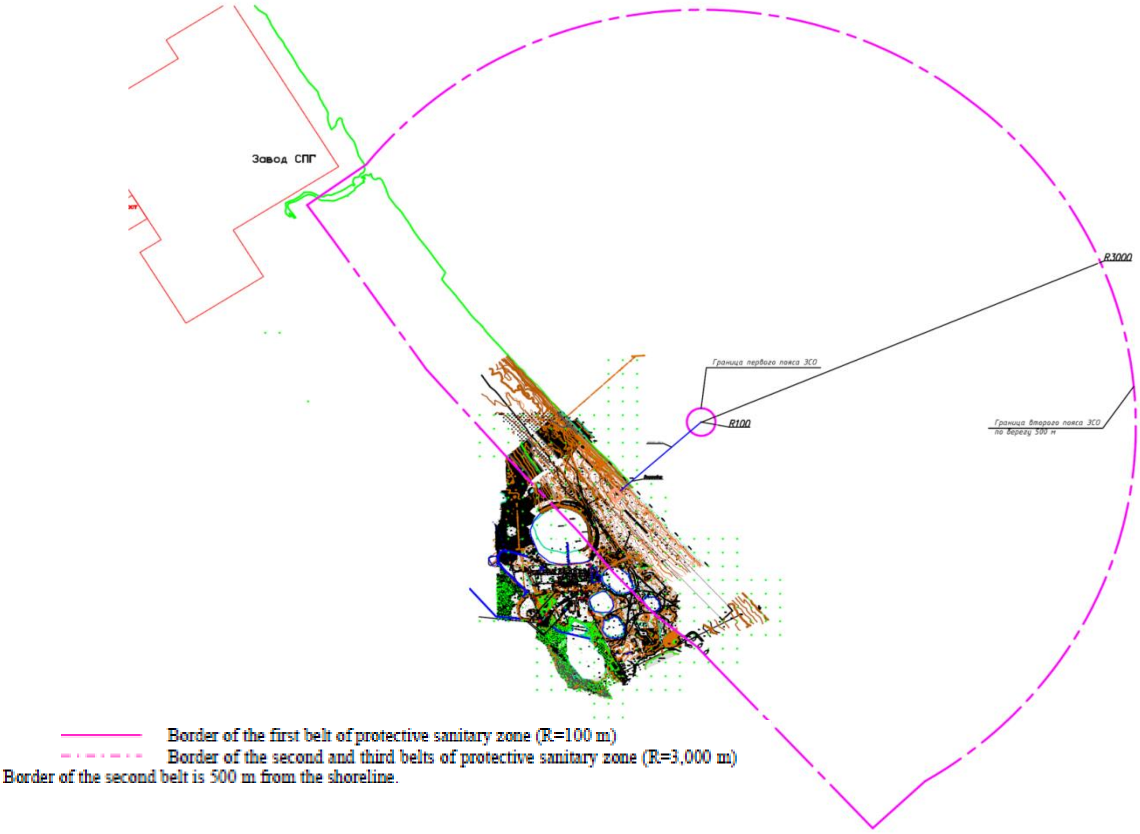


Figure 9.6.2: Protective sanitary zone for water supply in the Gulf of Ob

Waste water (brine) from the desalination will be discharged to the Gulf of Ob. The brine will be co-mingled with treated sanitary waste water of a much lower salinity prior to discharge via a common outfall in order to reduce the overall salinity of the discharge. Given this level of pre-dilution and the natural variation in salinity in the Gulf of Ob, no significant salinity impacts are anticipated.

9.6.3.2 WELL FIELDS AND ACCOMMODATION CAMPS

During the operational phase of the Project, water for sanitation and processing will be supplied to the accommodation camps from a water abstraction facility to be sited on the Gulf of Ob, with potable water being first treated in the desalination unit (see above).

The water facilities system will supply 3,500 people, with a future expansion of up to 5,200 people. The calculated volume of water consumption during full-scale operation is 1,899.5 m^3/day, including fire water reserves. The water temperature in the water supply system will be maintained at no lower than 5ºC above zero whereas open air temperatures may reach 53ºC below zero. Hot water will be generated by a designated boiler-house.

Fire water reserves will initially be abstracted from the Gulf of Ob and the replenished using recycled water (see Section 9.4). Additional pumps will be installed at water abstraction facilities to replenish fire water reserves (486 m^3) within 24 hours if necessary.

9.6.3.3 UPPER FUEL & LUBRICANTS STORE

During the operational phase, potable water will be delivered to the Upper Fuel & Lubricants store (hereinafter referred to as "the Store") in plastic bottles by vehicles (5 litres per person) on a daily basis.

Water for fire reserves will be abstracted from a nearby nameless lake situated at a distance of 350m south of the Store. The lake is 1.5 m deep, which is assessed as being sufficient to avoid full freezing and to provide year-round firewater. The water abstraction facility will be equipped with fish protection filtering devices and water consumption will be metered. Given the infrequent abstraction required, the impact on the lake is assessed as **Low**.

9.6.3.4 LNG PLANT

The LNG Plant and its infrastructure will be supplied with water from the abstraction facility on the Gulf of Ob, with potable supplied from the desalination unit (see above) A separate fire water supply loop system will be constructed at the LNG plant consisting of a pump station, fire water storage tanks (two tanks with a capacity of 20,000 m^3 each) and in-site ring fire water supply networks.

Other LNG Plant facilities will be supplied with water from two separate water supply systems: a sanitary/potable water supply system; and a process/fire water supply system.

The maximum volume of water consumption at the operational phase of the Plant will amount to 2,722.5 m^3/day, including 541.7 m^3/day of potable water for sanitary needs, 980.7 m^3/day of raw water for process needs and 1,200.1 m^3/day of reused water for process needs.

9.6.3.5 SEAPORT

A sanitary and fire water supply system will be in operation at the sea port. Potable water will be imported from Sabetta and stored in tanks. Hot water for administrative buildings will be generated by boilers. Ships will not be supplied with potable water from the seaport.

A fire water supply system will be fed from the abstraction facility on the Gulf of Ob (see above).

9.6.3.6 AIRPORT

During the operational phase, the airport and its infrastructure will be supplied with water from the Sabetta accommodation camp. Tanks with two-day water reserve capacity will be installed in each airport building. Hot water will be produced with the use of boilers. Imported process water will be stored in tanks and be used, among other needs, for fire suppression.

9.6.3.7 SIDW LANDFILL

During SIDW landfill operation, water will be used for sanitary, drinking, process and fire suppression needs. Sanitary and potable water for the personnel will be delivered in bottles at the rate of 25 l per person per day.

Process water from the LNG Plant will be transported by tanker and be stored in fire water storage tanks. This water will be used for watering of landfill sections with disposed solid domestic wastes and industrial wastes, if required, in addition to fire suppression (161.5 m^3 over the whole operational phase).

9.6.3.8 IMPACT ASSESSMENT

Water abstraction during the operation phase will mainly be from the Gulf of Ob. In order to mitigate potential abstraction impacts on aquatic fauna, all abstraction points will utilise fish protection systems. With the application of these controls, impacts on aquatic fauna will be highly localised and of low severity and are therefore assessed to be of **Low** significance.

Water for fire reserves at the Upper Fuel and Lubricant Store will also be abstracted from a nearby nameless lake situated at a distance of 350m south of the Store. The total volume of the lake is 24,000m^3 and the total volume required for abstraction is 486m^3. This is not expected to have a significant effect on the recharge of the lake and hence the impact is assessed as **Low**.

9.6.4 SUMMARY

Table 9.6.2 Summary of Impacts from Water Abstraction and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
Recharge of lakes	Lake Glubokoye	Construction	• Maintain abstraction rates to existing levels and within existing permitted levels • Monitoring of the water level to prevent excess drawdown of the lake.	**Negligible**
	Artificial pits	Construction	• The water abstraction facility will be equipped with fish protection filtering devices and water consumption will be metered	**Negligible**
	Un-named lake adjacent to Upper Fuel storage area	Construction & Operation	• Water extraction only in case of firefighting reservoir filling • Equipment of water extraction facilities with water control devices	**Low**

Table 9.6.3 Summary of Water Abstraction Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
Water abstraction rates	Construction	All lake abstraction points	Abstraction rates	Continuous
Water abstraction rates	Operation	All abstraction points in Gulf of Ob and onshore lakes	Abstraction rates	Continuous

Table 9.6.3 Summary of Water Abstraction Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
Water quality	Construction & Operation	Lake Glubokoye, Gulf of Ob and Bezymyannoye Lake.	1. Analysis of water at intake points: For microbiological, parasitological, organoleptic and general analysis. 2. Inorganic/organic parameters 3. Radiological indices	1. Monthly 2. Quarterly 3. Yearly

9.7 WASTE MANAGEMENT

9.7.1 INTRODUCTION

The construction and operation of Project facilities will result in the generation of numerous types of waste. Unless properly managed this waste has the potential to produce negative impacts upon human health, groundwater, surface water and ecology. This chapter presents an assessment of waste generation and describes methods of waste management that will reduce negative impacts to acceptable levels at each relevant Project facility. The relevant Project facilities considered are:

- Well pads
- LNG plant
- Accommodation camps
- Seaport and associated facilities
- Airport
- SIDW Landfill

The types of waste predicted to be produced from each of the above facilities during both the construction and operational phases have been characterised according to their estimated rate of generation and waste hazard class. Practices have been developed to ensure that the handling, transport, temporary storage, treatment and disposal of each waste type can be managed appropriately. Waste is classified according to the RF Federal Waste Classification Catalogue (FWCC). The FWCC utilises five different waste classes, which is somewhat different to those applied in other countries, such as member states of the European Union, where it is often the case that wastes are simply classified into three groups namely hazardous, non-hazardous and inert[17]. A summary of the FWCC classes is provided in Table 9.7.1 below, together with a broad comparison with typical 'international' waste classifications.

[17] The EU definition of inert waste is extremely restrictive and would exclude any reactive wastes including ferrous metals, wood etc. As such very little Project construction waste would be classified as inert under the EU definition.

Table 9.7.1: Overview of the FWCC Waste Classifications

RF Hazard Class	RF Hazard Description	Waste Stream Examples	Equivalent Typical International Classification
I	Extremely hazardous	Mercury containing fluorescent lights, activated carbon contaminated with mercury sulphide.	Hazardous
II	High hazard	Concentrated acids, alkalines, halogenated solvents, lead acid batteries, dry batteries, etc.	
III	Moderate hazard	Used lubrication oil, oily sludge, oily rags, used oil filters, non-halogenated solvents, paint wastes, etc.	
IV	Low hazard	Domestic trash, non-ferrous metal scrap, some chemicals, some construction waste, treated sewage sludge, treated medical wastes, water based drilling mud, etc.	Non-Hazardous
V	Practically non-hazardous	Inert wastes: plastic, ferrous metal scrap, inert construction wastes, food waste, brush wood, non-treated wood waste.	

The overall philosophy for waste management is as follows:

- Removal of recyclable materials to suitable external companies
- The development of the following on-site waste facilities for the treatment and disposal of remaining wastes:
  - A solid industrial and domestic waste (SIDW) landfill
  - Five waste incinerators (3 located adjacent to the SIDW, and 2 located at the LNG waste water treatment plant for the thermal treatment of dried sludges)

An overview of the waste facilities is provided in Section 9.7.2, while a description of waste generation and management at each of the Project facilities is provided in Section 9.7.3 through to 9.7.8. Impacts and mitigation are assessed in Sections 9.7.9 through to 9.7.12.

The management of legacy wastes from historical industrial activities is addressed in Chapters 7 and 11.

9.7.2 OVERVIEW OF WASTE TREATMENT FACILITIES

In the very early stage of construction, the bulk of construction waste is planned to be removed for treatment / disposal by specialist third party companies. During the early part of the first phase of construction it is intended that a solid industrial and domestic waste (SIDW) landfill will be developed for the disposal of solid industrial and domestic waste, non-toxic and low-toxic waste (i.e. street sweepings, food and solid domestic waste, bulky construction material waste, and sludge from sewage treatment facilities).

The landfill will accept solid domestic and industrial waste from the Yamal LNG facilities and will be located approximately 1 km to the south-west of the LNG Plant auxiliary facilities. The selection of this location is based on:

- The close proximity to operational facilities.
- Minimal length of required access road and power transmission line.

- Presence of relatively low permeability soils.
- Absence of water protection zones for water bodies/water abstraction facilities.

The landfill will be designed to minimise leachate leakage to groundwater and will include facilities for leachate collection and disposal.

To protect surface waters and groundwater from contamination during operation the following mitigation and monitoring measures are proposed by the Project design documents for the landfill construction:

- using imported mineral soils to build up the landfill;
- using imported soils to build an embankment around the landfill periphery;
- reinforcing slopes with geogrids filled with crushed stones of 40 mm – 70 mm diameter;
- reinforcing slopes with grass and cladding through a peat and sand mixture,
- lining the landfill pit with “Netma-Teplonit” geotextile;
- strengthening the slopes and the base of the landfill pit with a compacted clay layer 50 m thick and lining cell bases with “Teploplax” thermal insulant;
- construction of a drainage ditch around the landfill periphery; and
- landfill cells will be constructed no less than 2 m from groundwater.

Monitoring wells will be constructed to monitor the groundwater level, the physical, chemical and bacteriological composition of groundwater on the landfill territory and within its sanitary protection zone (SPZ) during operation. It is proposed that eight monitoring wells will be installed around the landfill i.e. two monitoring wells in the north, south, east and west respectively.

To mitigate surface water and groundwater contamination, leachate, process effluents and storm water will be stored on location in accumulator tanks before being transported to the treatment plant at the Sabetta accommodation camp.

The landfill site will also accommodate three KTO-50.K40 incinerators with a capacity of 50 kg/hour (500 t/year) designated for incineration of combustible wastes (solid and liquid domestic waste, oil sludge, and other combustible waste). The KTO plant will consist of a double-deck block-modular structure comprising four combined modules and a free-standing stack of up to 15 m in height. This will be a natural gas-fired incinerator, with a fuel consumption rate of between 9.0 m^3/h to 23.1 m^3/h (if necessary the incinerator may run on liquid fuel in the interim period before fuel gas is available).

The incinerator emissions will meet the Project Standards as stated in the Project Standards Document (Appendix 2). Incineration of wastes will occur at temperatures of 850-900°C. Because of this, solid fractions are completely combusted. Dioxins are destructed in the afterburner at temperature of up to 1200°C. Heat power from furnace gases is used for the heating of wet wastes prior to their loading into the incinerator. Furnace gases are adsorbed with lime and activated carbon. In addition, the plant will contain a dust recovery device. See Section 9.2 for assessment of air quality impacts from the incinerators.

9.7.3 WELL PADS

9.7.3.1 CONSTRUCTION PHASES

Well pad construction will be carried out in three phases over a five year period. The construction activities will comprise equipment assembly and preparatory works, drilling and casing of wells, well testing and well suspension operations. The types and amounts of waste generated at a drilling site within the whole construction period per one well are listed in Table 9.7.2.

Table 9.7.2: Estimated waste to be generated during construction per well

Waste description	Operations and processes	Hazardous features	Hazard Class	Amount (tonnes)
Spent mercury-containing lamps, spent luminescent mercury-containing bulbs	Replacing of lighting devices	Toxicity	I	0.012
Naturally Occurring Radioactive Material (NORM)	Not anticipated			
Total: waste of Hazard Class I				**0.012**
Spent motor oils	Well construction operations	Fire hazard	III	0.656
Spent gear oil	Well construction operations	Fire hazard	III	0.251
Oil filters	Well construction operations	Fire hazard	III	0.004
Total: waste of Hazard Class III				**0.911**
Rags contaminated with oils (the oil content is less than 15%)	Cleaning of equipment and hands	Fire	IV	0.286
Construction debris	Construction operations	None determined	IV	0.5
Rubber-asbestos wastes (including spent products and rejects)	Well construction operations	None determined	IV	0.775
Welding cinder	Welding operations	Absent	IV	0.003
Ungraded domestic garbage (except for bulky garbage)	Personnel activities	None determined	IV	1.23
Drill cuttings	Drilling operations	Reactive ability	IV	1,007.45
Wastes (sludge) from cesspools and	Personnel activities	None	IV	1,290.603

Table 9.7.2: Estimated waste to be generated during construction per well				
Waste description	**Operations and processes**	**Hazardous features**	**Hazard Class**	**Amount (tonnes)**
sanitary wastewater		determined		
Total: waste of Hazard Class IV				**2,300.847**
Unsorted ferrous metal scrap	Well construction operations	Absent	V	12.79
Uncontaminated waste plastic package	Packaging from reagents	None determined	V	1.01
Ungraded kitchen refuse	Cooking	None determined	V	0.541
Waxed paper waste	Packaging from reagents	None determined	V	7.742
Remains and ends of steel welding electrodes	Welding operations	Absent	V	0.0045
Total: waste of Hazard Class V				**22.0863**
Total				**2,323.856**

The Project design incorporates the following measures to reduce the environmental impact of well pad construction:

- Low-waste drilling technology including drilling mud reuse.
- Controlled collection of all types of drilling waste in specially designated areas.

Drilling waste fluids

Wells will be drilled from a reduced number of pads to minimize the footprint associated with the drilling operations. Oil-based mud (OBM) is used in the intermediate, production casings and liner drilling phases; otherwise water-based mud (WBM) is used. Drill cuttings will be separated from mud using centrifuges or thermal desorption systems so that mud can be re-circulated for re-use. The drill cuttings will be disposed to lined pits at the well pads (see below).

Drill muds will be replenished with fresh drill muds to compensate mud losses. Spent drill muds will be treated by centrifuge to separate the sludge and water. The wastewater will be reused for further mud make-up before eventually being sent to the wastewater treatment plant at the LNG plant (see section 9.4). The bentonite sludge will be disposed to lined pits. After completion of drilling, WBM will be thickened prior to being discharged to the cuttings pit and OBM will be reused by drilling contractors (once commissioned a hummermill will be used to treat OBM).

The cuttings and mud pits will be located beyond the boundaries of water protection zones and will be recorded in the State Register of waste disposal facilities. The base and walls of each mud pit will be lined with an impermeable membrane to prevent leakage of waste drilling fluids. This will be protected from the actions of permafrost by a layer of elastic polyurethane foam. Each well cluster site and mud pit will have a common sanitary protection zone (SanPiN 2.2.1/2.1.1.1200-03

"Sanitary protection zones and sanitary classification of enterprises, facilities and other structures").

Upon completion of well construction works, the cuttings and mud pits will be covered with a geomembrane and capped with mineral soil and topsoil. With these measures in place, the leakage of contaminants from the hardened drill cuttings to soil, surface waters and groundwater is considered highly unlikely.

Other wastes

In addition to drilling wastes, well construction works will result in the generation of spent oils / lubricants, rags contaminated with oils, polyethylene waste, metals, construction waste, packaging materials as well as solid and liquid domestic waste.

Spent fuel and lubricants will be collected, temporarily stored (in areas provided with secondary containment) and then removed in sealed metal containers.

Solid domestic waste (including kitchen refuse and oily rags etc.) will be collected and temporarily stored in accordance with SanPiN 42-128-4690-88 "Sanitary rules of maintenance of territories in residential areas". Liquid domestic waste from accommodation cabins at drilling well sites will be collected and stored in tanks at designated areas with secondary containment. Liquid domestic waste will then be periodically transported to sewage treatment facilities in the Sabetta accommodation camp.

Metal scrap, rubber wastes, welding cinder, spent motor oils, spent gear oils, remains and ends of steel welding electrodes, construction debris, and spent mercury-containing lamps will be removed by specialist licensed companies for further recycling, decontamination or disposal.

Wastes will be transported by appropriate vehicles as follows:

- Solid domestic waste will be transported by refuse trucks
- Liquid waste will be removed from cesspits by vacuum tank trucks approximately every 15 days.

9.7.3.2 OPERATIONS PHASE

Waste generation from the well pads during operation will be minimal during operations. The only wastes generated will be those arising during routine maintenance and inspection. These will be collected by maintenance staff and returned to designated waste collection points at the LNG and Sabetta accommodation camps.

9.7.4 LNG PLANT

9.7.4.1 CONSTRUCTION PHASE

The LNG Plant and associated facilities will be completed in three phases over a five year period. The construction workforce is estimated to peak in 2014 at approximately 7,000 personnel, working in rotation (i.e. 3,500 on site at any given time).

Construction waste will be generated during the following activities:

- Installation of pipelines;
- LNG plant construction and assembling works.
- Maintenance of construction machinery and vehicles;

- Replacement of spent mercury-containing lamps used for outdoor lighting of construction sites and amenity rooms.

In all, it is estimated that around 50 types of waste will be produced, totalling approximately 3,994 tonnes over the period of construction. Of this, over 50% is classified as Hazard Class III, approximately 45% falls into Hazard Classes IV and V, and only 1% of the total amount is rated as waste of Hazard Classes I and II (see Table 9.7.3. below).

Table 9.7.3: Estimated waste generation during construction of LNG Plant facilities (tonnes)

Hazard Class	Total waste generation (per hazard Class)	Waste removal to external companies for recycling	Re-use / decontamination at own facilities	Disposal to landfill
I	0.564	0.564	0.000	0.000
II	40.888	40.888	0.000	0.000
III	2, 197.254	1,082.620	854.374	0.000
IV	768.796	303.368	335.298	130.130
V	1, 027.446	496,125	3.617	527.703
TOTAL	**3,994.060**	**1,882.677**	**1,193.289**	**657.833**

Construction sites are to be equipped with bio-toilets and a sewage accumulator tank. Sewage will be removed to treatment facilities in the Sabetta accommodation camp (see section 9.4).

The majority of wastes to be generated during LNG Plant construction are of low hazard classes, and so the potential environmental impact is considered to be moderate. To minimise this impact, temporary waste storage sites will be specially equipped to minimise risk of contaminant migration and agreements with specialist companies involved in waste recycling operations will be concluded prior to commencement of relevant construction activities.

9.7.4.2 OPERATIONAL PHASE

The main components of waste generation during LNG Plant operation include:

- Residues from pipeline pigging.
- Used filters from process equipment.
- Packaging from chemical reagents
- Wastes from maintenance and repair of main and auxiliary equipment.
- Operation of process wastewater, storm water and sanitary wastewater treatment facilities.
- Cleaning of site territories and premises.
- Personnel activities.

Mercury-containing luminescent lamps to be used for lighting of the LNG Plant territory and its infrastructure and acid batteries necessary for provision of continuous power supply to electrically-driven equipment are the most hazardous types of waste.

Oil-containing sludge will be generated in the process of crude gas pipeline pigging and tank cleaning operations.

No industrial waste will be generated from operation of the methanol recovery plant. Solid wastes are expected to be periodically generated when replacing spent catalysts, filters and membranes from treated water plants.

Scheduled maintenance of basic and auxiliary equipment will result in the generation of spent motor, hydraulic and transformer oils, rags contaminated with oils, spent oil and fuel filters, and waste detergent solution used for washing turbines.

Sludge will be generated from the operation of process wastewater/surface effluent treatment facilities.

In all, the operation of the main and auxiliary facilities of the LNG Plant is predicted to generate over 12,000 tonnes of Hazard Class I to V waste per annum, comprising 53 individual waste types. The bulk of these wastes will be of Hazard Class IV (see Table 9.7.4).

Table 9.7.4: Estimated waste generation during operation of LNG Plant facilities (tonnes/year)

Hazard Class	Total waste generation (per hazard class)	Waste removal to external companies for recycling	Re-use / decontamination at own facilities	Disposal to landfill
I	0.483	0.483	0.000	0.000
II	3.069	3.069	0.000	0.000
III	1,974.030	372.230	1,601.800	0.000
IV	9,995.873	27.320	195.066	9,773.487
V	45.948	12.243	11.340	22.365
TOTAL	**12,019.403**	**415.345**	**1,808.206**	**9,795.852**

Industrial and domestic waste will be temporary stored in facilities to be constructed at specially allocated and equipped sites in accordance with relevant Project Standards.

Waste handling procedures are provided for:

- The incineration of combustible waste at the KTO-50.K40 plant.
- The management of recyclable waste and hazardous waste by specialist companies (under agreements). Hazardous waste such as spent mercury-containing lamps and devices, oil sludge and oily waste will be sent for decontamination/recycling to companies having an appropriate license.
- The disposal of non-recyclable waste to the Project SIDW landfill.

With the above processes in place, the level of potential environmental impact from waste management of LNG Plant facilities is considered to be moderate.

9.7.5 ACCOMMODATION CAMPS FOR CONSTRUCTION WORKERS AND PLANT OPERATORS AND THE SABETTA ACCOMMODATION CAMP

9.7.5.1 CONSTRUCTION PHASE

During the construction phase, waste will be generated from construction, assembling and dismantling operations, the operation of vehicles, construction machinery and mechanisms, and personnel's activities.

Construction, assembling and dismantling operations will result in the following types of waste:

- Steel pipe remains.
- Used steel welding electrodes and welding cinder (10% of total mass of electrodes).
- Spent diesel oils.
- Rags.
- Solid domestic waste.
- Waste metal.
- Waste wires and cables.
- Reinforced concrete rubble.
- Glass and construction debris.

In all, more than 20 types of industrial waste will be generated. The bulk of these will be rated as Hazard Classes IV and V (see Table 9.7.5) and no Class I wastes are anticipated. In addition, wastes of uncertain hazard class will be generated in the amount of 33.036 t or 33% of total waste amounts.

Table 9.7.5: Estimates of industrial waste to be generated over the whole period of accommodation camp construction (construction workers and plant operators) (tonnes)

Construction Phase	Total amount	Hazard Class			
		V	IV	III	II
1	4,889.67	3,941.267	938.379	7.514	2.51
2	5,041.92	4,756.451	276.455	6.496	2.51
3	203,24	134.432	62.312	6.496	-
Total	10,134.86	8,832.13	1,277.146	20.506	5.02

Waste management will follow the requirements of SanPiN 2.1.7.1322-03 (Hygienic requirements to disposal and decontamination of industrial and domestic waste). Construction waste will be collected and temporarily stored at specially equipped sites within the industrial facility area or within a construction site. Wastes will then be collected for disposal or recycling, as outlined below.

Wastes generated during the construction phase will be sent for decontamination, recycling or disposal to specialist companies, such as LLC "Regionstroy Construction Company" (waste metal structures), LLC "Almaz" (metal scrap, spent batteries), MU "SalekhardRemstroy" (other types of waste) and to other specialist companies having appropriate valid licenses for these types of operations. Agreements with specialist waste contractors will need to be in place prior to commencement of construction.

Clean unsorted timber waste will be temporary stored and then incinerated at the "Forsazh-2M" unit in the Sabetta accommodation camp (described below).

Waste will be removed for recycling/disposal in parallel with construction activities. Waste collection will take place at least once a month or immediately after completing operations in a given location. In light of the above, the duration and intensity of impacts on the environment during construction is considered to be minor.

9.7.5.2 OPERATIONAL PHASE

The types of waste to be generated during operation are presented in Table 9.7.6.

Table 9.7.6: Estimates of waste to be generated during operation of accommodation camps (construction workers and Plant operators) (Tonnes / year)

Line	Waste	Amount
1	Spent mercury-containing lamps, spent luminescent mercury-containing bulbs and rejects	1.168
2	Spent motor oils	6.267
3	Spent gear oils	0.94
4	Sludge from pigging of pipelines and cleaning of drums, containers, and asphalt spreaders from oil and petroleum products	8.663
5	Bark waste	0.554
6	Rags contaminated with oils (the oil content is less than 15%)	3.136
7	Ungraded domestic garbage (except for bulky garbage)	14.101
8	Spent pneumatic tubes	0.043
9	Medical waste (used dressing materials)	0.476
10	Sludge from wastewater mechanical/biological treatment facilities	8.037
11	Solid materials contaminated with oil and mineral fatty products (spent oil filters and spent air filters)	0.084
12	Unsorted clean wooden waste	12.458
13	Kitchen refuse	1.272
14	Mixed fabric cuttings	5.511
15	Oil-contaminated sand (the oil content is less than 15%)	0.54
16	Sludge from wastewater mechanical/biological treatment facilities	8,037
17	Solid materials contaminated with oil and mineral fatty products (spent oil filters and spent air filters)	0,368
18	Wood ashes	0.818
	Total	**58.841**

Industrial and domestic waste will be temporarily stored in appropriate containers to be installed at specially equipped sites in conformity with RF procedures for temporary storage of waste and environmental and sanitary requirements.

Combustible waste will be incinerated at the “Forsazh-2M” unit installed in the Sabetta accommodation camp. This unit has a capacity of 180 kg/hour. Owing to the high combustion temperature (approximately 1200°C in the after-burner – see also Section 9.7.7) in a thermal incinerator, compound organic matters are completely decomposed into simple components.

The waste types accepted for incineration comprise: spent oil and air filters, rags, domestic refuse, spent pneumatic tubes, medical waste, kitchen refuse, and street sweepings. Ashes from the incinerator will be removed by a specialist company (on the basis of an agreement) having a valid license for handling this type of waste. The proportion of ashes accounts for 3% to 5% of the total mass of wastes.

Wastes prohibited from incineration include inflammable substances (gasoline, solvents), halogen-containing waste and wastes that contain heavy metals.

Mercury-containing waste will be periodically collected by specialist contractor once viable quantities have accumulated. Other types of waste are to be sent to other specialist companies or will be disposed at the Project’s SIDW landfill.

Any contaminated soils, together with other oil-containing waste, will be subject to decontamination under agreements with specialist companies.

9.7.6 SEAPORT AND ITS AUXILIARY FACILITIES

9.7.6.1 CONSTRUCTION PHASE

The seaport facilities will be constructed over a period of 17 months. The main types of waste predicted to be generated during construction are construction debris, packaging materials, domestic refuse, sludge from cesspools, sludge from wastewater treatment plants, and wastes from sea port vessels. The estimated amounts of waste to be generated in the course of onshore construction operations are listed below (see Table 9.7.7).

Table 9.7.7: Estimated waste generation in the course of onshore construction operations

Types of waste	Hazard Class	Total amounts (tonnes per construction period)
Spent mercury-containing lamps, spent luminescent mercury-containing bulbs and rejects	I	0.002
Ungraded domestic garbage (except for bulky garbage)	IV	46.37
Sludge from cesspools and sanitary wastewater	IV*	1,890.50
Mineral fiber wastes	IV*	1.26
Ruberoid wastes	IV	0.68
Ferrous scrap with admixtures or contaminated with harmful substances	IV*	3.16
Broken concrete pieces, fragmented concrete wastes	V	2254,43

Table 9.7.7: Estimated waste generation in the course of onshore construction operations		
Types of waste	**Hazard Class**	**Total amounts (tonnes per construction period)**
Fragmented cement wastes	V	1.20
Wooden wastes	V	943.41
Polypropylene scrap	V	0.25
Unsorted steel scrap	V	1,029.29
Remains and ends of steel welding electrodes	V	0.09
Gypsum fragments (gypsum fiber wastes)	V	0.06
Ceramics fragments	V	1.47
Polyethylene film wastes	V	0.003
Polyester fiber/thread wastes	V	0.12
TOTAL waste amounts to be generated in the course of onshore operations		6,172.295
Hazard Class I		0,002
Hazard Class IV		1,941.97
Hazard Class V		4,230.323

Sludge from cesspools is to be removed to sewage effluent treatment facilities in the Sabetta accommodation camp. Solid domestic waste will be initially disposed of to a licensed specialist company until the SIDW landfill becomes available. Mercury-containing waste will be delivered to a licensed company for subsequent demercurization. Other types of industrial wastes will be supplied to other licensed companies for recycling. Relevant agreements should be concluded prior to commencement of construction.

Wastes from vessels involved in construction operations in the sea port water area will be returned to home ports. These types of wastes consist of bilge water (2,104 tonnes, Hazard Class III), domestic refuse (51 tonnes, Hazard Class IV), sanitary wastewater (2,032 tonnes, Hazard Class IV), and kitchen refuse (30 tonnes, Hazard Class V).

During construction operations, wastes should be temporary stored in containers installed at sites with appropriate hard pavement (secondary containment).

9.7.6.2 OPERATIONAL PHASE

As much as 2,084 tonnes/year of industrial and domestic wastes of Hazard Classes III to V will be generated at the sea port facilities during operation (see Table 9.7.8). Of this, almost 90% will consist of sludge from cesspools, domestic refuse from amenity rooms and street sweepings. All types of waste are to be sent to licensed specialist companies for recycling or disposal.

Table 9.7.8: Estimated waste generation during operation of sea port facilities (tonnes)		
Types of waste	**Hazard Class**	**Standard amounts (tonnes per operational period)**
Spent mercury-containing lamps, spent luminescent mercury-containing bulbs and rejects	I	0.10
Bilge waters from ships	III	171.0
Floating film from oil traps (petrol traps)	III	1.06
Ungraded domestic garbage (except for bulky garbage)	IV	241.84
Sludge from cesspools and sanitary wastewater	IV	1,128.90
Rags contaminated with oils (oil content less than 15%)	IV	0.30
Domestic waste (street sweepings)	IV	498.18
Sludge from a stormwater treatment plant	IV	39.12
Spent carbon filters contaminated with mineral oils (oil content less than 15%)	IV	1.26
Rubber-asbestos wastes (including spent products and rejects)	IV	0.10
Unsorted food waste (kitchen refuse from a caboose)	V	1.63
Uncontaminated ferrous metal chips	V	0.23
TOTAL:		**2,083.72**

Wastes will be collected and temporarily accumulated in containers installed at a specially equipped site on the sea port territory.

Oil-contaminated (bilge) water and sanitary wastewater from vessels will be delivered to special wastewater collector vessels on the basis of agreements. Food waste from cabooses and domestic refuse from vessels will be temporary accumulated in two portable containers, with a capacity of 10 m^3 each, installed on the berth territory. These types of waste will then be removed to the Project's SDW landfill.

Bunkering of vessels with fuel and oils as well as bilge water removal will be performed by request or under agreements with other supply bases.

No maintenance or repair of vessels, vessel equipment and structures (or their elements) will be performed during a preparatory stage. These operations will be carried out at home port bases or at other vessel maintenance bases.

Scheduled routine repairs and maintenance of vehicles will be carried out at support bases in the Sabetta accommodation camp.

9.7.7 AIRPORT

9.7.7.1 CONSTRUCTION PHASE

During construction, wastes will be generated in the course of construction and assembling works, operation of vehicles, construction machinery and construction personnel's activities. The waste types and waste handling procedures will be very similar to those already described for the construction of the accommodation camps.

9.7.7.2 OPERATIONAL PHASE

In the Operational Phase, wastes will be generated by the operation and repair of vehicles and the cleaning of rooms and the airport territory etc. (although it should be noted that routine maintenance of aircraft will not be undertaken at the airport). The estimated amount of industrial and domestic waste will reach 6,092 tonnes/year. Of this, 6,035 tonnes is estimated to be Hazard Classes IV and V, 0.394 tonnes of Hazard Class I, 0.51 tonne of Hazard Class II, and 55.3 tonne of Hazard Class III.

Wastes will be temporary stored at specially equipped sites on the airport territory, from where they will be removed either to the Project waste facility or, in the case materials for recycling, to specialist companies having appropriate valid licenses for waste recycling, decontamination and disposal. The management of waste water, including used/collected de-icing fluid, from the airport is described in Section 9.4.

9.7.8 LANDFILL FOR SOLID INDUSTRIAL AND DOMESTIC WASTE DISPOSAL (SIDW LANDFILL)

A designated landfill is planned to be developed for the disposal of Project waste throughout the Project's 25 year lifetime. For the first three years the landfill will be used for the disposal of wastes arising from the Project construction phase.

Landfill construction works are anticipated to generate construction debris, waste packaging materials and domestic waste from personnel activities. Wastes from the maintenance of construction vehicles and machinery (spent oils, spent batteries, filters, etc.) will be handled by the construction vehicles /machinery contractors.

In all, 125 tonnes of waste will be generated during landfill construction operations and approximately 30 tonnes in the course of landfill operation (see Table 9.7.9).

Table 9.7.9: Estimates of waste to be generated in the course of construction and operation of the SIDW landfill

Line	Types of waste	Amount, tonnes per phase
Construction Phase		
1	Remains and ends of steel welding electrodes	0.532
2	Welding cinder	0.230
3	Rags contaminated with oils (the oil content is less than 15%)	1.211
4	Paint materials waste	0.117

Table 9.7.9: Estimates of waste to be generated in the course of construction and operation of the SIDW landfill		
Line	**Types of waste**	**Amount, tonnes per phase**
5	Waste of insulating wires and cables	0.526
6	Polyethylene film waste	0.528
7	Unsorted steel scrap	0.256
8	Unsorted clean wooden waste	0.020
9	Broken concrete pieces, fragmented concrete wastes	10.227
10	Broken reinforced concrete pieces; fragmented reinforced concrete	16.754
11	Crushed stones which have lost consumer properties	90.299
12	Bitumen and asphalt solid waste	0.914
13	Unsorted domestic garbage	3.075
14	Unsorted kitchen refuse	0.640
Operational Phase		
15	Rags contaminated with oils (the oil content is less than 15%)	0.332
16	Ashes, slag and dust from fire-chambers and incinerators	27.513
17	Unsorted domestic garbage	0.600
18	Unsorted kitchen refuse	0.175

Sludge from cesspools and sanitary wastewater will be removed to designed sewage effluent treatment facilities in the Sabetta accommodation camp.

Ferrous metal scrap will be temporary accumulated at a site and be subsequently collected by specialist companies for recycling.

Construction debris and other types of waste to be generated during construction and operation of the landfill, including slag and ashes from the KTO-50.K40 plant, are planned to be disposed to the SIDW landfill. There is also the potential for ashes to be used in economic operations, subject to agreement with the relevant RF Authorities (Rospotrebnadzor).

A site for temporary storage and sorting of solid domestic/ industrial waste will be located within a landfill service zone. This will have secondary containment (ground surfaces will be covered by concrete slabs).

9.7.9 IMPACT ASSESSMENT

9.7.9.1 OVERVIEW

Potential impacts associated with waste management include:

1. Impacts on third party waste management facilities (e.g. impact on available capacity)
2. Impacts on human health from control of hazardous waste

3. Impacts on surface water from control of liquid waste (see Section 9.4)
4. Impacts on groundwaters from control of liquid waste and leachate control from the landfill (see Section 9.6)
5. Impacts on ecology from:
    a. Contamination of terrestrial, freshwater and marine environments from control and liquid and solid waste
    b. Attraction of vermin/scavenging fauna to waste storage areas

Each of these aspects is addressed in turn below.

9.7.9.2 IMPACTS ON THIRD PARTY WASTE FACILITIES

The volumes of waste to be sent to third party waste facilities is relatively low during all stages of the project and are not anticipated to significantly affect the long-term capacity of such wastes. The unmitigated impacts on such facilities is assessed as **moderate**. However, with the application of the following mitigation measures, the residual impacts on third party waste facilities is assessed as **low**:

- Regular collection of waste by appropriate licensed contractors.
- Segregation of hazardous waste types.
- Disposal/treatment of most waste within licensed designated facilities.
- Minimisation of waste volumes (including recycling, incineration, compaction and minimisation of drill wastes).
- Limited volumes of hazardous wastes.
- Use of only licenced third-party waste facilities

9.7.9.3 IMPACTS ON HUMAN HEALTH

The design of the waste management facilities will help ensure that potential impacts on human health are maintained to acceptable levels. Potential impacts are associated with exposure to contaminants released to the environment, pathogens associated with uncontrolled waste storage, and attraction of vermin to food wastes. Without further procedural controls, the impacts of waste management on human health may be **moderate** to **high**. However, with the application of the following mitigation controls, the residual impacts to human health are assessed as **low**:

- Secure temporary storage of wastes within designated facilities.
- Regular collection of waste by appropriate licensed contractors.
- Segregation of hazardous waste types.
- Training in waste handling.
- Disposal/treatment of waste within licensed designated facilities.
- Control of vermin at waste facilities by removal of food sources.

9.7.9.4 IMPACTS ON SURFACE WATER

Both temporary waste storage and permanent waste disposal facilities have the potential to impact surface water quality through release of contaminants. Without adequate design and control to risk of contaminant releases to surface waters could potentially lead to hence long-term impacts on water quality, hencing having a **moderate** impact on water quality. However, with the application of the following location, design and mitigation controls, releases of contaminants to surface waters will be effectively controlled and hence residual impacts are ass assessed as **low**.

- Provision of secondary containment to temporary waste storage facilities
- Provision of low permeability liner for SIDW landfill.
- Location of SIDW landfill in an area of relatively low permeability soils and outside of protection zones for water bodies/water abstraction facilities.
- Provision of low permeability liner for mud pits, together with encapsulation following completion.

9.7.9.5 IMPACTS TO GROUNDWATER

Both temporary waste storage and permanent waste disposal facilities have the potential to impact groundwater quality through release of contaminants. Without adequate design and control to risk of contaminant releases to groundwaters could potentially lead to hence long-term impacts on water quality, hencing having a **moderate** to **high** impact on water quality. However, with the application of the following location, design and mitigation controls, releases of contaminants to groundwaters will be effectively controlled and hence residual impacts are assessed as **low**.

- Provision of secondary containment to temporary waste storage facilities.
- Location of SIDW landfill in an area of relatively low permeability soils and outside of protection zones for water abstraction facilities.
- Provision of low permeability liner for SIDW landfill.
- Provision of low permeability liner for mud pits, together with encapsulation following completion.

9.7.9.6 IMPACTS ON ECOLOGY

The generation and management of Project wastes have the potential to impact ecology through either contamination of habitats (especially freshwater and marine environments – see surface waters above) and attraction of fauna (birds and rodents) to waste food areas. The attraction of rats could also lead to localised risk of the predation of eggs of ground nesting birds, although this be localised. Nonetheless, without adequate controls, such impacts may be of **moderate** severity. However, with the application of the following location, design and mitigation controls, residual impacts on ecology are ass assessed as **low**:

- Remove food source for vermin by: secure temporary storage of wastes within designated facilities, regular collection of waste by appropriate licensed contractors and disposal/treatment of waste within licensed designated facilities.
- Use of rat control measures (e.g. bait boxes) as necessary around food waste and storage areas
- Minimise risk of contaminating marine habitats by requiring all vessel waste to be transported to home port during construction. During operation, all bilge water to be collected and all refuse/sewage to be handled by on-shore licensed facilities.
- Minimise risk of contaminating aquatic/marine habitats by: containment of temporary waste storage facilities, locating SIDW landfill in an area outside of protection zones for water

bodies, provision of low permeability liners for SIDW landfill and mud pits and encapsulation of mud pits following completion

9.7.9.7 MEASURES AIMED AT MITIGATING IMPACTS OF INDUSTRIAL AND DOMESTIC WASTE ON THE NATURAL ENVIRONMENT

In addition to the mitigation measures identified above, the following organizational measures will be implemented throughout the Project lifecycle:

- Ensure timely conclusion of agreements with specialist companies for acceptance, recycling, decontamination and disposal of wastes.
- Assign persons responsible for supervision over the waste handling procedure at each LNG Plant facility.
- Develop relevant job descriptions,
- Training of workers and managerial staff in hazardous waste management.
- Logging / record keeping of waste generation and waste disposal.
- On-site waste storage facilities and waste removal schedule should be agreed with relevant supervisory agencies / authorised persons in the field of environmental protection, public health and social affairs.
- Develop a document specifying permissible norms of waste generation and limits for waste disposal (a PNOOLR document); have this document approved by supervisory agencies and obtain permissible limits for waste disposal.
- Effect in due time payments of pollution charges for waste disposal.
- Ensure coordination with the relevant Russian Federation authorities (Rosprirodnadzor / Rospotrebnadzor) with regard to all issues relating to safe waste handling.

A ‘Master’ Construction Waste Management Plan (CWMP) will be developed, which will serve as a key management tool for the Project and incorporate all relevant aspects of waste planning, forecasting, training and management over the entire duration of construction. This CWMP will be a dynamic document and be updated as necessary during construction phases. Each individual construction contractor should also develop their own individual CWMP, based on the ‘Master’ CWMP.

In addition, an Operations Waste Management Plan (WMP) will also be developed for each of the staged phases of operation. Management plans are discussed in greater detail in Chapter 14.

9.7.10 SUMMARY

Table 9.7.10: Summary Impacts from Waste Generation and Mitigation Control

Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
Waste facilities	Project and third party waste facilities	Construction and operation	• Regular collection of waste by appropriate licensed contractors. • Segregation of hazardous waste types. • Disposal/treatment of most waste within licensed designated facilities. • Minimisation of waste volumes (including recycling incineration, compaction and minimisation of drill wastes) • Limited volumes of hazardous wastes • Use of only licensed third-party waste facilities	**Moderate** reducing to **Low** with application of mitigation measures
Impact on human health	Construction workers, plant operators.	Construction and operation	• Secure temporary storage of wastes within designated facilities. • Regular collection of waste by appropriate licensed contractors. • Segregation of hazardous waste types. • Training in waste handling. • Disposal/treatment of waste within licensed designated facilities. • Control of vermin at waste facilities by removal of food sources. • Use of rat control measures (e.g. bait boxes) as necessary around food waste and storage areas	**Low**
Impact on surface water	Surface water receptors	Construction and operation	• Provision of secondary containment to temporary waste storage facilities • Provision of low permeability liner for SIDW landfill. • Location of SIDW landfill in an area of relatively low permeability soils and outside of protection zones for water bodies/water abstraction facilities.	**Low**

Table 9.7.10: Summary Impacts from Waste Generation and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			• Provision of low permeability liner for mud pits, together with encapsulation following completion.	
Impact on groundwater	Groundwater receptors	Construction and operation	• Provision of secondary containment to temporary waste storage facilities. • Location of SIDW landfill in an area of relatively low permeability soils and outside of protection zones for water abstraction facilities. • Provision of low permeability liner for SIDW landfill. • Provision of low permeability liner for mud pits, together with encapsulation following completion.	**Low**
Impact on ecology	Terrestrial, aquatic & marine flora & fauna	Construction and operation	• Remove food source for vermin by: secure temporary storage of wastes within designated facilities, regular collection of waste by appropriate licensed contractors and disposal/treatment of waste within licensed designated facilities. • Minimise risk of contaminating marine habitats by requiring all vessel waste to be transported to home port during construction. During operation, all bilge water to be collected and all refuse/sewage to be handled by on-shore licensed facilities. • Minimise risk of contaminating aquatic/marine habitats by: containment of temporary waste storage facilities, locating SIDW landfill in an area outside of protection zones for water bodies, provision of low permeability liners for SIDW landfill and mud pits and encapsulation of mud pits following completion	**Moderate** reducing to **Low** with application of mitigation measures

Table 9.7.11: Summary of Waste Generation Impacts Monitoring Requirements

Aspect	**Phase**	**Location**	**Parameters**	**Periodicity**
Groundwater	Landfill pre-construction	SIDW Landfill – Baseline monitoring (Groundwater monitoring boreholes, installed within shallowest groundwater aquifer, located up and down the hydraulic gradient from the landfill) NOTE: Practicality of groundwater borehole installation will be dependent on permafrost conditions in local area.	Groundwater level, pH, ammoniacal nitrogen, nitrate, nitrite, alkalinity (as $CaCO_3$), biochemical oxygen demand, chemical oxygen demand, arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, manganese, tin, zinc, phosphate, phenols, cyanide (free and total), sodium, potassium, calcium, magnesium, electrical conductivity, total organic carbon, chloride, sulphate and iron.	On two occasions within a six month period before landfill construction.
Groundwater	Landfill Operation	SIDW Landfill – Groundwater monitoring boreholes, installed within shallowest groundwater aquifer, located up and down	Groundwater level, pH, ammoniacal nitrogen, nitrate, nitrite, alkalinity (as CaCO3), biochemical oxygen demand, chemical oxygen demand, arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, manganese, tin, zinc, phosphate, phenols, cyanide (free and total), sodium, potassium, calcium, magnesium,	Every six months during the first two years of landfill operation. Once per year after two years of landfill operation.

Table 9.7.11: Summary of Waste Generation Impacts Monitoring Requirements				
Aspect	**Phase**	**Location**	**Parameters**	**Periodicity**
		the hydraulic gradient from the landfill. NOTE: Practicality of groundwater borehole installation will be dependent on permafrost conditions in local area.	electrical conductivity, total organic carbon, chloride, sulphate and iron.	
Groundwater	Pre-construction	Aquifer intended for wastewater reinjection, within calculated radius of influence.	Radionuclides, pH, alkalinity (as $CaCO_3$), biochemical oxygen demand, chemical oxygen demand, arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, manganese, tin, zinc, phosphate, phenols, cyanide (free and total), sodium, potassium, calcium, magnesium, electrical conductivity, chloride, sulphate and iron.	On two occasions within a six month period before commencement of reinjection.
Groundwater	Operation of reinjection wells	Aquifer intended for wastewater reinjection, within calculated radius of influence.	Radionuclides, pH, alkalinity (as $CaCO_3$), biochemical oxygen demand, chemical oxygen demand, arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, manganese, tin, zinc, phosphate, phenols, cyanide (free and total), sodium, potassium, calcium, magnesium, electrical conductivity, chloride, sulphate and iron.	Once per year.

Table 9.7.11: Summary of Waste Generation Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
Surface water	Pre-construction	Baseline monitoring – selected surface watercourses up and downstream of SIDW landfill.	Dissolved oxygen, suspended solids, pH, alkalinity (as $CaCO_3$), biochemical oxygen demand, chemical oxygen demand, arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, manganese, tin, zinc, phosphate, phenols, cyanide (free and total), sodium, potassium, calcium, magnesium, electrical conductivity, total organic carbon, chloride, sulphate and iron.	On two occasions within an ice free period (e.g. spring thaw and summer low flow) before landfill construction.
Surface water	Operation of landfill	Selected surface watercourses up and downstream of SIDW landfill.	Dissolved oxygen, suspended solids, pH, alkalinity (as $CaCO_3$), biochemical oxygen demand, chemical oxygen demand, arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, manganese, tin, zinc, phosphate, phenols, cyanide (free and total), sodium, potassium, calcium, magnesium, electrical conductivity, total organic carbon, chloride, sulphate and iron.	On two ice-free occasions per year (e.g. spring thaw and summer low flow).
Surface water	Pre-construction	Baseline monitoring – selected surface watercourses up and downstream of mud pits.	Dissolved oxygen, radionuclides, suspended solids, pH, alkalinity (as $CaCO_3$), biochemical oxygen demand, chemical oxygen demand, arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, manganese, tin, zinc, phosphate, phenols, cyanide (free and total), sodium, potassium, calcium, magnesium,	On two occasions within an ice free period before mud pit construction

Table 9.7.11: Summary of Waste Generation Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
			electrical conductivity, chloride, sulphate and iron.	
Surface water	Operation and post closure of mud pits	Selected surface watercourses up and downstream of mud pits.	Dissolved oxygen, radionuclides, suspended solids, pH, alkalinity (as $CaCO_3$), biochemical oxygen demand, chemical oxygen demand, arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, manganese, tin, zinc, phosphate, phenols, cyanide (free and total), sodium, potassium, calcium, magnesium, electrical conductivity, chloride, sulphate and iron.	On two ice-free occasions per year (e.g. spring thaw and summer low flow).
Ecology	Landfill operation	SIDW Landfill	Inspection of landfill operations to ensure appropriate placement of daily cover to deter vermin.	Daily (by site management).
Air quality	Operation of Incinerators	All Project incinerators	See Section 9.2	See Section 9.2
Waste volumes	Construction and Operation	All Project facilities	Records of all waste volumes by FWCC waste classification. Records to include volumes and disposal/treatment routes.	Continual with monthly reporting

9.8 NOISE AND VIBRATION

9.8.1 INTRODUCTION

Noise and vibration emissions will occur at all stages of the proposed Project lifecycle, including: construction, commissioning, operation and decommissioning. Impacts on the environment from noise and vibration emissions during each stage of the project lifecycle differ significantly in duration, scale and magnitude.

Noise

The Project is located in a sparsely populated area, and hence potential noise impacts will be in relation to:

- Humans. The primary receptors to noise emissions will be the Project workforce both while working at the construction and operation facilities and also at the accommodation facilities during non-working hours. These impacts include:
    - Occupational health and safety related noise impacts
    - Noise nuisance impacts, primarily at the Project's accommodation camps, namely the Sabetta Camp (during construction and operation) and the LNG workers' accommodation camp (during operation). There are also smaller temporary satellite contractor accommodation camps located within the Licence Area. There is also the potential for reindeer herders to be affected by Project noise in the event that their migration routes pass in close proximity to the construction areas although any such impacts would short in duration. Residents at Tambey are sufficiently far from the construction site as to not be affected by noise impacts.

  These impacts are assessed through comparison with the Project's adopted noise standards (see below and also the Project Standards Document in Appendix 2 of the ESIA). In addition, the extent of the noise impacts is also assessed and controlled through Sanitary Protection Zones (SPZ) around the Project's principal operating facilities that are developed under Russian Federation regulations for the protection of human health from noise and air quality (see also Section 9.2) impacts. Separate SPZs are set for the operational phase for the following Project facilities:
    - Well pads
    - Camp utilities areas
    - LNG plant
    - Airport
    - Seaport (main facilities)
- Fauna. Noise emissions may lead to disturbance of both terrestrial fauna (including seabirds) from airborne noise and also (sub-surface) marine fauna from underwater noise emissions.

The noise standards adopted by the Project are summarised below.

Table 9.8.1: Adopted Project Noise Standards (equivalent sound level L_{Aeq} dB(A))		
Category	**Day time (07:00 – 23:00)**	**Night time (23:00 – 07:00)**
Residential areas/dormitories	55	45
Office buildings	60	-
Production facilities	80	-

Where appropriate, modeling has been undertaken to predict noise impacts at receptor locations and also as part of the determination of the dimensions of the SPZ. Noise modeling has been performed by FRECOM on behalf of Yamal LNG in line with the methods set out in SNiP 23-03-2003, “Noise Protection”. M., 2004 (using the “Ecologist-Noise” model developed by Integral).

Vibration

The only vibration sources of potential significance relate to drilling and piling activities. Due to the absence of third party buildings and dwellings in the Project Licence Area, vibration impacts from road vehicles are considered to be negligible and are therefore not considered further in this ESIA. Vibration-related impacts may include:

- Disturbance of humans and terrestrial fauna from perceptible ground-borne vibration.
- Vibration induced underwater noise disturbance on marine fauna (see noise impacts above).

(Note that there are no sources of ground-borne vibration at levels sufficient to induce property damage and also there are no permanent non-Project building in the near vicinity of the construction sites and therefore these are not considered further in this ESIA.)

9.8.2 CONSTRUCTION

A full list of noise sources is provided in Annex A to this chapter and a summary of noise and vibration sources during the construction phase is presented in Table 9.8.2 below.

Table 9.8.2: Noise and Vibration Sources during Construction	
Emission type	**Sources**
Noise	Drilling rigs (well fields only) Road vehicles Mobile construction equipment Stationary construction equipment Pipe crackers Augar piles Helicopters
Vibration	Drilling rigs Sheet piling (leading to underwater noise)

The assumed noise source levels of noise-significant equipment used in the noise assessment have been derived in accordance with Russian Federation standard SN 2.2.2/2.1.8.562-96 and equipment passports (where available) and are presented in Annex A.

9.8.2.1 AIRBORNE NOISE

LNG and Infrastructure Facilities

During the construction phase, airbourne noise impacts have been assessed for the main construction facilities in Design Document 11-035.2-OOC-8.3 through consideration of:

1. Calculation of average sound levels from sources located on the construction sites
2. Calculation of the radius at which the day time and night time residential area noise limit (55dB(A)) is attained (the 'noise nuisance' zone).

The list of noise sources and associated noise source levels is provided in Annex A.

Noise impacts were assessed using only the most significant noise sources, whereby sources that are15dB below the loudest source were disregarded. The predicted noise nuisance zones based on continuous and discontinuous noise sources are provided in Table 9.8.3 (see Annex A for the a list of noise source levels).

Table 9.8.3: 55 dB(A) noise nuisance zone (m) from continuous noise sources

No	Facility	55dB(A) Nuisance Zone (m)	
		Continuous sources	Discontinuous sources
1	Preparation of construction areas	62.5	41
2	LNG Plant construction	70	78.5
3	Infrastructure facilities	67	78.1

It is therefore predicted that noise nuisance levels (55dB) around the construction facilities are within 100m of the construction facilities. On this basis disturbance to both humans (at accommodation camps and any reindeer herder camps) and fauna is predicted to be **low**.

Well Pads

The primary noise sources at the well pads relate to drilling operations, which are temporary and intermittent in nature. The noise impacts at the well pads during drilling activities have been assessed using the "Ecologist-Noise" model. The maximum noise level within the perimeter of the well pad facility sites is predicted to be 53dB and therefore Project noise standards for occupational health and safety will be met. Flaring during well testing is likely to the highest noise source at the well pads and will result in localised (predicted to be of the order of 100m) noise disturbance, that may affect local ecology, including birds. However, well test flaring is both infrequent and of limited duration. Given the temporary/intermittent nature of the noise impacts and the relatively low noise intensity levels (compared to project standards) both the occupational noise impacts and noise impacts on fauna at the well pads is assessed as **Low**.

The main Sabetta accommodation camp is located remotely from the well pads and will not be affected by well drilling noise. Temporary contractor satellite accommodation camps are located within the Licence Area, some of which will be closer to well pads (see Chapter 4). Nonetheless, these will be located well outside of the well pad perimeters and hence noise levels at these camps will meet project standards. Noise impacts on the accommodation camps are therefore assessed to be **Low**.

Helicopters

Helicopters are the primary personnel transport mode during construction and can also be used to reach remote parts of the Licence Area. Helicopter noise can lead to noise disturbance of humans and fauna during take-off and landing and, due to the height of flight, overflight (for further discussion of helicopter noise impacts on fauna, and avifauna in particular, see Section 9.9.2.3). Each noise event will be of a short duration, but there will be a number of flights each day and the peak received noise levels directly under a overflying helicopter will be well in excess of 55dB(A). Therefore the noise nuisance from helicopters without mitigation has the potential to lead to a **High** impact. Mitigation controls to reduce noise impacts from helicopter operations will include:

- Daytime operation only of helicopters (avoiding night time disturbance to accommodation camps, any reindeer chums present and fauna)
- Route design to avoid overflight of residential/accommodation camps
- Route design to avoid overflight along the coastal strips (to avoid impacts on seabirds and marine mammals
- Adherence to minimum altitude heights except where safety requirements over-ride.

With the application of these mitigation controls noise nuisance impacts will be reduced to **Moderate**.

Mitigation

Despite the predicted low/negligible noise impacts efforts will nevertheless be made to minimise noise levels. Mitigation of noise impacts during construction activities will be achieved through the following measures:

- control of location of machinery/mechanisms with running engines;
- improvements to the quality of access and on-site roads (to minimise road ‘rumble’)
- adoption of maximum speed limits for road traffic on construction sites;
- ensuring of timely repair or replacement of machinery with a high level of noise and vibration;
- equipping of vehicles and construction equipment with silencers and casings;
- use of construction machinery equipped with electric or hydraulic drives where practicable;
- provide engineers and technicians with equipment for measuring noise and vibration levels at workplaces;
- Auger and vibro-piling techniques will be used in preference to impact piling to reduce noise impacts.

9.8.2.2 VIBRATION

According to the Russian regulatory documentation (GOST 12.1.012-90 and SN 2.2.4/2.1.8.566-96), safe vibration levels are achieved in soil mass at depths of 40 m down to 100 m from the surface source of vibration. Therefore, at well depths deeper than 100 m vibration effects on both ecosystem components and humans are assumed to be negligible. Vibration can be distributed in deep areas over long distances, but its intensity reduces to the power of two with distance.

Therefore, vibration impacts are assumed to be limited to the shallow portions of well drilling and these are assessed as of medium intensity, temporary/short duration, and local in character. On this basis the vibration impacts from drilling are assessed as **Low**.

Nonetheless the following general good practice measures to reduce vibration impacts during construction will be implemented:

- construction of vibration-proof baffles around foundations of vibration-creating equipment;
- installation of equipment on vibration-proof foundations.

9.8.2.3 UNDERWATER NOISE

During the construction period underwater noise will be generated by the following activities:

- General vessel movements
- Dredging of the seaport, approach channel and navigation channel
- Piling as part of the seaport construction, including the trestle jetty structure.

Of these, dredging and piling activities are of primary potential significance and are considered in more detailed below.

Underwater noise has the potential to impact marine fauna including pinnipeds, cetacea and fish. This assessment is based on impacts to the following characteristic species based on their potential presence in the zone of influence of the piling and dredging activities (see Chapter 7). Audiograms are provided below for each of these species, taken from Nedwell *et al.* (2004)[18].

- **Beluga whale *Delphinapterus leucas***

  The beluga whale is one of only two whales thought to be potentially present in the northern reaches of the Gulf of Ob (the other being the bowhead whale *Balaena mysticetus*). Although the likelihood of their presence in the navigation construction area is low, it is nonetheless cautiously considered in the assessment of marine works in this area. There is no evidence of beluga whale reaching as far as the seaport construction, and hence is not considered in the assessment of the marine works in this area. Audiograms for the beluga whale are presented in Figure 9.8.1 and show a peak hearing range between 10 to 100 kHz, with an increasing hearing threshold down to below 100 Hz. Other studies[19] indicate temporary hearing damage in the form of Temporary Threshold Shift (TTS) may occur at exposures over 165 dB re 1 µPa in the frequency range of 11.2 to 90 kHz. Assuming strong avoidance behaviour occurs at 90dB above the hearing threshold[20], strong disturbance is cautiously assumed to occur at levels in excess of 140dB re 1 µPa (this will

[18] "Fish and Marine Mammal Audiograms: A summary of available information" Subacoustech, 2004, Dr. J.R. Nedwell, Mr. B. Edwards, Dr. A.W.H. Turnpenny, Dr. J. Gordon

[19] Popov *et al.*, (2013) Hearing threshold shifts and recovery after noise exposure in beluga whales, *Delphinapterus leucas*. J Exp Biol. 1 May 2013; 216(Pt 9):1587-96.

[20] "Validation of the dB_{ht} as a measure of behavioural and auditory effects of underwater noise", Nedwell et al, 2007.

be a conservative assessment threshold for source levels in frequency ranges below 10 kHz).

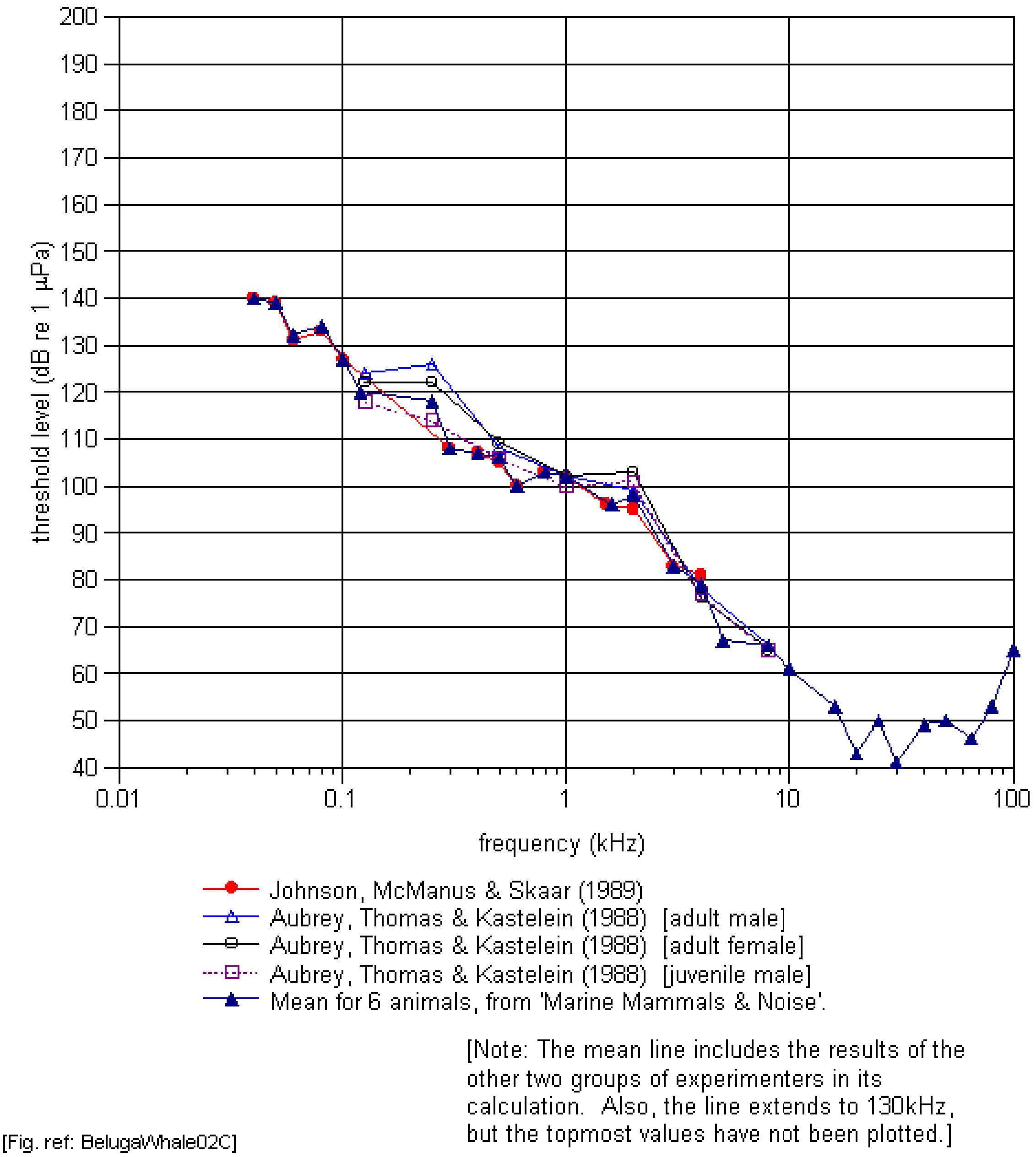


Figure 9.8.1: Audiogram data for the beluga whale (reproduced from Nedwell et al 2004)

- **Ringed seal *Phoca hispida***

The ringed seal is one of the two most common species of seal found along the coastline of the Gulf of Ob and Kara Sea (the other being the bearded seal *Erignathus barbatus*). Although, like other pinnipeds in the region, the Ringed seal within the Gulf of Ob is mainly restricted to the northern coasts of the Yamal Peninsula, the 2013 survey data identified ringed seals as far down the Gulf of Ob as the mouth of the Sabetta and Venuymuyeyakha rivers. This means that it is the marine mammal species most likely to be present in the coastal areas of the seaport and the immediate vicinity of the farther offshore navigation channel, and is therefore considered here in the assessment of marine activities in both these areas. An audiogram for the ringed seal is shown in Figure 9.8.2. The species has a hearing threshold of between 70 to 80 dB re 1µPa in the frequency range of 1 to 20 kHz. There are limited data available for TTS for ringed seals, although strong disturbance is assumed to occur above 160dB re 1 µPa.

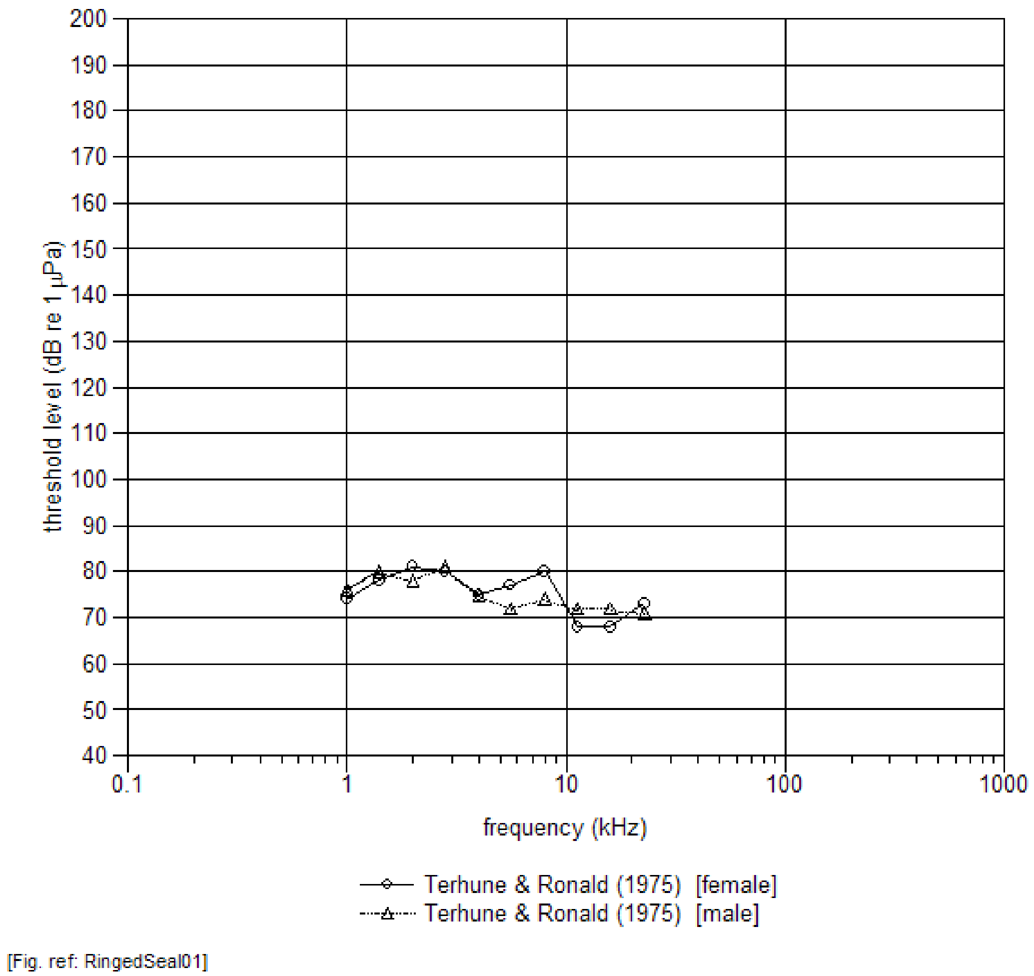
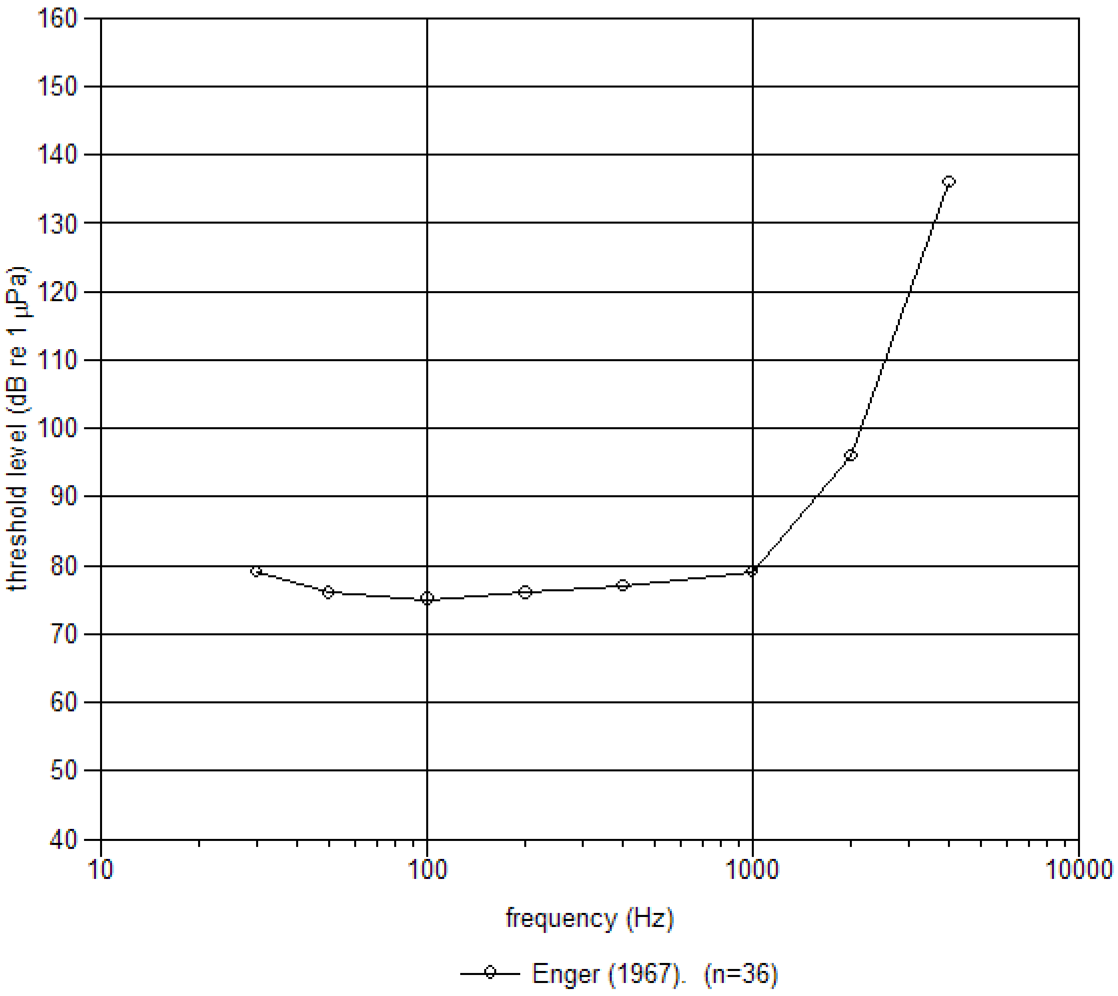


Figure 9.8.2: Audiogram data for the ringed seal (reproduced from Nedwell *et al.* 2004)

- **Herring *Clupea pallasi suworovi***

Herring are one of a number of marine and anadromous fish species present in the Gulf of Ob and are selected for inclusion in this assessment due to the high acoustic sensitivity of the Clupeoidea, especially at low frequency sounds. Audiogram data for herrings (based on the *Clupea harengus* species) are presented in Figure 9.8.3 below, which shows a peak hearing range between 30 to 1000 Hz with a hearing threshold in this frequency range of around 75 to 80dB re 1µPa. Strong disturbance in this frequency range is assumed to occur at levels above 165dB re 1µPa.



[Fig. ref: Herring_G_01]

Figure 9.8.3: Audiogram data for herrings (reproduced from Nedwell *et al.* 2004)

Dredging Activities

A review of underwater noise sources by Nedwell and Howell has identified limited noise measurements for dredging in the literature[21]. Available data for dredging shallow waters show peak spectral source levels of around 177 dB re 1 µPa @ 1 m between 80 and 200 Hz. This frequency range is outside the peak hearing range of the beluga whale, although will still be audible (the hearing threshold at 200 Hz is around 120 dB re 1 µPa). Audiogram data at frequencies below 1 Hz are limited for the ringed seal, although significant disturbance would be expecteed based on its peak hearing range between 1 to 20 Hz.

[21] "A review of offshore windfarm related underwater noise sources", Nedwell and Howell, Report to the UK Collaborative Offshore Wind EnergyResearch into the Environment (COWRIE), 2004.

Navigation Channel Dredging

Dredging impacts in the navigation channel (where the presence of beluga whale is unlikely but possible) are assessed assuming simple spherical spreading of sound[22], the noise contours in 20dB intervals for dredging of the navigation channel are shown in Table 9.8.4.

Table 9.8.4: Predicted noise contours for dredging	
Distance form source (m)	**Noise level (dB re 1 μPa)**
1	177
10	157
100	137
1,000	117

This noise source level would be audible to beluga whale to around 1 km from the dredging activity. However, behavioural response/disturbance is only likely to occur in the near vicinity of the dredging activity.

The noise impact on marine mammals will be limited to localised disturbance in the immediate vicinity of the dredging activity and the width of Gulf of Ob in the area of the navigation channel is sufficiently wide (generally well over 50 km) to allow avoidance of the esonified area. Overall, the noise impacts on marine mammals from dredging are assessed to be **low**.

Herrings are hearing specialists at low frequencies and have a peak hearing range that coincides with the likely peak energy spectra from dredging. Within this frequency range the hearing threshold of the herring is under 80dB. It therefore likely that dredging activities will be audible to herring over a significant distance (several kilometres). However, significant behavioural response (assumed at over 165dB re 1μPa) would only be anticipated in very close proximity (less than 10m) to the dredging activity. The noise impacts of dredging on herring are therefore assessed as **low**. Other fish species in the Gulf of Ob will be significantly less sensitive to noise sources in this frequency range and therefore noise impacts on other fish species will typically be **low**.

It is recommended that Marine Mammal Observers (MMOs) and associated marine mammal protection protocols are implemented to ensure mammals are not present in safety zones prior to or during dredging activities. However, dredging activities are an Associated Facility activity that will be undertaken by a third party and YLNG has no direct control of these activities and therefore is no in a position to guarantee that such practices are implemented. Nonetheless, Yamal LNG will undertake best endeavours to ensure that this occurs pursuant to general agreements with Rosmorport.

Seaport/Approach Channel Dredging

Noise impacts from dredging within the seaport basin and approach channel will be similar to that in navigational channel, although the overall significance is likely to lower as beluga whales are not anticipated to be present in this area.

[22] This equates to a reduction in sound level of 20 dB for each tenfold increase in distance.

Piling (Seaport construction)

Nedwell and Howell report that a number of offshore pile driving noise measurements are available in the literature for piles with diameters ranging from 208 mm to approximately 4 m. Source levels vary, ranging from 192 to 261 dB re 1 µPa @ 1 m and typically increase with pile diameter. Pile driving contains a broad range of frequencies peaking between 100 and 1,000 Hz, but with nonetheless significant source levels up to around 20 kHz. Based on review of the available data, the 1m source level, S is estimated from the pile diameter, D (m), using the following formula:

$$S = 24.3D + 179 \text{ dB re } \mu\text{Pa}$$

The piles required for the trestle jetty construction will have an external diameter of 1420 mm, and hence the source level is estimated (rounded to the nearest 5dB) to be 215 dB re 1 µPa @ 1 m. Using this source level, the predicted noise contours are provided in Table 9.8.5 assuming simple transmissions loss with distance (r) for shallow waters of 15log10(r).

Table 9.8.5: Predicted noise contours for impact piling

Distance form source (m)	Noise level (dB re 1 µPa)
1	215
10	200
100	185
1,000	170
2,154	165
4,642	160
10,000	155

Strong disturbance of ringed seals is assumed to occur for received noise levels above 160dB within the peak hearing range of 1 to 30 kHz, which is above the main frequency range for impact piling. The 160dB level is conservatively assessed to extend to over 4km, although due to the peak frequency range of piling compared to the peak hearing range of ringed seals and the non-constant nature of the impact piling actual disturbance is likely to be restricted to significantly closer to the piling activity). On this basis, the unmitigated impact on ringed seals is assessed as **moderate**.

Impacts on fish may also occur with strong disturbance ranges for hearing-specialists such as herring likely to be of the order of around 2km. In addition, anadromous fish species may also be present in area of the seaport. However, the mouth of the nearest significant river, the river Sabettayakha, is some 3 km north of the seaport area and furthermore the width of the Gulf of Ob in that area is over 35 km, providing the opportunity for migrating fish to avoid the immediate construction area. Overall the unmitigated impact to fish is assessed as **moderate**.

The impacts to marine fauna during piling activities in the seaport area will be mitigated through the application of the following mitigation measures:

- Use of vibro-piling techniques in all cases where ground conditions allow. Where vibro-piling is not feasible, auger piling will be used in preference to impact piling where feasible. This will lead to a significant reduction in the noise scoure level as compared with impact piling. Review of reported noise 1m source levels for impact and vibro-piling of 4m diameter piles indicates that vibro-piling source levels can be over 30dB lower than impact piling. Conservatively assuming a 20dB reduction for the jetty construction through the use of vibro-piling, the noise contours are re-assessed in Table 8.4.6 below. These indicate that even under conservative assumptions, strong disturbance of marine mammals will occur within less than 200m and risks of TTS are reduced to the immediate vicinity of the piling activity.

Table 9.8.6: Predicted noise contours	
Distance form source (m)	**Noise level (dB re 1 µPa)**
1	195
10	180
100	165
215	160
1,000	150
4,642	140
10,000	135

- Soft-start (i.e. gradual build up in the power and intensity) piling methods will be applied in order to disturb marine fauna from the immediate vicinity of the construction activity where physical harm (e.g. TTS) could otherwise occur.

With the adoption of these mitigation measures the residual impacts are assessed to reduce to **low** for both marine mammals and fish.

9.8.3 COMMISSIONING AND OPERATION

Noise and vibration sources during the commissioning and operation phases are summarised in Table 9.8.7 below.

Table 9.8.7: Noise and Vibration Sources during Commissioning and Operation		
Facility	**Emission type**	**Sources**
Well field	Noise	Drilling rigs Wind power generators (wells 21 and 106)
	Vibration	Drilling rigs
Sabetta camp facilities	Noise	Boiler-house Automated gas distribution system (AGDS) Firing fighting facilities Mobile automated power plant (MAPPs) Water treatment facilities
LNG Plant	Noise	Gas receiving facilities LNG process equipment: • Gas generators and compressors • Flaring system • Other Process equipment Power plant Auxiliary/emergency power plant (including at LNG accommodation camp)
Airport	Noise	Road vehicles Mobile construction equipment Mobile generators

Table 9.8.7: Noise and Vibration Sources during Commissioning and Operation		
Facility	**Emission type**	**Sources**
		Aircraft (during landing and take-off cycle (LTO))
Seaport (main)	Noise	Ventilation equipment Shipboard installations and engines Pumping stations
Shipping	Noise	Ice-breaking/ice class vessels

The assumed sound power levels of noise-significant equipment have been derived in accordance with Russian Federation standard SN 2.2.2/2.1.8.562-96 and equipment passports (where available). The sound power levels are summarised in Annex A.

9.8.3.1 AIRBORNE NOISE

Noise impacts are assessed for the operational phases of each of the main project facilities in turn below.

- **Wells pads**

  The primary noise sources at the well pads relate to drilling operations, which are similar to those during construction. The noise impacts are therefore assessed to be:

  - **Low** for occupational noise impacts and noise impacts on fauna at the well pads
  - **Negligible** for the Sabetta and LNG accommodation camps and also for passing reindeer herders.

- **Sabetta Camp**

  Noise levels from the utilities at the Sabetta camp during operations have been assessed by FRECOM on behalf of Yamal LNG in line with the methods set out in SNiP 23-03-2003, "Noise Protection". M., 2004 (using the "Ecologist-Noise" model developed by Integral). The results of the assessment have been used to estimate SPZ requirements for day and night time noise control for the key noise generating facilities, and these are summarised in Table 9.8.8 below.

Table 9.8.8: Calculated SPZ for Key Noise Sources at the Sabetta Camp	
Facility/Source	**SPZ width for noise control (m)**
Boiler House	40
Fire-station	45
AGDS	40
Water treatment plant	100
Fire suppression station	50

The noise assessment indicates that noise levels at the accommodation blocks from the above facilities are below 35dB (and well within Project standards). Noise impacts from the facilities at the Sabetta camp during operations are therefore assessed to be **Low.**

- **LNG Plant**

Noise impacts during the operation of the LNG plant have been assessed using "Ecologist-Noise" model, based on assumed significant noise sources as specified in Annex A. As the LNG plant will operates on a 24-hour basis, the noise assessment considers compliance with both day time (55dB(A)) and night time (45dB(A)) noise standards for residential areas. The assessment has been undertaken through consideration of 'noise nuisance zones', namely the maximum distance from the LNG Plant at which day time and night time noise levels exceed 55dB(A) and 45dB(A) respectively. The calculated nuisance zones for key individual equipment are presented in Table 9.8.9[23] below.

Table 9.8.9: Calculated Noise Nuisance Zones at the LNG Site during Operations

Facilities, process operations	**Noise Nuisance Zone (m)**	
	Day time 55dB(A)	**Night time 45dB(A)**
Receiving facilities		
Gathering station, switch valve station	1.7	5.5
Auxiliary room block	1.5	4.6
Gas separation unit	40	108
Methanol regeneration unit	1	1
Condensate stabilization unit	20	57
Methanol day tank, methanol pumping station	9	28
Stabilized condensate storage	109	303
Gas compressor house for condensate stabilization	41	112
Flare system	40.5	112
LNG Process Plant		
Acid gas removal	193	495
Gas drying and mercury removal unit	350	808
Liquefaction and refrigerating unit	470	990

[23] Data from Design Document 11-035.2-OOC-8.3

Table 9.8.9: Calculated Noise Nuisance Zones at the LNG Site during Operations		
Facilities, process operations	**Noise Nuisance Zone (m)**	
	Day time 55dB(A)	**Night time 45dB(A)**
Rectification unit	175	420
Flare systems	64.6	183.2
LNG Storage and Offloading		
Pump house	1	1
Heating Medium System	176	240
Auxiliary power plant	7.6	23.6
Services facilities area		
Administration building	4.1	12.5
Communication hub	4.5	14.2
MRS	1.5	5.1
Materials and equipment depot	1	1
Garage-parking area	3.4	10.7
Domestic WPS 1 2,3Industrial and storm waters tank	1	2.3
Fire-fighting water supply pumping station zone	1	3.1
Fire house and gas rescue station zone		
Fire house	2.2	6.9
Gas rescue station	1	3.1

The above noise sources have been aggregated in order to assess the overall 45dB noise contour around the LNG site and to confirm noise levels at reference points on the edge of the SPZ. The 45dB contour and the SPZ for the LNG facility are shown in Figure 9.8.4 below. Noise levels are assessed to be below 45dB within 1km of the LNG facility and meet noise standards at the edge of the SPZ. On the basis of the noise nuisance distances, the size of the proposed SPZ and given the distance of the LNG plant from the LNG and Sabetta accommodation camps (both >>1km), noise impacts on the camp are assessed to be **negligible**. Impacts on fauna are assessed as **low** on the basis of the overall zone of potential noise disturbance.

In relation to occupational health noise impacts, detailed noise zoning studies are being performed as part of the detailed design of the main process areas and will be used to define noise protection areas (i.e. areas where personnel protective equipment is required and also where specific sound-proofing of manned areas is required. With the application of these controls occupational noise impacts will be **low**.

Mitigation of noise impacts during the operation of the LNG Plant will be achieved through the following measures:

- Appropriate placement of process equipment and workplaces, as well the creation of noise suppression zones by using sound-absorbing construction materials;
- Placement of main equipment of foundations that prevent resonant phenomena;
- Soundproofing and vibration-proof insulation of facilities;
- Adherence to process procedures and equipment operating rules;
- Performance of regular inspections, routine and major repairs of all equipment;
- Use of personal protection equipment by the personnel as necessary.

- **Seaport**

Noise impacts during the operation of the seaport have been assessed using “Ecologist-Noise” model as part of the development of the Seaport OVOS[24]. As the seaport will operate on a 24-hour basis, the noise assessment considers compliance with both day time (55dB(A)) and night time (45dB(A)) noise standards for residential areas.

The primary noise sources during the operation of the seaport will include (see Annex A for inventory of equipment and source noise levels):

- Ventilation equipment;
- Transformer substation;
- The complex machinery;
- Parking and vehicular traffic;
- Marine facility;
- Pump installations.

The predicted aggregated noise levels around the seaport are presented in Table 9.8.10 and the 45dB contour for the seaport is shown in Figure 9.8.4 below, together with the seaport SPZ.

Table 9.8.10: Predicted noise levels around the seaport during operation

Point	Location (from border of facility)	Equivalent sound level, L_{Aeq} dB(A)
1	100m north	43.8
2	100m north-east	48.5

[24] Document 2030-4478-00-8.8-OOS, LLC "Eco-Express-Service" Mastering the South Tambeyskoye condensate field. Construction of objects of the sea port near the village. Sabetta on the Yamal Peninsula, including the creation of the shipping approach channel in the Gulf of Ob. Objects of the preparatory period. Tom 8.8. Book 8.

Table 9.8.10: Predicted noise levels around the seaport during operation		
Point	**Location (from border of facility)**	**Equivalent sound level, L_{Aeq} dB(A)**
3	100m east	43.4
4	100m south-east	34.8
5	100m south	39.2
6	100m south-west	43.8
7	100m west	39.3
8	100m north-west	43.3
9	200m north	40.3
10	200m north-east	44.9
11	200m east	40.7
12	200m south-east	33
13	200m south	36.5
14	200m south-west	41.1
15	200m west	37.0
16	200m north-west	40.3

All predicted noise levels are below the night time noise limit of 45dB within 100m of the boundary of the seaport facility. The only exception to this is assessment point 2 (to the north east of the seaport in the seaward direction), at which the 45dB limit is attained at 200m from the facility boundary. On the basis on the noise assessment, an SPZ is therefore set around seaport as follows:

- 200m from the facility boundary in the north-east direction (this is over the sea)
- 100m from the facility boundary in all other directions.

The overall size of the noise impact zone is considered to be small, limiting impacts on fauna and having no discernible impacts on the accommodation areas both of which are several kilometres for the boundary of the seaport facility. Noise impacts from the operation of the seaport are therefore assessed as **low** (terrestrial fauna) to **negligible** (accommodation areas).

- **Airport**

The main noise sources from the operation of the airport will be aircraft during the landing and take-off (LTO) cycle.

The assessment data[25] suggests that noise levels at the Sabetta accommodation camp may exceed Project Standards during night time operation of the larger aircraft type (IL-76) that are planned to use the airport. However, the total number of flights is limited (two per day), of which number of IL-76 aircraft movements is anticipated to be approximately four per month. The noise impacts from the operation of the airport are therefore assessed to be **Moderate**.

Therefore, additional measures for protection of the personnel from noise in the Sabetta accommodation camp will be taken, most important of which will be the avoidance of night-time flights. Other mitigations controls include sound insulation of dwelling houses, etc.), and environmental surveys and measurements are recommended to be conducted in order to define a sanitary zone size. In addition noise mitigation operational controls (e.g. noise abatement routing and take-off/departure profiles etc.) may be considered if monitoring data indicate them to be necessary. With the application of these additional mitigation controls, residual impacts are assessed as **Low**.

Aircraft movements may also lead to the disturbance of fauna, and in particular birds. However, due to the low number of aircraft movements the disturbance will be infrequent (approximately 4 times per day – each take-off and landing) and each period of disturbance will only last for a few minutes. The noise impacts on fauna from aircraft movements are therefore assessed as **low**.

- **Summary**

A summary of the aggregated noise impacts around the main facility areas, together with the SPZs is shown on Figure 9.8.4.

[25] Data from airport design documentation

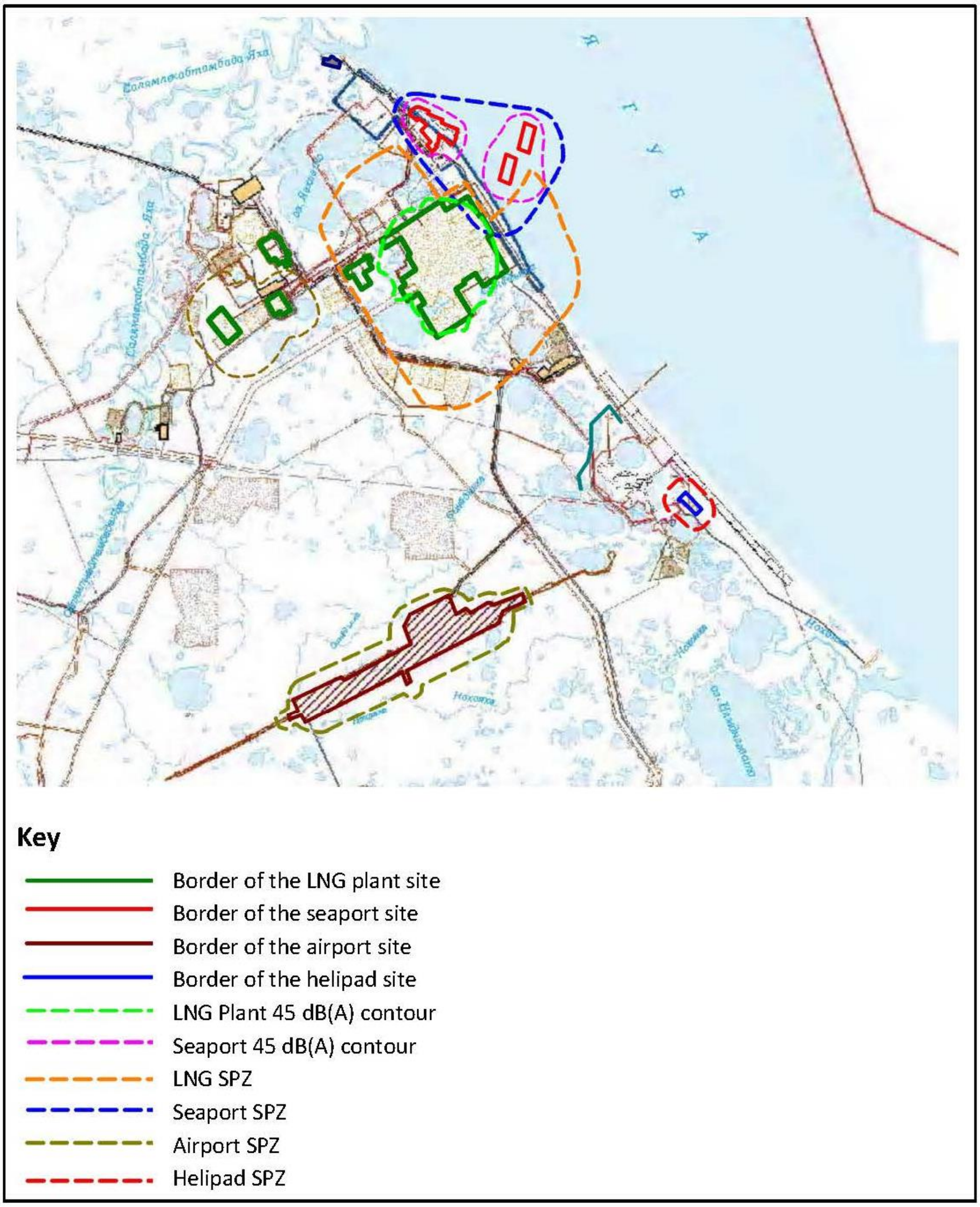


Figure 9.8.4: Summary SPZ and 45dB(A) contours around main facilities

9.8.3.2 UNDERWATER NOISE

Ice-breaking

Icebreakers and ice-class vessels will be used to break a path through ice. This is achieved by ramming of the ice, although bubbler systems may also be used to aid clearing ice from the vessel's path. Noise is generated from both the propeller cavitation and the bubbler systems. Bubbler sound levels have been estimated at 192 dB *re* 1 µPa at 1 metre between 0.1 to 20 kHz and propeller noises during ramming at up to 197 dB *re* µPa at 1 metre between 0.1 to 22kHz[26]. Icebreaking is considered by the US National Marine Fisheries Services (NMFS) to be a "threshold Level B sound", which equates to a harassment threshold for continuous noise for marine mammals of 120dB. Other studies have indicated that noise disturbance occurs at approximately 90dB above the hearing threshold (see Section 9.10.2.4).

Some modelling studies of ice-breaking in the literature [27] have identified that sound level decays to 120 dB in about 20km, therefore an approximate 40km wide area would be subject to the sound levels of >120 dB, although the actual spreading and attenuation of sound is dependent on site-specific depth and topography[26].

The effects of ice-breaking on marine mammals have been considered based on available literature. This is not an exhaustive list and data is not available for many species. The sound levels and spectra produced by ice-breaking are in auditory range of some marine mammals present in the region. TSS and avoidance behaviours are recorded for beluga whales at the sound levels expected to be produced by ice-breaking. Available literature indicates that propeller and bubbler noises respectively are predicted to be audible at ranges over 52 to 78 km and 35 to 53 km (these are variable dependent upon the depth and topography). Disturbance of beluga from ice-breaking has been reported through field trials to occur at to occur at 81dB at 5kHz. These disturbance thresholds are lower than generally reported for broadband noise and LGL and Greeneridge[28] concluded that this apparent heightened behavioural sensitivity of belugas to ice breakings is at least partly due to ice confinement.

Behavioural changes in response to ice-breaking included swimming away, change of calls, changing diving behaviours, and avoidance of the area for 2 days after[29]. Researches have, however, concluded that Beluga whales are unlikely to get close enough to icebreaking for the noises to interfere/mask their communication systems or damage their auditory systems. It has also been postulated that animals may endure louder noises if important behaviours were occurring such as mating, nursing or feeding[26]. Bowhead whales have also been shown to exhibit disturbance behaviours in response to icebreaking noise at a predicted 10 to 50 km away from an icebreaker ship, with perceived likely biological implications, e.g. while feeding and also for calves

[26] Erbe, C. and Farmer, D. M. 2000. Zone of impact around icebreakers affecting beluga whales in the Beaufort Sea. Journal of Acoustic Society America. 108 (3). p. 1332 – 1339.
[27] NMFS. 2005. Endangered Fish and Wildlife; Notice of Intent to Prepare an Environmental Impact Statement. Federal. Register. 70 (7). p. 1871-1875.

[28] LGL and Greeneridge 1986
[29] Cosens, Susan E., and Larry P. Dueck. "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.

and mothers[30]. No research was located on the auditory systems of the bowhead whale, although evidence suggests bowheads have good hearing for frequencies below 0.4 kHz[31] (within the range of icebreakers).

Although it is unlikely that cetaceans penetrate into the Gulf of Bay during the winter, the disturbance corridor of the shipping channel between the Gulf of Ob and the Northern Sea Route on cetaceans may be as wide as 50km either side of the icebreaking vessel. It should also be noted that beluga whales will only swim under to distances of up to around 100km underwater, and hence these impacts are only likely to felt during period where the ice edge is less than 150km from the shipping channel. Nonetheless, overall, the noise impacts from icebreakers on cetaceans are assessed as **moderate**.

Vessel noise (ships other than ice-breakers) have been demonstrated not to strongly affect pinnipeds (seals, sea lions, fur seals, and walrus) that are already in the water and showed varying implications for behaviour when pinnipeds were hauled out[32]. The noise impacts from icebreakers on pinnipeds are therefore assessed as **low**.

Dredging

Underwater noise impacts from maintenance dredging activities will be similar to those during the construction period and the same mitigation measures will be applied as during construction. Residual impacts on marine mammals and fish are therefore assessed to be **low**.

9.8.3.3 VIBRATION

The main vibration sources during operations relate to well drilling and are similar to those during construction and therefore operations phase vibration impacts are assessed as **Low**.

General measures to reduce vibration impacts during operation will include:

- Installation of vibration-proof baffles around foundations of vibration-creating equipment;
- Installation of equipment on vibration-proof foundations.

30 Richardson, W.J., C.R. Greene, Jr., J.S. Hanna, W.R. Koski, G.W. Miller, N.J. Patenaude, and M.A. Smultea. 1995. 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.

31 Ketten, D. R. The Cetacean Ear: Form, Frequency, and Evolution. In: Thomas, J. A., Kastelein, R. A. and Supin, A. Ya. Marine Mammal Sensory Systems. Eds. New York: Plenum, 1992. 773.

32 Richardson, W.J, 1995. Disturbance reactions pp. 241-324 In W.J. Richardson, C.R. Greene Jr., C.I. Malme and D.H. Thomson, eds. Marine Mammals and Noise. Academic Press, Inc.

9.8.4 SUMMARY

Table 9.8.11: Summary of Noise Impacts and Mitigation Control				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
Airborne noise impacts	Humans (occupational health and safety)	Construction	Mitigation of noise impacts during construction activities will be achieved through the following measures: • control of location of machinery/mechanisms with running engines; • improvements to the quality of access and on-site roads (to minimise road 'rumble') • adoption of maximum speed limits for road traffic on construction sites; • ensuring of timely repair or replacement of machinery with a high level of noise and vibration; • equipping of vehicles and construction equipment with silencers and casings; • use of construction machinery equipped with electric or hydraulic drives where practicable; • provide engineers and technicians with equipment for measuring noise and vibration levels at workplaces; • Auger and vibro-piling techniques will be used in preference to impacts piling to reduce noise impacts.	**Low**
	Humans (accommodation camps)			**Negligible**
	Fauna			**Low**
Airborne noise impacts from helicopters	Humans and fauna	Construction	• Daytime operation only of helicopters (avoiding night time disturbance to accommodation camps, any reindeer chums present and fauna) • Route design to avoid overflight of residential/accommodation camps • Route design to avoid overflight along the coastal strips (to avoid	**High** reducing to **Moderate** with the application of the identified mitigation measures.

<table>
<tr><th colspan="5">Table 9.8.11: Summary of Noise Impacts and Mitigation Control</th></tr>
<tr><th>Impact</th><th>Receptor</th><th>Phase</th><th>Design and Mitigation Actions</th><th>Residual Impact</th></tr>
<tr><td></td><td></td><td></td><td>impacts on seabirds and marine mammals
• Adherence to minimum altitude heights except where safety requirements over-ride.</td><td></td></tr>
<tr><td>Vibration impacts</td><td>Humans/fauna</td><td>Operation</td><td>General measures to reduce vibration impacts during construction will include:
• construction of vibration-proof baffles around foundations of vibration-creating equipment;
• installation of equipment on vibration-proof foundations.</td><td>Low (Well drilling)
Negligible (Other construction activities)</td></tr>
<tr><td rowspan="3">Airbourne noise impacts</td><td>Humans (occupational health and safety)</td><td rowspan="3">Operation</td><td rowspan="3">Mitigation of noise impacts during the operation of the LNG Plant will be achieved through the following measures:
• Appropriate placement of process equipment and workplaces, as well organization of noise suppression zones by using sound-absorbing construction materials;
• Placement of main equipment of foundations that prevent resonant phenomena;
• Soundproofing and vibration-proof insulation of facilities;
• Adherence to process procedures and equipment operating rules;
• Performance of regular inspections, routine and major repairs of all equipment;
• Use of personal protection equipment by the personnel as necessary.
Mitigation of noise impacts during the operation of the airport will be developed depending on results of monitored impacts, but mitigation options include:
• sound insulation of dwellings</td><td>Low</td></tr>
<tr><td>Humans (Sabetta and LNG accommodation camp)</td><td>Low (LNG Camp)
Moderate reducing to Low with mitigation (Sabetta camp)</td></tr>
<tr><td>Fauna</td><td>Low</td></tr>
</table>

Table 9.8.11: Summary of Noise Impacts and Mitigation Control				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
			• noise abatement routing and take-off/departure profiles • night-time flight restrictions	
Underwater noise	Marine fauna	Construction and Operational dredging	Best endeavours to convince Rosmorport to keep marine mammal observers on dredge vessel	**Low** (marine mammals) **Low** (fish)
Underwater noise	Marine fauna	Construction seaport piling	• Use of vibro-piling techniques in all cases where ground condition allow. Where vibro-piling is not feasible auger piling will be used in preference to impact piling where feasible. This will lead to a significant reduction in the sound scoure level as compared with impact piling. • Soft-start piling methods will be applied in order to disturb marine fauna from the immediate vicinity of the construction activity where physical harm could otherwise occur.	**Moderate** reducing to **Low** with mitigation (marine mammals) **Moderate** reducing to **Low** with mitigation (fish)
Underwater noise	Marine mammals	Operation (shipping)	• Operation in defined shipping channels • Use of ice-class LNG carriers (rather than ice-breakers)	**Moderate** (icing breaking) **Low** (non-icing breaking)
Vibration impacts	Humans/fauna	Construction	General measures to reduce vibration impacts during operation will include: • Installation of vibration-proof baffles around foundations of vibration-creating equipment; • Installation of equipment on vibration-proof foundations.	**Low** (well drilling) **Negligible** (Other operation activities)

Table 9.8.12: Summary of Noise Monitoring Requirements				
Aspect	**Phase**	**Location**	**Parameters**	**Periodicity**
Noise levels – occupational health	Construction	Confined construction work areas with potentially noisy equipment	Noise levels (L_{Aeq}, L_{Amax}) to confirm compliance with occupational health and safety levels and designation of hearing personal protection equipment zones	Annual
Noise levels – nuisance	Construction	Locations of relevant public exposure	Measurements to be undertaken by accredited bodies in accordance with: • GOST 23337-78 'Noise. Noise measurement methods in residential areas and inside of houses and public buildings' • GOST 12.1.003-83 'Noise. General safety requirements' • SN 2.2.4./2.1.8.562-96 'Noise at workplace, indoors of houses and public buildings and in residential built-up areas' • MUK 4.3.2194-07 Noise level monitoring in residential built-up areas, inside of houses and public buildings and premises' The measurements should be taken on a work day with the facility in a constant operation mode for a week and the most unfavorable wind direction in terms of the location of production pads relative to the noise generating bodies being measured.	Twice a year (summer and winter) for both day and night time
Ultrasound	Construction	Locations of relevant occupational and public exposure	Measurements undertaken by accredited bodies in accordance with SN 2.2.4./2.1.8.583-96 'Ultrasound at workplaces, inside of houses and public buildings and in residential built-up areas'	CHECK SN 2.2.4./2.1.8.583-96
Noise levels - nuisance	Operation	Perimeter of all SPZ	Noise levels (L_{Aeq}, L_{Amax})	Quarterly and during flaring operations
Noise levels - nuisance	Operation	Facades of accommodation blocks at Sabetta and LNG worker camps	Noise levels (L_{Aeq}, L_{Amax})	Monthly Monitoring at Sabetta during aircraft operations (including IL-76 operations)

9.9 TERRESTRIAL FLORA AND FAUNA

9.9.1 INTRODUCTION

The terrestrial flora and fauna present within the Project Licence Area is described in detail in Section 6 of Chapter 7. Impacts are assessed for the following ecological receptors that are considered to be of significant value or sensitivity:

- Designated and protected sites;
- Critical habitats as defined by IFC Performance Standard 6, as well as the underlying qualifying ecological features (e.g. significant populations of migratory birds);
- Natural habitats as defined by IFC Performance Standard 6;
- Species assessed as threatened either by IUCN RL, RDB RF or RDB YNAO; and
- Habitats or species that provide significant ecosystem services (e.g. fish).

The proposed development will result in construction, commissioning and operational impacts as detailed below.

9.9.2 CONSTRUCTION

Construction of the Yamal LNG Project includes the development of South Tambey Gas Condensate field (well drilling, construction of well clusters and linear infrastructure including gas pipelines, access roads and power transmission lines) in addition to the construction of an LNG Plant, a seaport, an airport, and worker accommodation camps. See Chapter 4 for full details.

Construction impacts will include both direct and indirect affects:

- direct impacts resulting in loss of habitats, both permanent (such as well pads, LNG Plant, airport, accommodation, sea port, permanent roads and other infrastructure construction) and temporary (such as sand quarrying areas, dredging, temporary roads and pipeline construction routes); death or injury of individual plants and animals and fragmentation (blocking of or alteration to migration routes).
- indirect impacts on habitats, plants and animals such as pollution, disturbance and reduced food availability.

9.9.2.1 DESIGNATED SITES

No designated sites or otherwise protected areas are present within the Project Licence Area. The nearest protected areas to the Project Licence Area are (see also section 7.6.2):

- Yamal State Biological Reserve (regional importance) - located 139 km to the north of the proposed facility; and
- Gyda State Natural Reserve (federal significance) - located 119 km to the north of the proposed facility.

No pathways of impacts have been identified that could extend over the large distance between the Project Licence Area and any designated sites. Therefore no designated sites will be affected by the proposals.

9.9.2.2 HABITATS

A range of habitats will be lost during the construction phase, including the construction of the well pads, LNG plant, gas pipelines, roads, seaport and airport and associated infrastructure. This will have direct and indirect impacts on flora and fauna species. Temporary roads will be built along the gas pipeline routes. Permanent roads will be built to connect well pads with stores sites and the Sabetta accommodation camp. In order to avoid impacts on some of the water channels single-span bridges will be constructed across all rivers except there the span exceeds 50m. Smaller rivers will be culverted with metal culverts.

Table 9.9.1 shows the area of each habitat type within the Mining Allotment Area, along with the area that will be lost to the development. The footprint of the development will be approximately 40 km^2, representing over 4% of the total Mining Allotment Area. The natural habitats that will be greatest affected in terms of area will be:

- Floodplain vegetation series in combination with sedge-sphagnum-hypnum and cottongrass-sedge-hypnum bogs (9.14 km^2); and
- Complex of polygonal sedge-sphagnum-hypnum bogs, fringed by cloudberry-lichen-moss communities on the swells, and cottongrass-sedge-hypnum bogs (8.5 km^2).

For the majority of natural habitat types, the loss represents between 2 and 5% to the development, except for water bodies which are 0.12%. The Mining Allotment Area is approximately half the size of the Project Licence Area, therefore the losses of habitat are likely to represent between 1-2.5% of those present in the Project Licence Area.

Due to the small parcel sizes of Forb-graminoid, horsetail-graminoid meadow communities on the valley slopes, it was not possible to measure the area of this habitat from remote sensing. However, it would be reasonable to assume that a similar proportion of the overall resource of habitat will be lost. Forb-graminoid, horsetail-graminoid meadow communities on the valley slopes qualifies as critical habitat under criterion 4 as defined by IFC Performance Standards 6.

The loss of Riparian and lakes including bare sands are difficult to interpret as they include large areas of bare sand created during the construction of works that had proceeded prior to the survey including the airport. These areas would likely have been covered by natural habitats prior to construction in similar proportions to those recorded in unaffected areas. Following construction, some habitats will begin to regenerate in some areas such as the areas used for temporary storage of sand.

The overall direct impact from loss of habitat is assessed as being **Moderate.**

Table 9.9.1: Area of each habitat type present in the onshore mining allotment area existing and lost to development

Type of vegetation	Vegetation number on map	Plant community type	CAVM Category[1]	Area of habitat (km^2)	Area of habitat lost to development (km^2)	Area of habitat lost as percentage of whole
Tundra	1	Polygonal dwarf-shrub cottongrass-lichen-moss tundra along with sedge-moss communities in cracks	G3	52.07	1.51	2.89%
	2	Dwarf-shrub moss-lichen tundra, spotted	G3	50.20	1.84	3.67%
	3	Complex/combination of dwarf-shrub graminoid-cottongrass-moss tussock tundra, with willows and Marsh Cinquefoil-sedge coenoses in depressions, and dwarf-shrub cottongrass-sphagnum wetland/waterlogged tundra	S1	132.34	3.89	2.94%
	4	Complex of wetland/waterlogged grass-moss tussocky tundra, sometimes with meadow grasses, and wetland/waterlogged graminoid-cottongrass-moss tundra with arctophila (pendant grass)-sedge-hypnum communities in pools	S1	2.99	0.09	2.87%
	5	Dwarf-shrub herb/forb-moss-lichen sparse communities, sometimes with patches of bare sand	G3	13.38	0.36	2.71%
Bogs	6	Complex of polygonal sedge-sphagnum-hypnum bogs, fringed by cloudberry-lichen-moss communities on the swells, and cottongrass-sedge-hypnum bogs	W2	263.36	8.50	3.23%

Table 9.9.1: Area of each habitat type present in the onshore mining allotment area existing and lost to development

Type of vegetation	Vegetation number on map	Plant community type	CAVM Category[1]	Area of habitat (km^2)	Area of habitat lost to development (km^2)	Area of habitat lost as percentage of whole
	8	Cottongrass-sedge sphagnum-hypnum marshes/eutrophic bogs in depressions and river valley's bottoms	W2	32.14	1.06	3.30%
	7	Arctophila-sedge-hypnum marshes/eutrophic bogs in lacustrine depressions , ephemeral streams, channels and hollows/pools	W1	89.42	3.17	3.54%
Intrasonal habitates	9	Floodplain vegetation series in combination with sedge-sphagnum-hypnum and cottongrass-sedge-hypnum bogs	Riparian corridors	191.94	9.14	4.76%
Sands	10	Riparian and lake habitats - bare sands, drift sands and filled sands * - includes airport and some other project objects	-	135.54	10.56	7.79%
Water bodies	-		-	10.35	0.01	0.12%
Total				**973.73**	**40.13**	**4.12%**

In addition to direct impacts to habitats, indirect impacts could occur from air pollution and waste. The deposition of air pollutants such as nitrogen dioxide has the potential to affect vegetation through the process of eutrophication. The impacts from air pollution are described in full in section 9.2. During the construction phase, the areas affected by air pollutants are likely to be restricted to relatively close proximity to the LNG plant and Port construction areas. The project air quality standards will be met and following the implementation of standard control measures, the impacts to habitats are assessed as **Low**.

During construction there will be a potential risk of impacts to freshwater aquatic habitats arising from pollution. Section 9.4 assesses in details potential impacts to surface waters from a range of activities. Following the implementation of appropriate mitigation, the residual impact to surface water bodies from pollution is assessed as **Low**.

Construction waste will have the potential to cause impacts by contaminating terrestrial, freshwater and marine environments. The assessment and control of impacts from waste are addressed in detail in section 9.7. Without adequate controls, such unmitigated impacts may be of **moderate** However, with the application of the mitigation controls, residual impacts on ecology are assessed as **low**.

9.9.2.3 SPECIES

Rare Plants

A single species listed in the RDB YNAO was recorded in the study area during 2010 and 2013 field surveys: northern jacob's ladder *Polemonium boreale*, (status 3 - a rare species). None listed on the IUCN RL or in the RDB RF were recorded. Impacts on northern jacob's ladder are likely to be limited to loss of habitat. Based on the area of habitat losses within Project Licence Area, without mitigation habitat losses could cause an impact to rare plants of **moderate severity**.

Fish

Based on the available literature and previous studies in the region, the rivers and lakes within the Project Licence Area as well as the brackish coastal waters of the Gulf of Ob may have up to 27 fish species, of 14 families (Table 7.6.18 in Section 7.6.2). During the 2013 surveys, 14 freshwater/ anadromous/semi-anadromous fish were recorded within the Project Licence Area, along with two marine species. None of these species are listed on IUCN RL, RDB RF or the RDB YNAO. Neither Siberian sturgeon or sterlet, which are IUCN RL Endangered and Vulnerable species respectively, and thought to be present in the Gulf of Ob waters, were recorded during surveys undertaken in 2013. Neither species is considered likely to regularly occur within the Project Licence area rivers or lakes. However, fish provide significant eco-system services and therefore impacts to fish are assessed.

The Potential impacts on fish may occur as a result of the direct habitat loss, the creation of road crossings, from quarrying sand from lakes and abstracting freshwater from rivers and lakes, as well as from pollution and waste.

The direct loss of waterbodies will be limited to 0.01 km^2 which represents 0.12% of the available resource within the Mining Allotment Area. A much larger area of waterbodies will be affected by sand quarrying. This has the potential to cause deterioration in habitat quality (e.g reduction in invertebrate prey densities) as well as direct mortality of fish. However, the lakes will likely restore over time either from remaining fish stocks, or through natural recolonisation. The severity of impact on fish from habitat loss and deterioration are assessed as **moderate** in the short term, reducing to **low** as lakes naturally restore and are recolonised.

The creation of road crossings has the potential to block streams and watercourses that are used for seasonal migration by fish. Construction works near riverbanks may also lead to sediment runoff that could also affect fish, including migratory fish. To mitigate these risks, any construction work on the banks of freshwater rivers and lakes will be implemented during the winter period (i.e. outside of migration season and coinciding with low sediment runoff potential. Effects of hydrological impacts on fish will be controlled through the construction of culverts and bridges that allow continued passage of fish and therefore not impact fish. The culvert cross-section is calculated to take into account passage of flood water and, normally, it does not cause any water flow-rates providing any insurmountable obstacles for fish migrations.

During construction there will be a potential risk of impacts to fish arising from pollution. Section 9.4 assesses in details potential impacts to surface waters from a range of activities. Following the implementation of appropriate mitigation, the residual impact to fish from pollution is assessed as **Low**.

If uncontrolled, fishing to feed the construction workers could cause depletion of fish stocks and result in an unmitigated impact of **moderate** severity. Following the implementation of mitigation, to include the control on fishing and purchasing locally caught fish, the impacts are likely to be **low.**

Birds

The avifauna in the Arctic tundra subzone in the north-eastern parts of the Yamal peninsula includes about 80 bird species, of which 52 are likely to breed (46 confirmed and six probable), five species are transient migratory and around 25 species are vagrant. The proximity of the coast, together with the large area of wetlands means that aquatic and semi-aquatic bird species are common in the Yamal.

Of the birds having been previously recorded breeding within the Project Licence Area, a number have been assessed as threatened by either the IUCN, RDB RF and RDB YNOA.

- **Black-throated diver** *(Gavia arctica)* assessed as category 2 (by the RDB RF). Not included in RDB YNAO and assessed as Least Concern by IUCN RL.
- **Brent goose** (*Branta bernicla*) assessed as category 3 by the RDB RF. Not included in RDB YNAO and assessed as Least Concern by IUCN RL.
- **Steller's eider** (*Polysticta stelleri*). Not included in RDB RF or RDB YNAO. Assessed as Vulnerable (VU) by IUCN RL.
- **Long-tailed duck** (*Clangula hyemalis*). Assessed as Vulnerable (VU) by IUCN RL. Not included in RDB RF or RDB YNAO.
- **Peregrine** (*Falco peregrinus*). Included in the RDB RF (category 2) and RDB YNAO (category 3) and assessed as Least Concern by IUCN RL.
- **Snowy owl** (*Bubo scandiaca*). Listed within RDB YNAO (category 2). Not included in RDB RF and assessed as Least Concern by IUCN RL.

As described in Chapter 7, it has not been possible to define Discrete Management Units (DMUs) for breeding birds habitats, and estimation of the size of the bird populations within them. Key among the uncertainties in this regard is the uncertainties in bird densities identified in 2013 due to the atypical conditions encountered. In order to further investigate the nature of the DMUs and the potential breeding bird habitats within them, further surveys will be required, and these will be developed as part of a Biodiversity Action Plan (BAP). Yamal LNG has committed to reinstatement of legacy waste and contamination areas within the Licence area reinstated (see also Chapter 11), and consideration of such reinstatement will be included within the BAP in order the best return these areas to usable breeding bird habitat and to act as potential offsets for habitat loss.

The Project Licence area is not considered to support a significant population of peregrine or snowy owl.

There is no universally accepted quantitative threshold for assessing significance of impacts to bird populations. A 1 % threshold (e.g. 1 % loss of species population at a specified geographic level) is widely used as a useful benchmark. However, in a review of decisions made by competent authorities in relation to impacts to European designated sites (including Special Protection Areas designated due to their international importance for birds), it was found that in many cases even the loss of considerably less than 1% would be likely to be significant and in some cases could adversely affect site integrity (Hoskin and Tyldesley, 2006)[33]. Therefore, a 1% threshold is applied as representing an impact of high severity in relation to bird populations.

Construction impacts on birds are likely to be dominated by loss of habitat but will also include noise and visual disturbance. Habitat used by birds that will be lost during the construction phase includes areas of lakes, rivers and streams used by aquatic species; the seaport and dredging zones used by marine species, and terrestrial habitat used by grazing, nesting and foraging terrestrial species lost to the development footprint. The direct loss of habitats affects approximately 4% of the Mining Allotment Area and 2% of the Project Licence Area. Assuming that this will cause a proportional reduction in the breeding bird population supported by these habitats, it will represent an unmitigated impact of potentially **High** severity (conservatively acknowledging current uncertainties in breeding bird population estimates and DMUs). Mitigation measures are detailed in Table 9.9.2 which would reduce the residual impacts to **Moderate to Low.**

In addition to habitat loss, there is the potential for disturbance may be from human presence, construction work, vehicles, ship, aircraft and helicopter movements. Generally, birds are relatively undisturbed by normal traffic movements if the people remain in the vehicle. During the 2013 field surveys several instances of birds nesting very close to existing construction activities were recorded (figure 9.9.1). However, this may be due to lack of a perception of threat, which could change if any hunting or egg-collecting were to take place from construction workers. Aeroplane and helicopters have been widely shown to cause much higher disturbance to birds than land based vehicles or boats. This may be due to the much higher risk perception by birds from aerial predation. Anecdotal observations were made during 2013 that flight initiation of birds was

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[33] Hoskin, R., & Tyldesley, D. 2006. How the scale of effects on internationally designated nature conservation sites in Britain has been considered in decision making: A review of authoritative decisions. English Nature Research Reports, No. 704.

stimulated by disturbance from helicopters up to 2 km distance. Strong lights have been shown to attract migrating birds to buildings and structures where they become at risk from collision and disorientation. In bad weather this can cause large mortality events. Without mitigation, the unmitigated impact from disturbance including that from helicopters is assessed as being of **High** severity. Mitigation measures are detailed in table 9.9.2 which would reduce the residual impacts to **Moderate to Low.** The potential future use of the airport for helicopters of third party developments, may also lead to cumulative helicopter noise impacts on birds and this is further considered in Chapter 13.

Figure 9.9.1: White-fronted goose nest near the new port

9.9.3 COMISSIONING AND OPERATION

Impacts to flora and fauna from the commissioning and operation phase include impacts such as road traffic collisions, pollution and emission events, waste generation, loss of migration routes, and collision of flying species with power transmission lines; as well as impacts such as disturbance from vehicles, planes, helicopters and other equipment using the roads, port and airport.

9.9.3.1 DESIGNATED SITES

No pathways of impacts have been identified that could extend over the large distance between the Project Licence Area and any designated sites. Therefore no designated sites will be affected during the operational phase.

9.9.3.2 HABITATS

It is not anticipated that further areas of habitat will be lost during commissioning and operational phases, and in fact some areas of habitat will be reinstated. Temporary loss of habitat during the construction period will be reinstated as soon as possible after completion of construction, with planting/seeding with locally sourced native species. Lakeside gravel quarrying areas will be allowed to regenerate, and will be reseeded where appropriate. Road embankments will be reinforced by geo-grids filled with crushed stone and peat. These will also be seeded/replanted. These areas will be temporarily fenced to allow vegetation to grow without grazing pressure.

Operational air quality impacts on vegetation (specifically lichen) have been assessed in Section 9.2. Critical loads for tundra environments are assumed to been in the range of 3 to 15 kg/N/ha/yr, based on review of available literature[34,35]. Inspection of Figure 9.2.3 shows that predicted deposition rates are well below the critical load rate in all locations. Overall, the impacts on vegetation from ambient NO_x and nitrogen deposition are assessed as **negligible**.

During the operational phase there will be a potential risk of impacts to freshwater aquatic habitats arising from pollution. Section 9.4 assesses in details potential impacts to surface waters from a range of activities. Following the implementation of appropriate mitigation, the residual impact to surface water bodies from pollution is assessed as **Low**.

Waste generated during the operational phase will have the potential to cause impacts by contaminating terrestrial, freshwater and marine environments. The assessment and control of impacts from waste are addressed in detail in section 9.7. Without adequate controls, such impacts may be of **moderate** severity. However, with the application of the mitigation controls, residual impacts on ecology are assessed as **low**.

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[34] Review and revision of empirical critical loads and dose-response relationships, Coordination Centre for Effects, 2010

[35] APIS indicative critical load values: Recommended values within nutrient nitrogen critical load ranges for use in air pollution impact assessments (http://www.apis.ac.uk/indicative-critical-load-values)

9.9.3.3 SPECIES

Rare Plants

There will be no direct impacts to rare plant species from additional habitat loss during the operational phase. Indirect impacts from reduction in air quality are unlikely as critical loads will not be exceeded.

Fish

During operation there will be a potential risk of impacts to fish arising from pollution. Sections 9.4 assesses in detail potential impacts to surface waters from a range of activities. Following the implementation of appropriate mitigation, the residual impact to fish from pollution is assessed as **Low**.

If uncontrolled, fishing to feed the operational facility staff could cause depletion of fish stocks and result in an impact of **moderate** severity.

Birds

There will be no direct impacts to birds from additional habitat loss during the operational phase.

The impacts to birds from disturbance would be similar to the construction phase, although the increase in flights of both helicopters and fixed winged planes could increase levels of disturbance. Increased light levels associated with the operational facilities and port could cause significant bird collision events during bad weather. This could cause an unmitigated impact of **moderate** severity. Following implementation of mitigation measures described in table 9.9.2, the severity of the impacts would be reduced to **moderate to low**.

An overhead 6kV power transmission line will be installed to provide power supply to the Sabetta Upper Fuel & Lubricants Store, water abstraction facilities and the Sabetta accommodation camp. There will be a risk of birds colliding with transmission lines. Larger migratory species are most at risk of collision. Night time risks of colliding with transmission lines are limited by the summer presence of birds which coincides with long daylight hours (polar days). Nonetheless, collision risks with transmissions lines could cause an unmitigated impact of **moderate** severity. The level of bird strikes will be monitored and if any problems are detected, then wire markers will be installed to increase visibility to birds, which would reduce the residual impacts **to low** severity.

The mitigation measures required to avoid, minimise and offset impacts described above are detailed in Table 9.9.2, along with the residual impacts. Proposed monitoring measures are summarised in Table 9.9.3.

9.9.4 MITIGATION AND RESIDUAL IMPACTS SUMMARY

Table 9.9.2: Summary of Ecology Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
Impacts on Ecology	Designated Sites	Construction	None required	**Negligible**
	Designated Sites	Commissioning and Operation	None required	**Negligible**
Habitat Loss	Terrestrial Habitats (natural habitats)	Construction	• Permanent roads will be built to connect well pads with stores sites and the Sabetta accommodation camp. Off-road travel and use of temporary tracks will be prohibited. • Areas of temporary loss of habitat during the construction period (e.g. sand storage areas) will be reinstated as soon as possible after completion of construction, with planting/seeding with locally sourced native species. • Road embankments will be reinforced by geo-grids filled with crushed stone and peat. These will be seeded/replanted. • Restoration areas will be temporarily fenced to allow vegetation to grow without grazing pressure. • A habitat management plan will be produced to manage the restoration of terrestrial habitats. • Restoration of habitats will be monitored for a minimum of ten	**Moderate to low**

Table 9.9.2: Summary of Ecology Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			years (and thereafter further monitoring requirements will be determined on the basis of the status of recovery). The results of the monitoring will inform any required changes to the habitat management plan. • Further focused surveys will be undertaken to build on the existing surveys and to better define the potential for critical habitats for breeding bird assemblages within targeted areas as part of a Biodiversity Action Plan, which will also develop methods for an off-setting strategy will be produced to compensate for any habitat loss. • Reinstatement of legacy waste and contamination areas will be reinstated (see also Chapter 11). Consideration such reinstatement will be included within the BAP in order the best return these areas to usable habitat.	
	Aquatic habitats and fish	Construction	• In order to avoid impacts in the water channels single-span bridges will be constructed across all rivers except there the span exceeds approximately 50m. Bridge supports will not be constructed within river beds. Smaller rivers will be culverted with metal culverts • A habitat management plan will be produced to manage the restoration of aquatic habitats. • Restoration of lakes following dredging will be monitored for up to 20 years and the results will inform any required changes to the habitat management plan. • If fish populations do not recover in affected lakes, steps will be taken to improve rate of restoration (e.g. fish stocking)	**Low**
	Habitats	Commissioning and	• Project activities to be limited to designated footprint – e.g. all	**Low**

Table 9.9.2: Summary of Ecology Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
		Operation	travel on constructed roads (no off-road driving). • Any future additional project facilities to be constructed either within existing footprint, or on previously disturbed areas where possible.	
Habitat Loss	Forb-graminoid, horsetail-graminoid meadow communities (critical habitat)	Construction	• A pre-construction survey will be completed to produce a detailed map showing areas Forb-graminoid, horsetail-graminoid meadow communities. • Roads, pipelines and transmission lines will be micro-sited to avoid losses of Forb-graminoid, horsetail-graminoid meadow communities. • A detailed assessment would be completed to assess precise levels of loss of Forb-graminoid, horsetail-graminoid meadow communities caused as a result of construction activities • A Biodiversity Action Plan and off-setting strategy will be produced to compensate for habitat loss.	**Low**
Habitat Loss	Rare Plants	Construction	• Pre-construction surveys will identify any rare plants in the footprint of the development. • Any rare plants will be translocated to unaffected areas prior to construction. • Populations of rare plants within the Project Licence Area will be monitored.	**Low**
Habitat Loss	Breeding Birds	Construction	• A Biodiversity Action Plan and off-setting strategy will be produced to compensate for habitat loss. Measures may include working with local people to reduce the effects of	**Moderate to Low**

Table 9.9.2: Summary of Ecology Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			overgrazing. • Bird populations will be monitored over the life time of the Project. The results of the monitoring will feed into the Biodiversity Action Plan to inform actions taken. Also causal factors for population changes will be investigated and published into respected international journals to inform the wider conservation knowledge of arctic birds.	
Bird Strike	Birds	Commissioning and Operation	• Monitoring of bird strike along power lines. • Installation of wire markers (to increase visibility to birds) if problem areas are detected.	**Low**
Disturbance	Birds	Construction and operation	• Vehicles will be limited by speed controls on roads. • Workers will be encouraged to minimise leaving vehicles unless necessary. • Hunting and egg-collecting will be strictly forbidden. • The lighting engineers will work with experienced ornithologists to produce a detailed lighting design to reduce vertical and horizontal light spill. Lights will be selected with colouration known to reduce attraction by birds. • Helicopter and aeroplanes will be restricted to designated flight corridors away from key breeding areas. • Disturbance to birds will be monitored for the life span of the project and corrective measures will be incorporated in the Biodiversity Action Plan. • The facility and built structures will be monitored during peak migration for signs of bird collisions. If significant mortality events occur, the causes will be investigated and appropriate	**Moderate to Low**

Table 9.9.2: Summary of Ecology Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			mitigation measures will be adopted to reduce the risk (e.g. change in lighting direction, colouration etc.). • Construction workers and facility staff will receive training in relation to the importance of the bird populations (and other ecological receptors) and measures to be taken to reduce impacts.	
Alien and invasive species	Habitats and species	Construction and Operational	• The presence of alien and invasive species will be monitored for the life time of the project. • If alien or invasive species are detected, control measures will be considered to avoid impacts to natural habitats and species.	**Low**
Waste water	Habitats and species	Construction and Operational	• Process and domestic wastewaters will be treated to meet Project standards prior to discharge to the receiving bog environment and will therefore not result in significant impacts on the marsh/bog water quality. • Sediment controls measures including silt fencing will be used during earthworks in the vicinity of surface waterbodies where necessary. • Further details of surface water impacts and mitigation control are provided in table 9.4.15	**Low**
Waste contaminants	Habitats and species	Construction and Operational	• Minimise risk of contaminating aquatic habitats by: containment of temporary waste storage facilities, locating SIDW landfill in an area outside of protection zones for water bodies, provision of low permeability liners for SIDW landfill and mud pits and encapsulation of mud pits following completion.	**Low**

Table 9.9.2: Summary of Ecology Impacts and Mitigation Control

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			• Mitigation measures for waste control are detailed in Table 9.7.10.	
Air Quality	Terrestrial Habitats and species	Construction and Operational	• Emissions to air to be minimised. See section 9.2 and Table 9.2.10 for details of mitigation to reduce air quality impacts.	**Low**
Water Abstraction	Fish	Construction and Operational	• The water abstraction facility will be equipped with fish protection filtering devices.	**Low**
Pollution	Aquatic Habitats and fish	Construction and Operational	• Minimise risk of contaminating aquatic/marine habitats by: containment of temporary waste storage facilities, locating SIDW landfill in an area outside of protection zones for water bodies, provision of low permeability liners for SIDW landfill and mud pits and encapsulation of mud pits following completion. • Pollution will be prevented by implementing a pollution control plan. Sections 9.3 and 9.4 and Table 9.3.2 provide further information on this.	**Low**
Hunting and Fishing	Birds and fish	Construction and Operational	• Hunting, fishing and egg-collecting by construction workers and facility staff will be strictly forbidden. • Purchasing fish, eggs or meat from local people will be strictly forbidden	**Low**

Table 9.9.3: Summary of Ecology Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
Terrestrial Habitats	Commissioning and Operation	Project Licence Area	Vegetation Change Monitor change in distribution of vegetation types using remote sensing techniques.	Once every five years.
Terrestrial Habitats	Construction Commissioning and Operation	Project Licence Area Five 5m*5m survey plots per vegetation type. Location of each plot to be randomly selected within Project Licence Area.	Vegetation Change The surveys would be completed using fixed point quadrats to record plant species diversity, ground cover and structure, combined with photographic records. Level of grazing / signs of overgrazing	Once per summer, every other year.
Terrestrial Habitats	Construction Commissioning and Operation	Any areas of impacted and restored vegetation	Habitat Restoration Plant species diversity, ground cover and structure, combined with photographic records of fixed point quadrats.	Once per summer, every other year.
Freshwater Aquatic Habitats	Construction Commissioning and Operation	To include all waterbodies that are directly impacted (e.g. hydraulic quarries), water bodies that could be affected indirectly (e.g. by run-off), as well as water bodies away from the impacted area that would serve as control sites.	Habitat Restoration Monitor changes to aquatic environment including hydrochemistry, pollution, water temperature, water level, flow rates etc. Phytoplankton, zooplankton, zoo benthos and fish (Species diversity, density and age class).	Once per summer, every other year.
Rare Plants	Construction Commissioning and Operation	Existing known locations	Rare plant distribution Distribution and number of individuals of rare plant species	Once per summer, every other year.
Birds	Construction Commissioning and Operation.	Project Licence Area Minimum of ten survey plots. Each plot 50 m*50 m	Breeding success Fixed point / constant effort monitoring of nesting densities of each species, number of eggs per nest.	Once per summer, every year.
Birds	Construction Commissioning and Operation.	Project Licence Area Ten survey plots. Each plot 5 km*5 km	Breeding success Fixed point / constant effort monitoring of number of broods of each species, number of adults and juveniles.	Once per summer, every year.

Birds	Commissioning and Operation.	Project Licence Area	Disturbance Signs of disturbance by construction works and facility staff. Disturbance by helicopters and aeroplanes	Once per week during spring summer and autumn, every year.
Birds	Commissioning and Operation.	Along route of power lines, especially in vicinity of rivers and lakes. Buildings and port facilities.	Bird Strike (mortality) Number and species of birds killed through collision with power lines, buildings and or structures	Once per week during spring summer and autumn, every year.
Terrestrial Mammals	Construction Commissioning and Operation.	Random sample plots	Small mammals Small mammal species and densities.	Once per summer, every year.
Terrestrial Mammals	Construction Commissioning and Operation.	Existing known locations of breeding earths	Artic fox Monitoring of existing known fox earths for presence / absence and signs of breeding	Once per summer, every year.
Terrestrial Mammals	Construction Commissioning and Operation.	Project Licence Area	Polar Bear Number, age of animals and behaviour. Time of year, length of stay. Interactions with people and facilities. Any damage caused either to people, project facilities or any mortality / injuries to the bears.	Continuous
Alien and invasive species	Construction Commissioning and Operation.	Project Licence Area	Alien and invasive species Location, species and number / density. Any action or management to control / eradicate.	Continuous

9.10 MARINE FLORA AND FAUNA

9.10.1 INTRODUCTION

Impacts to marine flora and fauna are assessed in this section. In undertaking this assessment it is noted that many of the activities that have the potential to impact on the marine environment are Associated Facilities (see Chapter 4 for further details) as they are undertaken by third parties without any direct control by Yamal LNG. Such Associated Facilities include:

- All offshore dredging activities (see Section 9.4 for further details)
- Construction of the ice barrier in the sea port
- MOF and Main Seaport operation

As such, while the impacts on the marine associated with these activities are assessed in this section, Yamal LNG does not have control over the implementation of suggested mitigation controls.

As noted in Chapter 7, the surface water bodies within the Project Area and the Gulf of Ob are habitats of valuable fish species (salmon, whitefish, smelt). Many of these are objects of commercial and sport fishery. Commercial fisheries exist only in the southern and central parts of the Gulf of Ob. Some reindeer herders seasonally catch cisco for subsistence in the coastal waters north of Seyakha - Cape Khasre traverse (see also Chapters 8 and 10). The seasonal lifecycle of the Yamal fish is described in Chapter 7.6. The summer season is the period of:

- feeding and growth of whitefish larvae in rivers and lakes (nelma, muksun, pydschjan (pyzhyan), broad whitefish, peled, vendace, smelt);
- migration of young fish into lower reaches and estuaries; migration of whitefish spawners into rivers (cisco, muksun, broad whitefish, vendace, nelma);
- entry of navaga, horned sculpin, polar cod, etc. from the sea into the Gulf of Ob estuaries and feeding of juveniles and adult species of nelma, muksun, broad whitefish, pydschjan, and vendace.

By winter, all fish populations, except mature species that entered rivers to spawn in upper reaches, migrate into the Gulf of Ob. The northern boundary of the whitefish occurrence in the Gulf of Ob is the confluence of fresh and saline waters, i.e. a rough line traversing the bay from the Seyakha estuary on the western shore to Cape Kharse on the eastern shore. During additional hydrobiological surveys undertaken in 2013, it was established that the navaga and vendace populations in the Gulf of Ob were feeding. All inland water bodies in the subject area are characterised by limited resources of zooplankton and zoobenthos, which characterises these water bodies as lacking fish feeding reserves. No critical habitats of fish and other aquatic organisms were identified.

9.10.2 CONSTRUCTION

9.10.2.1 POTENTIAL IMPACTS

The potential impacts on the marine environment during the construction phase are summarised in Table 9.10.1 below.

Table 9.10.1: Potential impacts to marine flora and fauna during construction

Activity	Potential Impact
Dredging	Sedimentation impacts on benthic flora and fauna (see also section 9.4.2.8)
	Raised turbidity impacts on palegic fauna (see also section 9.4.2.8)
	Underwater noise impacts on marine mammals and fish (see also section 9.8.2.3)
Construction activities in and around inland rivers	Release of sediment into rivers and downstream to coastal environments, affecting benthic flora and fish migration
Piling (during jetty construction)	Underwater noise impacts on marine mammals and fish (see also section 9.8.2.3)
Discharges to sea (from vessels and onshore waste water treatment)	Changes to water quality leading to impacts on marine flora and fauna Introduction of invasive species in ballast water
Water abstraction	Ingestion of marine fauna (young fish, phyto- and zooplankton)

Assessment of the above impacts is assessed in the following subsections.

9.10.2.2 SEDIMENTATION AND TURBIDITY IMPACTS DURING DREDGING

Underwater construction works in the Gulf of Ob, including dredging activities, will result in:

- loss of bottom areas to be used for construction of ice protection and other facilities within the port area;
- increased turbidity generated by port and navigational (access and marine channels) dredging and soil dumping;
- redeposition of bottom sediments on sea bed during dredging and soil dumping

Impact Assessment

Construction of hydraulic engineering facilities in the port water area is interpreted as partial "withdrawal" of the seabed area. The seabed area required for construction of jetties is 98,400 m^2. The occupation of this seabed area will inevitably result in destruction benthic habitats. On the other hand, submerged offshore constructions act as an artificial reef that will be later inhabited by aquatic organisms. The density of benthos living on artificial structures is usually higher than that in adjacent seabed areas. This, along with the relatively small area of the seabed to be occupied and short jetty construction time, allows assessment of potential impact as **Low**.

As stated above, dredging operations generate raised sediments and thereby affect aquatic organisms. The potential impacts to plankton, benthos and fish fauna as discussed in turn below.

Impacts on plankton

Suspended solids released into water affects its optical properties, reducing the sunlight penetration zone and associated photosynthetic activity of plankton algae.

According to toxicological study of natural suspended solids undertaken by FGUP NIRO, adverse effects on photosynthesis and filtration nutrition of invertebrates may be observed at the minimum (threshold) concentration of suspended solids of 10 mg/l. this concentration was recommended and formally approved as the MPC for suspended solids in fishery (fishable) water bodies.

High concentration of suspended solids during construction will primarily result in reduced transparency and consequent adverse effects on phytoplankton growth and status.

Zooplankton (crustaceans, particularly at early development stages) and saprophytes are most sensitive to elevated levels of suspended solids. High concentrations of suspended solids affect filtration organs and, consequently, nutrition and reproduction of zooplankton, changing its behaviour, and causing physiological stress and potentially death. A considerable reduction of zooplankton biomass in natural environment has been identified at persistent (throughout a season) concentration of suspended solids of more than 20 mg/l (Williams, 1984).

Ichtyoplankton (eggs and larvae of fish) is also very sensitive to elevated levels of suspended solids content. High turbidity arrests development of spawned eggs and larvae.

According to the survey findings, the Gulf of Ob is characterised by seasonal distribution of suspended solids. Maximum concentrations vary from 20 to 30 mg/l. In summer, concentrations of suspended solids in surface and bottom layers at some stations increase to 40 or 50 mg/l. This primarily applies to the bottom layer. Local increases of suspended solids levels are observed in autumn, particularly in the marginal filter area, i.e. in the area of proposed construction of the marine navigation channel.

Information about dredging and dumping soil volumes and associated turbidity areas is detailed in Section 9.4 and Tables 9.4.6 and 9.4.7. The estimated distance from navigation channel dredging operations to an isoline of threshold concentration of suspended solids of 10 mg/l (MPC for water bodies) will be approximately 9,000 m; for dumping this will vary from 6,600 m to 8,400 m. During port area and access channel construction activities, this distance will range from 2,300 m to 6,000 m for dredging and from 2,300 m to 2,700 m for dumping. The sediment plume with concentrations of suspended solids varying from 10 to 100 mg/l will persist for 240 to 390 hours during operations in the port area and up to 320 hours during operations in the navigation channel area (Tables 9.4.9 and 9.4.10).

It should be noted that, according to data of FGBNU GosNIORKh, zooplankton death rates at increasing concentrations of suspended solids are as follows:

- 50% at 50 to 75 mg/dm^3;
- 75% at 75 to 100 mg/dm^3; and
- 100% at more than 100 mg/dm^3.

However, Roskomrybolovstvo (formerly Rosselkhoznadzor) recommends that the following percent and concentration ranges be used to estimate suspended solids associated death rates of aquatic organisms[36]:

[36] Letter of Rosselkhoznadzor #FS-GK-5/4496 dd. 16.05.2007

- 50% at 20 to 100 mg/dm^3; and
- 100% at 100 mg/dm^3 or greater.

Given the above figures and baseline concentrations of suspended solids in the Gulf of Ob, it is assumed that concentrations from 20 to 100 mg/dm^3 will result in death of 50% of plankton organisms (i.e. within 8,900 m from marine navigation channel operations and within 5,900 m from port operations), while concentrations of 100 mg/dm^3 or greater will kill 100% of zooplankton.

Studies of the impact of suspended mineral solids on aquatic organisms (A.A. Shavykin, S.A. Sokolov, P.S. Vaschenko, 2011) and the finding of S.A. Patin (S.A. Patin, 2001, 2004, 2005) allow the conclusion that effects of seabed operations on aquatic organisms can be assessed as reversible and minor. This assessment also used the scale of impacts and environmental effects of offshore operations developed by S.A. Patin (S.A. Patin, 2001, 2004) and provided in the table below.

Table 9.10.2: Scale of impacts and environmental effects of offshore operations

Scale of impact and character of effects*	**Parameters of impact and effects**
Spatial extent	
Point [1]*	Area of impact <100 m^2
Local [2]	Area of impact >100 m^2 <1 km^2
Community [3]	Area of impact >1 km^2 <100 km^2
Sub-regional [4]	Area of impact >100 km^2
Regional [5]	Area of impact encompasses an entire region
Duration of impact	
Short-term [1]	< 24 hours
Temporary [2]	>24 <= one season
Long-term [3	> one season <= one year
Permanent [4]	> one year

Table 9.10.2: Scale of impacts and environmental effects of offshore operations	
Scale of impact and character of effects*	**Parameters of impact and effects**
Reversibility of effects	
Reversible [0] (acute stress)	Environmental and biological recovery takes several hours to one season
Slowly reversible [3]	Environmental and biological recovery takes one season to three years
Irreversible [5] (permanent stress)	Effects persist for more than three years
Overall assessment	
Insignificant [∑=2-4]	Environmental and biological effects are absent or unidentifiable against natural variations
Minor [∑ =5-7] (tolerance range)	Identifiable environmental effects and short-term reversible biological effects below minimum response threshold at population level (1 to 10% of standard population parameters)
Moderate [∑ =8-10] (compensation range)	Identifiable environmental effects and biological stress effects without signs of degradation or loss of self-recovery capacity (under 1% of standard population size)
Major [∑ =11-14] (damage range)	Persistent structural and functional transformations of associations (deviations from standard population and association parameters >10%)
Disastrous (catastrophic)	Irreversible permanent signs of degradation (destruction) of populations and associations (deviations from standard ecosystem parameters >50%)

* Indices (ratings) of impact and effects are shown in square brackets

The above scale is applied to impact and effects assessment presented in this report. Given the scale of proposed underwater operations in the Gulf of Ob, the impact on plankton can be described as community-scale, temporary, and irreversible. The overall impact is assessed as **Low**.

Impact on Benthos

The impact of suspended mineral solids on zoobenthos is similar to that on zooplankton, i.e. destruction of benthic associations. Multiple reduction of benthic population is expected in the area of high turbidity.

According to data of FGBNU GosNIORKh, destruction of benthos buried under bottom sediment during dredging and dumping occurs when the sediment layer exceeds the vertical size of benthic organisms and the rate of sediment accumulation is greater than 0.5 mm/day (Lesnikov, 1986).

Other authors report that many benthic forms, particularly burrowing in fauna organisms (mobile detritophagous bivalve molluscs, gastropods, many polychaete worms, holothurians, etc.) are capable of surfacing after having been buried under a layer of bottom sediments (Maureretal., 1980, 1986). The time of surfacing depends on the sediment depth and composition and the size of organisms, varying from several hours to several days. Solid clayey silt and sands of medium and large grain size are most difficult for organisms to penetrate (Maureretal., 1980; 1986).

Accumulation of a bottom sedimentation layer of 1 to 5 cm threatens small and medium-size infauna and epifauna organisms. According to modelling of zoobenthos burying, crabs and big molluscs are capable of surfacing through 30 cm of soil. A layer of man-generated sediment of 3 to 5 cm seriously depresses aquatic organisms. Sediment layers of 0.6 cm do not affect species diversity. Impact of redeposited sand of less than 1 cm is assumed to be of no environmental consequence. A 2cm layer of soil/sediment is assumed to be critical for small zoobenthos organisms. Natural recovery of benthic associations (biocoenoses) in the arctic is often slower than in temperate areas and may exceed 13 years (Beuchel and Gulliksen, 2008[37] and Ivanov *et al*. 2013[38].

In and immediately around soil dumping areas sediment thickness will be far greater than 2 cm, leading to death of benthos in these areas. These areas may be potentially colonised by migrants from unaffected locations while weakened species emerging from under dumped soil will become easy prey for predators gathering in turbid waters.

Given the size and way of life of benthic organisms prevailing in the subject area of the Gulf of Ob, the thickness of bottom sediments lethal for benthos is assumed to vary from 1 to 5 cm (death of 50%) to 5 cm and greater (death of 100%). These values are based conservative principles (Medyankina, Sokolova et al., 2010).

Estimated distances from dredging operations to an isoline of threshold sediment thickness of ≥ 10mm are described in Section 9.4 and Tables 9.4.9 and 9.4.10 (700 to 2,000 m for dredging and dumping in the navigation channel area, and 376 to 2,030m for similar operations within the port area).

Characteristics of high turbidity areas during preliminary dredging operations are summarised in Tables 9.10.3 and 9.10.4.

[37] Beuchel F. and Gulliksen, B. (2008) Temporal patterns of benthic community development in an Arctic fjord (Kongsfjorden, Svalbard): results of a 24-year manipulation study. Polar Biology July 2008, Volume 31, Issue 8, pp 913-924.
[38] Ivanov, M.V, Smagina, D.S. Chivilev, S.M. Kruglikov, O.E. (2013) Degradation and recovery of an Arctic benthic community under organic enrichment. Hydrobiologia April 2013, Volume 706, Issue 1, pp 191-204

Table 9.10.3: Summarised characteristics of high turbidity areas during preliminary dredging operations			
Concentration of suspended solids, mg/l	>10	>50	>100
Volume of turbid water, m^3	310,308,000	237,972,000	205,824,000
Area of bottom sediment (redeposited suspended solids) with the thickness greater than 5mm will total 37,140,000 m^2			

Table 9.10.4: Summarised characteristics of integral geometry of high turbidity areas during underwater soil dumping			
Concentration of suspended solids, mg/l	>10	>50	>100
Volume of turbid water, m^3	37,339,000	32,360,000	34,184,000
Area of bottom sediment (redeposited suspended solids) with the thickness greater than 5mm will total 24,270,000 m^2			

Using the impact assessment scale (Table 9.10.1) and given proposed duration of non-stop dredging operations of 75 days, potential impact of these operations on benthos can be assessed as community-scale, long-term, with slowly reversible effects. The overall impact can be assessed as **Moderate**.

<u>Impact on Fish Fauna</u>

Eggs and, particularly, larvae of most fish species are very sensitive to suspended solids concentration. According to experiments with drilling mud, suspended solids concentration of 25 mg/l is lethal for 100% of pelagic eggs and larvae (Kalinicheva, 1086). Observation of pelagic eggs and larvae distribution in natural environments provided similar results, i.e. extensive destruction of eggs and larvae at concentrations of suspended mineral solids from 20 to 30 mg/l Williams, 1984).

However, other data indicate much higher tolerance of eggs and larvae to suspended solids (Patin, 2001). Death of 50% of salmon larvae and juvenile species is predicted at drill mud concentration in seawater of 100 mg/l (Matishov, Shparkovsky, Nazimov, 1995). A 50% death rate presumes a long-term (more than 24 hours) exposure of young fish to suspended solid concentrations of more than 100 mg/l. Acute (lethal) intoxication of sea and saline water fish occurs at suspended solid concentration of 500 to 1,000 mg/l (Patin, 2001).

To allow for a worst-case scenario, threshold concentrations of suspended solids for ichtyoplankton are assumed to be similar to those used for assessment on impact on zooplankton.

Adult fish species are capable of avoiding areas of high turbidity. However, available information relating to this issue is contradictory. On the one hand, some observations show that fish avoid water areas with suspended solid concentrations of 10 to 20 mg/l. On the other hand, evidence exists to demonstrate that spawning migration of salmon in estuaries is not affected by extreme suspended solid concentrations measured in grams per litre. High water turbidity is unlikely to impede the spawning migration of fish, particularly of anadromous and semi-anadromous species whose physiology and life potential serve a single purpose, i.e. movement towards spawning grounds. Benthic fish are most tolerant to high concentrations of suspended solids. Pelagic species, particularly plant feeders, are more sensitive to this kind of impact. Death of all fish species is caused by anoxia (lack of oxygen) in turbid water and results from damage to gill tissues accompanied by rapid changes of biochemical blood measurements.

No fish kill directly associated with underwater operations is expected as adult fish are most likely to be scared away by running machinery. No spawning grounds have been identified within the proposed operations area.

Thus, adverse impact on fish fauna will consist of losses of feeding grounds for benthos feeders, which are estimated according to lost areas inhabited by zoobenthos, using the same coefficients to calculate the time required for recovery of feeding resources. For plankton feeders, potentially lost feeding grounds correspond to the area of sediment plumes with increased turbidity and suspended solid concentrations greater than 10 to 20 mg/l, which affect their feeding resources, i.e. zooplankton.

Given the scale of proposed dredging and other underwater operations and areas of potential impact on fish feeding resources (zooplankton and zoobenthos), potential impact on fish fauna is assessed as **Major**.

Regular monitoring will be required to evaluate actual impact of dredging operations on marine biota. It should be conducted at observation points used for surface water monitoring in the Gulf of Ob.

Mitigation

Measures aimed at reduction of turbidity and sedimentation areas during soil moving operations (see Section 9.4.2.8 and Table 9.4.15 for further details):

- Loading of suction hopper dredgers without spilling process water overboard
- Unloading of hoppers and suction hopper dredgers at dumping location after these have been brought to a complete stop (adrift)
- Lowering backhoe dredger bucket close to the water surface within the hopper to avoid pulp spilling and splattering
- Loading of buckets to 75% of flat capacity to prevent soil from spilling back into the water
- Chemical analysis of water quality in the Gulf of Ob before, during and after execution of work
- Continuous industrial monitoring of compliance with process requirements for underwater operations

In addition, the compensation for fish proposed in consultation with fish protection authorities will consist of construction of new fish-breeding facilities for valuable fish species, such as Sturgeon or Whitefish (peled). This is further described below.

Residual Impacts

The application of the above mitigation controls will help to control the impacts of dredging, although the residual impacts are not expected to reduce significantly below the unmitigated impacts assessed above.

The exception to this is fish loss, where with the construction of new fish-breeding facilities, residual impacts are assessed as **Moderate**.

Fish Damage Calculations

Quantitative assessment of impact on marine biota was based on estimated losses of fish resources as a consequence of underwater operations in the Gulf of Ob during construction. Damage was evaluated in accordance with the Methods for calculating damage to aquatic biological resources (Order of Rosrybolovstvo No.1166 of 25.11. 2011).

Losses of aquatic biological resources during construction will consist of:

- death of plankton feeders resulting from zooplankton destruction;
- death of benthos feeders resulting from benthos destruction.

In accordance with the existing methods, the damage was calculated differentially for two components, i.e. permanent and temporary damage. Permanent damage is associated with withdrawal of seabed and water area for hydraulic engineering facilities resulting in reduction of feeding grounds of benthos and plankton feeders. Temporary reduction of feeding area and productivity of feeding resources is identified as temporary damage.

Removal of the top layer of seabed sediment during dredging will result in complete destruction of benthic associations and temporary reduction of feeding area for benthos feeders. High turbidity (generated by dredging and dumping operations) affects all aquatic life, including fish and fish feeding resources (zooplankton and zoobenthos), causing temporary reduction of both feeding resources productivity and plankton feeders' feeding area. In addition, construction of a jetty in the seaport means withdrawal of a seabed area and associated destruction of feeding grounds.

Thus, the total damage to aquatic biological resources in the Gulf of Ob from dredging operations in the marine navigation and access channel area and the seaport, including jetty construction (Vol. 8.3.4, Appx. 77668-1), will amount to 8,899.533 t, including:

- 3,369.07 t of plankton feeders as a consequence of zooplankton destruction;
- 4,558.018 t of benthos feeders as a consequence of zoobenthos destruction; and
- 2.445 t of benthos feeders as a consequence of partial seabed occupation.

Compensatory measures and implementation costs. According to the damage calculation methods (i.55), the type and scope of a compensatory action are determined by the character and scale of effects, which resulted in a loss of aquatic biological resources and deterioration of habitats (areas of reproduction (spawning), wintering, feeding, and migration).

Given the duration and scale of the impact of the Project construction operations on aquatic biological resources, the compensation proposed in consultation with fish protection authorities will consist of construction of new fish-breeding facilities for valuable fish species, such as Sturgeon or Whitefish (peled). Based on current sturgeon and whitefish reserves in the Gulf of Ob, the following reproduction targets are considered: 1.8% for Ob sturgeon, 8.4% for Muksun, and 89.8% for a river form of Peled.

Juvenile fish must be released in water bodies within 5 to 7 years. Total reproduction quantities equivalent to losses of biological resources through dredging in the Gulf of Ob will be:

- 8, 944,945 species of Sturgeon;
- 1,502,689,948 species of Peled; and
- 25,509,658 species of Muksun

Compensatory fish reproduction costs for the Gulf of Ob are estimated to total 1,714,207.5 thousand RR, including:

- 104,655.8 thousand for reproduction of Sturgeon;
- 1,517,716.8 thousand for reproduction of Peled; and
- 91,834.7 thousand for reproduction of Muksun.

Yamal LNG will use best endeavours to ensure that Rosmorport provides for continuous monitoring and control of implementation of compensatory measures to ensure that damage to aquatic biological resources is compensated in a timely manner.

9.10.2.3 SEDIMENTATION EFFECTS FROM INLAND RIVER WORKS

Operations under water and on the banks of water bodies are the major source of impact on aquatic biological resources associated with areas of high turbidity generated by bottom sediment roiling. Operations on the banks of inland water bodies (construction of bridges and roads, pipelines, power transmission lines) will be short-term, undertaken during the winter low water period. Sand Quarrying in adjacent artificial lakes may be undertaken in the summer fish migration period. However, their impact on aquatic organisms will be indirect, consisting only in soil wash from small floodplain areas affected by construction. Potential impact is therefore assessed as **Low**. A list of water bodies and details of water protection measures are included in Section 9.4.2.6.

9.10.2.4 UNDERWATER NOISE IMPACTS

The assessment of underwater noise form dredging and piling activities on marine fauna is assessed in section 9.8.2.3.

9.10.2.5 LIQUID DISCHARGES TO SEA

During construction, liquid discharges to sea will occur from the following onshore facilities/activities (once installed):

- Wastewater treatment plant
- Desalination units
- Hydrotesting

Liquid discharges to sea will also occur from vessels used for the import of materials to the MOF, and such discharges will include ballast waters and sewage waters. Without adequate controls in place these discharges would have to potential to have a significant impact on water quality (leading to impacts on marine flora and fauna), and also the risk of introduction of invasive species.

Impact Assessment

The treatment of shore-based discharges to the marine environment are described and assessed in Section 9.4. All discharges will meet the Project Standards as described in the Project Standards Document.

There will be no discharges from vessels to the Gulf of Ob. All wastewaters from vessels operated during construction phase and cargo delivery will be collected by special vessels. Without mitigation, discharges from cargo vessels may have a **moderate** impact on water quality and the introduction of invasive species in uncontrolled ballast water could lead to significant changes in ecology in the port area and potentially lead to a **High** impact without mitigation.

Mitigation

The treatment processes for discharges from shore-based facilities are described and assessed in Section 9.4. All discharges will meet the Project Standards as described in the Project Standards Document.

Impacts from vessel discharges will be controlled through the following mitigation controls (these will be requirements placed on the shipping contractors):

- Compliance with “Regulations on registration of oil relating operations, oil products and other substances, their mixtures, generated at vessels that may be harmful for health or marine environment” RD 31.04.17-97
- No preparation or cleaning of ballast tanks at the territory of the sea port
- Control of vessel ballast waters according “Manual on regulation and control of vessels with ballast water and management of it to decrease transportation of harmful aquatic organisms and pathogens” (resolution A.868 (20) 2007)
- Exchange of ballast water at sea depths of 1,000m (in the Kara sea)
- Full compliance with RF legislation requirements and MARPOL73/78
- There will be no discharge of waste water from vessels into the Gulf of Ob. Sanitary waste water and oil-containing bilge water from vessels, used during construction and delivery of cargo, will be collected by special bunker vessels according concluded contracts

Residual Impacts

All discharges from shore-based facilities will meet the Project Standards as described in the Project Standards Document, and on this basis the residual impacts on marine waters are considered to be **low**.

Application of the proposed mitigation controls on vessel discharges will reduce their impact to **Low**.

9.10.2.6 WATER ABSTRACTION

Abstraction of water from the Gulf of Ob has the potential to impact on marine fauna through ingestion into the abstraction pipe. These impacts will be adequately controlled through the use of a filters and fish protection devices at the abstraction location. With the adoption of this mitigation, impacts on marine fauna are assessed as **low**. However, continuous condition monitoring of water abstraction facilities and fish protective devices will be required to ensure adequate protection of fish and aquatic organisms.

9.10.3 OPERATION

The potential impacts on the marine environment during the operational phase are summarised in Table 9.10.5 below.

Table 9.10.5: Potential impacts to marine flora and fauna during construction

Activity	**Potential Impact**
Maintenance Dredging	Sedimentation impacts on benthic flora and fauna (see also section 9.4.2.8)
	Raised turbidity impacts on palegic fauna (see also section 9.4.2.8)
	Underwater noise impacts on marine mammals and fish (see also section 9.8.2.3)
Sand bar removal (dredging)	Changes to salinity affecting marine ecology (see also section 9.8)
Discharges to sea (from vessels and onshore waste water treatment)	Changes to water quality leading to impacts on marine flora and fauna Introduction of invasive species in ballast water
Water abstraction	Ingestion of marine fauna
Oil Spills	Oily of marine flora and fauna (see also Section 9.12)
Ice-breaking	Destruction of habitat, underwater noise and collision with fauna

Assessment of the above impacts is assessed in the following subsections.

9.10.3.1 MAINTENANCE DREDGING

Impacts and mitigation controls during maintenance dredging during operations will be similar to those during the construction phase.

9.10.3.2 LIQUID DISCHARGES TO SEA

Impacts and mitigation controls during the operation phase will be similar to those during construction and hence impacts are general similar in nature. However, during operations release of ballast waters will be more significant both due the size of the vessels involved ((LNG carriers and condensate tankers) and also as vessels during the operational will be largely loading rather than offloading.

With the continued application of the mitigation controls on vessels described above for the construction phase, residual impacts during operation are assessed to **Low**. Additional monitoring should be undertaken to ensure the long term effectiveness of these controls, including:

- Monitoring of ballast waters (in line with MARPOL requirements) from all LNG carriers and condensate tankers
- Monitoring of marine plankton and benthos in the port basin to identify if any new alien species are present.

Such monitoring would be the responsibility of the shipping contractors and Rosmorport (as the port operator) respectively. However, Yamal LNG will use best endeavours to ensure that they implement such measures.

9.10.3.3 SALINITY IMPACTS FROM SAND BAR REMOVAL

Dredging activities for the navigation channel have the potential to influence the salinity of water in the Gulf of Ob due to the removal of sand bars. Mathematical modelling has been performed to assess this potential impact using a 3D model for hydro dynamical and thermohaline processes, including information on the relief of the navigation channel. Separate modelling studies were undertaken by OOO “Eco-Express-Service” and AANII on behalf of Yamal LNG. The modelling results were assessed by SRO non-commercial partnership “Ecological International Community of Auditors” (OOO “PROEKSON” (2013)) on request of OAO “LENMORNIIPROJECT”. The results of these studies are summarised in section 9.4.2.8 and the following conclusions were drawn:

- Changes of velocity fields and variations of salinity fields against current conditions are not significant. This is determined by the location, length, and insignificant depth of the proposed navigation channel.
- Current salinity levels may be as high as those predicted for post-construction period.
- Variations of seawater penetration into the freshwater area, both with and without the channel, are largely determined by natural environmental conditions, such as river and surface runoff.

Thus, according to mathematical modelling, potential impact of the Kara Sea water on the Gulf of Ob after construction of the channel can be assessed as **Low**. No loss of value or fish productivity in the Gulf of Ob will occur as the ingress of seawater into the freshwater area of the Gulf of Ob after the channel construction will be insignificant.

Regular monitoring of water quality in the navigation channel and monitoring of plankton, benthos and fish fauna within the port and access channel area should be provided to identify effects, if any, of the salt water impact on the marine biota in the Gulf of Ob. Such monitoring would be the responsibility of Rosmorport (as the port operator). However, Yamal LNG will use best endeavours to ensure that they implement such measures.

9.10.3.4 WATER ABSTRACTION

Abstraction of water from the Gulf of Ob has the potential to impact marine fauna through ingestion into the abstraction pipe. This impact will be adequately controlled through the use of a fish filter at the abstraction location. With the adoption of this mitigation, impacts on marine fauna are assessed as **low**.

9.10.3.5 OIL SPILLS

Shipping and in particular the export of condensate pose potential oil spill risks. In order to control these risks, Yamal LNG will adopt the following approach to spill prevention and control:

- Prevention of any spills in the first instance through the robust design of production facilities and continuous monitoring for oil spills, adhering to international high standards and good international industry practice.

- Efficient and effective contingency planning in the event of a spill, which has been tried and tested by trained personnel with a clear chain of command and appropriate resources on hand to tackle any spill size.
- Minimisation of the volume and impact of any oil spill on the natural and human environment.

In order the meet these aims, Yamal LNG will develop an operations Oil Spill Response Plan (OSRP). This is described in further detail in Section 9.12.

9.10.3.6 SHIP STRIKE

Ship strike (collision) represents a potential risk to marine mammals, although the level of susceptibility to ship strike is species-dependent.

Tagging of Beluga whales has shown they are capable of diving to depths in exceedance of 2800 feet, they spend only 4-7% of their time at the surface and they can forage under sea ice that may cover 90 to 100% of the surface[39]. The sensitive hearing, well developed echolocation and detection capabilities, great maneuverability and diving capabilities of beluga whales indicates they are less vulnerable to ship strikes than other marine fauna, such as baleen whales. Despite this, records of ship strikes to odontocetes (toothed whale species), such as the beluga whales are recorded on the ship strike databases[40]. Pinnipeds facing shipping traffic in open water are expected to respond similarly to odontocetes and avoid collisions in most cases, given their manoeuvrability. However, their auditory discrimination and thus, their capacity to accurately detect and evade approaching vessels might be less than odontocetes.

In contrast, the physiological and life history characteristics of baleen whales make them more vulnerable to ships strikes, e.g. their surface feeding strategy, positive buoyancy, and often slower swimming speed compared to other marine species such as the beluga whale or pinnipeds. The bowhead whale lives it entire life in the polar regions, it is capable of breaking through ice up to 60 cm deep, is a relatively slow swimmer, a shallow diver and usually travels alone or in small herds. The fin whale is a faster swimmer than the beluga whale, often live in herds of 6-10, although may feed in far larger groups and may dive to routine depths of 200 metres (600 feet). The fin whale was recorded as the highest stuck whale in a study conducted considering stranding and collision records. The number of juveniles and calves where noted to be high, indicating a reduced ability to avoid ships when young. Various accounts of resting whales being hit are included in the review, including bowhead whales. Many of the collisions appear to be associated with faster moving vessels. Records suggest ship collision injuries/deaths are of greatest concern for whales for small

[39] Suydam, R. S., Lowry, L. F., Frost, K. J., O'Corry-Crowe, G. M., and Pikok, D. Jr. 2001. Satelite tracking of Eastern Chukchi Sea Beluga Whales into the Arctic Ocean. Actic, 54 (3). p. 237-243.

[40] Arctiv Council. 2009. Arctic Marine Shipping Assessment 2009 report.

endangered populations, such as the bowhead whale[41]. Recent data indicate the number of ship strikes to whales is likely 10 times that of whale stranding records[42].

These risks need to be put into the context of both the frequency of the vessel movements, the relatively short route between Sabetta and the Northern Sea Route, and the density of cetaceans in open water waters in this area. While there is generally limited data on cetaceans in this area, available evidence suggests that cetaceans are numbers are low and, for example, the main range of fin whale does not extend into the Kara sea (see Chapter 7 for further details), and no cetaceans are likely to be present in the immediate seaport area of the Gulf of Ob. Based on these considerations the overall risk of ship strike is assessed as **Low**.

9.10.3.7 ICE BREAKING

Potential adverse effects of ice breaking on marine fauna include noise effects and habitat changes from destruction of the ice. The effects of noise from ice-breaking are addressed in Section 9.8.3.2.

Marine mammals use many different features within the ice, including polynyas (area of open water surrounded by sea ice), leads (large fractures within sea ice), open water, the surface of the ice and underneath the ice. Particular species of marine mammal are reliant on the ice for survival; with different habitats being used for feeding, migration, reproduction and hiding from predators, for example willer whales that may migrate to these waters periodically. Ice-breaking ships may interfere with the use of these environments.

The potential effects of ice disturbance by ice-breaking include destruction of seal breathing holes, haul out areas and destruction of seal lairs and polar beer den. In the spring many of these mammals reproduce and give birth to their young; some pinnipeds and polar bears build structures in the ice, such as lairs. Ice breaking ships are likely to be required at these times of year to break a pathway through the ice. Ice-breaking can impact pinniped species using pack-ice to give birth, such as ringed, grey, hooded or harp seals, as the pups can be crushed with little opportunity to escape[43]. This may also be the case for polar bears who are known to demonstrate some site fidelity to the area where they den each year and may be concentrated in certain areas. Polar bears are also known to be curious about development activities and are rarely deterred by the

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[41] Laist, D. W., Knowlton, A. R., Mead, J. G., Collet, A. S. and Podesta, M. 2001. Collisions between ships and whales. Marine Mammal Science. 17(1). p. 35-75

[42] Williams, R., Gero, S., Bejder, L., Calambokidis, J., Kraus, S.D., Lusseau, D., Read, A.J., and Robbins, J. 2011. Underestimating the damage: interpreting cetacean carcass recoveries in the context of the Deepwater Horizon/BP incident. Conserv. Letters 4(3): 228-233

[43] Department of Fisheries and Oceans Unpublished data. In: Lawson, J.W. and Lesage, V. 2013. A draft framework to quantify and cumulate risks of impacts from large development projects for marine mammal populations: A case study using shipping associated with the Mary River Iron Mine project. Department of Fishereis and Oceans Canada. Scientific. Advisory. Secretariat. Research. Document.

presence of ships and land based activities; therefore may not move away from these activities[44]. There have also been observations of polar and seals being attracted to the broken channels produced behind ice breakers[45].

The area affected by direct disturbance from ice breakers is limited largely to the width of the icebreaking ships. Although the total area of ice disturbed during a winter period will depend on the extent to which ships follow the same shipping route and the extent to which the ice sheet moves around between the passage of ships. However, in the context of the entire Kara Sea it is unlikely that the total area disturbed would be a significant proportion of the total area. Therefore, the direct disturbance impacts from icebreaking on marine mammals is likely to be **low**.

44 Amstrup, S. C. and Gardner, C. 1994. Polar bear maternity denning in the Beaufort Sea. Journal of Wildlife Management. 58 (1). p. 1-10.
45 Belikov et al, Proceedings of the tenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group, October 25-29, 1988, Sochi

9.10.4 SUMMARY

Table 9.10.6: Summary of Marine Mitigation Controls

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
Vessel discharges (including invasive species)	Marine waters and biota	Construction and operation	• Compliance with "Regulations on registration of oil relating operations, oil products and other substances, their mixtures, generated at vessels that may be harmful for health or marine environment" RD 31.04.17-97 • No preparation or cleaning of ballast tanks at the territory of the sea port • Control of vessel ballast waters according "Manual on regulation and control of vessels with ballast water and management of it to decrease transportation of harmful aquatic organisms and pathogens" (resolution A.868 (20) 2007) • Exchange of ballast water at sea depths of 1,000m (in the Kara sea) • Full compliance with RF legislation requirements and MARPOL73/78 (including ballast water management) • There will be no discharge of waste water from vessels into the Gulf of Ob. Sanitary waste water and oil-containing bilge water from vessels, used during construction and delivery of cargo, will be collected by special bunker vessels according concluded contracts	**Low**
Underwater noise	Marine fauna	Construction (dredging and piling) and maintenance dredging	See Section 9.8	See Section 9.8

Table 9.10.6: Summary of Marine Mitigation Controls				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
Discharges from Shore	Marine environment (Phyto- and zooplankton, phyto- and zoobenthos, fish fauna)	Construction and operation	• As defined in Section 9.4	**Low**
Water abstraction	Marine fauna (Fish eggs and larvae, phyto-, zoo- and ichtyoplankton)	Construction and operation	• Equipment of water abstraction facilities with fish protective devices	**Low**
Ship strike	Cetaceans	Operation	• Use of defined shipping routes	**Low**
Ice disturbance	Marine mammals	Operation (ice-breaking vessels))	• Use of defined shipping routes	**Low**
Areas of high water turbidity during dredging	Phyto- and zooplankton, ichtyoplankton	Construction	Measures aimed at reduction of turbidity areas during soil moving operations (Section 9.4.2.8 and Table 9.4.15): • Loading of suction hopper dredgers without spilling process water overboard • Unloading of hoppers and suction hopper dredgers at dumping location after these have been brought to a complete stop (adrift) • Lowering backhoe dredger bucket close to the water surface within the hopper to avoid pulp spilling and splattering • Loading of buckets to 75% of flat capacity to prevent soil from	**Low**

Table 9.10.6: Summary of Marine Mitigation Controls				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
			spilling back into the water • Chemical analysis of water quality in the Gulf of Ob before, during and after execution of work • Continuous industrial monitoring of compliance with process requirements for underwater operations Dredging will be the responsibility of Rosmorport. However, Yamal LNG will use best endeavours to ensure that they implement such measures.	
Silting of seabed during dredging and dumping	Phyto- and zoobenthos	Construction	Unloading of hoppers and suction hopper dredgers at dumping location should be undertaken after the vessels/barges have been brought to a complete stop (adrift). Dredging will be the responsibility of Rosmorport. However, Yamal LNG will use best endeavours to ensure that they implement such measures.	**Moderate**
Destruction of spawning and feeding grounds during construction of hydraulic engineering facilities	Phyto- and zoobenthos, fish fauna	Construction	Creation of facilities for reproduction of valuable fish species. Yamal LNG will use best endeavours to ensure that Rosmorport should provide for continuous monitoring and control of implementation of compensatory measures to ensure that damage to aquatic biological resources is timely compensated in a timely manner.	**Moderate**

Table 9.10.7: Summary of Marine Monitoring Requirements				
Aspect	**Phase**	**Location**	**Parameters**	**Periodicity**
Ballast water	Operation	Vessel ballast tanks	Oil in water, Salinity, Colored Dissolved Organic Material (CDOM) , Plankton	All LNG Carriers and Condensate Tankers prior to ballast water discharge
Invasive species	Operation	Port basin	Plankton Benthos	Plankton – monthly during ice free season Benthos - annually
Shore-based discharges	Construction and operation	See Section 9.4	See Section 9.4	See Section 9.4
Death of phyto- and zooplankton and larvae/ juvenile fish in water intake facilities	Construction and operation	Temporary and permanent facilities for abstraction of water from surface water bodies	Dead juvenile fish and larvae in fish protective devices	Once a year
Impact of underwater operations on marine biocoenoses (associations)	Construction	Seaport water area, access channel, soil dumping area	Chemical and organoleptical properties of water Distribution and population of phyto- and zooplankton and fauna of benthic biotopes Monitoring of compliance with process requirements for underwater operations	Twice a year (before and after work execution) Ongoing
Impact of vessel and port operations on marine biocoenoses (associations)	Operation	Seaport water area, access channel, navigation channel	Chemical and organoleptical properties of water Distribution and population of phyto- and zooplankton and fauna of benthic biotopes Presence of invasive species; diversity, population and distribution of invasive species	Once a year in summer
Impact of potential salinity changes on marine biocoenoses (associations) in the Gulf of Ob	Operation	Navigation channel	Salt composition of water Distribution and population of phyto- and zooplankton, composition of fish fauna and benthic biotopes	2 or 3 times in summer

Table 9.10.7: Summary of Marine Monitoring Requirements				
Aspect	**Phase**	**Location**	**Parameters**	**Periodicity**
Marine mammals	Construction	Project Licence Area	Marine mammal observers to monitor presence of marine mammals during dredging and piling operations. Any mammals observed and action taken to be recorded.	Continuous during construction

9.11 LANDSCAPE AND VISUAL IMPACTS

9.11.1 INTRODUCTION

Landscape and visual impacts are assessed on the basis of the following two elements (see also Chapter 3):

- The character and sensitivity of the landscape, comprising:
  - Physical units and characterisation
  - Visual amenity and appearance
- The magnitude of the change to the landscape resource.

Each of these elements is described in turn below.

Note that:

- Potential lighting impacts on fauna are assessed separately in Sections 9.9 and 9.10.
- Cultural heritage aspects of landscape features are assessed in Chapter 10.

9.11.2 LANDSCAPE CHARACTERISATION AND SENSITIVITY

The topography of the Licence Area and surrounding region is a flat, lowland plain cut by river valleys and lakes, which is typical of the tundra region of the Yamal peninsula. The topography of the plain is made up of land that forms a series of 'steps', each with a different elevation as follows:

(I) Second marine terrace (14 to 20masl[46])

(II) First marine lacustrine-alluvial terrace (7 to 12masl)

(III) Modern lagoonal-marine laida[47] (0 to 5masl) (see Figure 9.11.1):

- The lowest part of the laida is a gently concave waterlogged depression between the littoral bar and the surface of the first terrace, composed of sands covered by detritus and peat (0 to 3masl)
- The littoral bar is composed of sands. This is asymmetric, with a ripply hummocky surface (3 to 5masl)
- Emerging spits and beaches (up to 3masl).

[46] Meters above sea level

[47] A low lying coastal plain that is submerged during high tides.

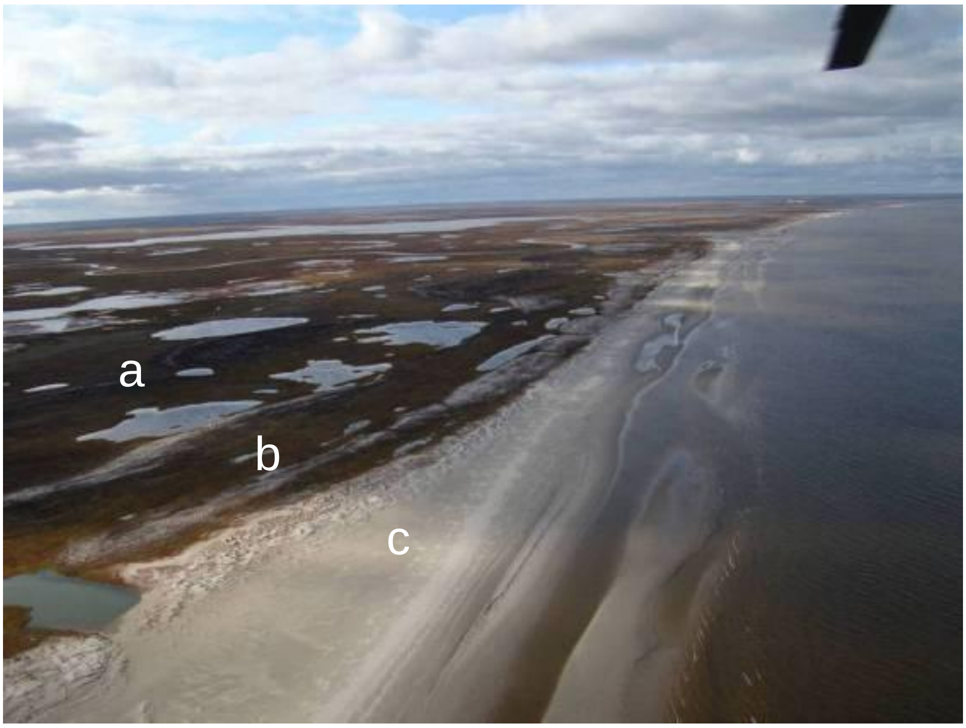

Figure 9.11.1: Lagoonal-marine laida a) - waterlogged surface; b) – the littoral bar; c) – spits and beaches

(IV) Modern alluvial systems (see Figure 9.11.2):

- Alluvial systems of major rivers (often reworked by cryogenic processes)
- Minor river valleys.

Figure 9.11.2: Typical river flood plain in the region

Further details on the topography of each step are provided in Chapter 7.

The flat nature of the landscape renders it susceptible to visual intrusion from elevated structures and from light impacts. The latter aspect is particularly significant during the long polar nights where lights may be visible from a considerable distance and for significant periods of time.

However, it is also noted that the landscape is already modified to some extent by numerous structures and facilities located in the Licence Area as a legacy of past industrial activities. These include, inter alia, previous accommodation facilities as shown in Figure 9.11.3 below.

Figure 9.11.3: Existing accommodation at Sabetta visible above the horizon from the beach and close-up of a legacy accommodation block

The visual amenity of the area is limited by the small population that use the area, and the only population to whom the Licence Area will typically be visible are:

- Tambey factoria. The factoria has a permanent population of 38 individuals. The factoria is some 30km north of the main Project facilities, and therefore the area of the main facilities offers very limited visual amenity to this population. However, some of the well pads in the northern portions of the Licence Area will be visible from Tambey.
- Reindeer herders. The Licence Area offers potential visual amenity to reindeer herders that use migration routes in its vicinity. This amenity is only provided during the period of the migration. Landmarks on the migration routes can offer navigational aids during migration.

In summary, the landscape of the Licence Area is characterised as:

- Typical of the common tundra topography of the wider region
- Partially modified by legacy industrial activity/facilities
- Susceptible to visual intrusion from structures, especially lighting, due to the relatively flat and undeveloped landscape, and the seasonally long periods of night-time
- Offering potential visual amenity to only a relatively small population and over limited time periods.

Overall, the landscape is classified as having **Medium Sensitivity**.

9.11.3 MAGNITUDE OF CHANGE

The nature of landscape and visual impacts during construction and operation will be broadly similar. Permanent structures at the main facilities will be visible above the horizon, including the wet and dry flare stacks, which at 125m high will be the tallest Project structures. These will represent a noticeable and permanent additional change to the visual landscape over and above the existing legacy structures in the Licence Area. This will be especially the case with respect to lighting outside of daylight hours. Emergency and start-up flaring both from flare stacks at the LNG facility and burn pits at the well pads will result in significant visual impact from light emissions and, in the case of burn pits, smoke. However, the overall impact of these visual impacts will be limited by the infrequent and relatively short duration of flaring events.

Localised changes to the topography will result from the filling in of surface waterbodies, mainly in the area of the LNG plant site.

Overall, the change in landscape resource is assessed as a **Medium Change**.

9.11.4 IMPACTS ASSESSMENT

On the basis of the assessed Landscape Sensitivity and Magnitude of Change above, the overall landscape impact severity is therefore assessed (see Chapter 3) to be **Moderate**.

Mitigation controls to reduce landscape and visual impacts will include:

- Angling and positioning of lights to minimise light spill outside of Project facility areas
- Appropriate painting of facilities (where possible and allowed for from a safety perspective) to minimise visibility above the horizon
- Reinstatement of construction areas
- Flaring minimisation to reduce light impacts from flares and the use of smokeless flares (although smoke is still likely from burn pits at the well sites)
- Use of piled structures to avoid impacts on permafrost.

While the above mitigation measures will help reduce landscape and visual impacts, the residual impacts are cautiously assessed to remain **Moderate**.

Monitoring measures to be undertaken include:

- Lighting assessments/monitoring to ensure correct positioning and angling of lights
- Monitoring of reinstatement success (see also Section 9.9)
- Monitoring of flaring volumes (see also Section 9.2)

9.11.5 SUMMARY

Table 9.11.1: Summary of Landscape and Visual Impacts and Mitigation Contorls Monitoring Requirements

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
Landscape and visual impacts	Humans, topography	Construction and operation	Mitigation controls to reduce impacts will include: • Angling and positioning of lights to minimise light spill outside of Project facility areas • Appropriate painting of facilities (where possible and allowed for from a safety perspective) to minimise visibility above the horizon • Reinstatement of construction areas • Flaring minimisation to reduce light impacts from flares • Use of piled structures to avoid impacts on permafrost.	**Moderate**

Table 9.11.2: Summary of Landscape and Visual Impacts Monitoring Requirements

Aspect	Phase	Location	Parameters	Periodicity
Light impacts from flaring	Commissioning and Operation	Flare stacks	Continuous flow monitoring at flare inlet to estimate the hydrocarbon flow to atmosphere.	Annual reporting
Reinstatement	Post-construction	See Section 9.9	See Section 9.9	See Section 9.9
Lighting	Construction and operation	All project facilities	Visual lighting inspection to ensure correct positioning and angling of lights	On set-up of lighting at each facility

9.12 GEOHAZARDS AND EMERGENCY SCENARIOS

9.12.1 GEOHAZARDS

9.12.1.1 OVERVIEW

A range of potential geohazards that could cause impacts on the Project facilities has been assessed as part of the design process[48] and for which relevant bases of design standards have applied. These include:

- Seismicity. The seismic zoning of the license area identifies it as not exceeding level V on the MSK64 Scale on returns periods of 500, 1000 and 5000 years (see also Chapter 7). An intensity Level V event is unlikely to result in significant property damage and will be felt indoors by most people but outdoors by few. The design of all structures will meet relevant RF standards for this MSK64 intensity zone.
- Permafrost heave and thaw. Risks associated with permafrost heave and thaw will be controlled through (see also Section 9.3):
  - Construction of above-ground facilities on piles.
  - Ventilation of underfloor spaces.
  - Seasonally and permanently operated refrigerating plants (thermal stabilisers).
  - Thermal shields (includes combination of filled soil and insulation material).
- Severe cold. Buildings will be designed in accordance with SNiP 23-01-99 with a design basis of:
  - Coldest day (98% probability) at -45ºC
  - Coldest five days (98% probability) at -41ºC.
- Snow cover. In accordance with SNiP 2.01.07-85, the design basis for buildings will be to withstand a snow cover weight of 2.4kPa
- High wind pressures. In accordance with SNiP 2.01.07-85, the design basis for buildings will be to withstand wind pressure of 0.6kPa
- Flood risk. Risks from sea flooding and river flooding have been controlled through the engineering design process. Specific mitigation controls implemented in the light of identified flood risks include:
  - Alignment of the location of certain facilities to reduce flood risks (specifically the airport site)
  - The well pads located in relatively close proximity to water bodies are constructed on artificial embankments and the embankment slopes will be reinforced with geo-grids, geotextile, etc. to prevent washout of the slopes and damage to any technical installations on those well pads.

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[48] Section 12 Part 3 of "Construction of Integrated facility for Production, Treatment, Liquefaction, LNG and Gas Condensate Offloading for the Yuzhno-Tambey GCF; Design Engineering Documentation", Institute Yuzhniigiprogaz.

- The airport will be constructed on raised made ground to a height of 2.5m above existing grade with embankment slopes constructed with earth-filled geotextile and reinforced with geo-grids.

In addition, the intrinsic elevated piled construction of the LNG facilities offers additional protection against coastal flood risks.

A summary of the risk/impacts to Project facilities associated with geohazards is provided in Table 9.12.1 below.

9.12.1.2 SUMMARY RISK/IMPACT ASSESSMENT

Table 9.12.1: Summary of Geohazard Risk/Impacts and Mitigation

Aspect	**Severity**	**Likelihood**	**Mitigation**	**Residual Risk**
Seismicity	Low	Unlikely	The design of all structures will meet relevant RF standards for MSK64 intensity Level V	Negligible
Permafrost heave and thaw	Moderate reducing to Low with mitigation	Probable	○ Construction of above-ground facilities on piles. ○ Ventilation of underfloor spaces. ○ Seasonally and permanently operated refrigerating plants (thermal stabilisers). ○ Thermal shields (includes combination of filled soil and insulation material).	Low
Severe cold	High reducing to Low with mitigation	Probable	Design basis in accordance with SNiP 23-01-99	Low
Snow cover on structures	High reducing to Low with mitigation	Probable	Design basis in accordance with SniP 2.01.07-85	Low
Wind pressure	High reducing to Low with mitigation	Probable	Design basis in accordance with SniP 2.01.07-85	Low
Flood risk	High reducing to low with mitigation	Probable	○ Alignment of the location of facilities to reduce flood risks ○ Construction of embankments with reinforced slopes around facilities in flood zones. ○ Construction of the airport on raised made ground with reinforced embankment slopes. ○ Elevated, piled construction of facilities at the LNG site	Low

9.12.2 EMERGENCY SCENARIOS

9.12.2.1 INTRODUCTION

Industrial hazards associated with the operation of the Project facilities have the potential to pose risks to workers (both in the work place and at accommodations), the general population and the environment. The key risks have been identified and assessed through the application of formal hazard identification processes and the performance of safety assessments / Quantified Risk Assessments. The key risks associated with human health and safety are described in Section 9.12.3. The primary environmental risks associated emergency scenarios are discussed in Section 9.12.4.

9.12.3 HEALTH AND SAFETY EMERGENCY SCENARIOS

The following worst case emergency scenarios have been identified and assessed for the primary Yamal LNG Project facilities[49].

- **Wells pads**
  - Failure of well equipment leading to gas release and 'string' fire
  - Failure of production well tree leading to horizontal torch fire
- **Gas gathering pipelines**
  - Depressurisation of gas-gathering pipeline (worst case from wells 1, 2 and 41) leading to unignited gas release
  - Depressurisation of gas-gathering pipelines with ignition leading to horizontal torch/fire (worst case at intersections with roads)
- **Inlet Facilities**
  - Depressurisation leak of gas from inlet line unit with ignition leading to spray fire
  - Explosion of gas-air mix in process buildings following depressurisation release at the:
    - gas separation unit
    - condensate stabilisation unit
    - compressor room for gas stabilisation
    - methanol regeneration unit
  - Explosion of gas-air mix following release at the methanol day tanks
  - Ignition of condensate spillage following catastrophic depressurisation of stable condensate storage tanks
- **LNG Plant**
  - Flare burning of pressured gas release in liquefaction process
  - Depressurisation of process pipe with ignition leading to horizontal torch/fire
  - Large scale burning of propane release from refrigerant storage
  - Explosion of gas-air mix following release at inlet line of LNG storage

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[49] Section 12 Part 3 of "Construction of Integrated facility for Production, Treatment, Liquefaction, LNG and Gas Condensate Offloading for the Yuzhno-Tambey GCF; Design Engineering Documentation", Institute Yuzhniigiprogaz.

The above risks will be managed to acceptable levels through:

- Implementation of design and engineering controls to relevant standards
- Development and implementation of appropriate operational and maintenance procedures (including inspection regimes)
- Development of emergency response plans
- Development of sanitary protection zones (SPZ) around the industrial facilities. The SPZs define areas around industrial facilities in which land use is restricted and, for example, accommodation and residential use is prohibited. The SPZs are determined under RF regulations through consideration various human health factors including air quality (see Section 9.2), noise (see Section 9.8) and safety risk zones. The sizes of the SPZs for the various Project facilities are summarised below:
    - LNG Plant: 1,000m
    - Airport: 200m
    - Seaport: 500m
    - Waste management facility: 500m

9.12.4 ENVIRONMENTAL EMERGENCY SCENARIOS

The primary environmental risk scenarios are identified as being associated with:

- Oil and chemical spills
- Air quality impacts during upset conditions (see Chapter 9.2 for further details)

9.12.4.1 OIL AND CHEMICAL SPILLS

Oil and chemical spills may occur during both the construction and operational phases. General approaches for the control of spills to protect soil, surface waters and groundwater are described in Sections 9.4, 9.5 and 9.6 respectively.

Bulk storage, handling and transport of hydrocarbon (including condensate product and diesel and kerosene fuels) at the onshore facilities, seaport and shipping represent the most potentially significant spill risks. The overall approach adopted for spill prevention and control is:

- Prevention of any spills in the first instance through the robust design of production facilities and continuous monitoring for oil spills, adhering to international high standards and good international industry practice.
- Efficient and effective contingency planning in the event of a spill, which has been tried and tested by trained personnel with a clear chain of command and appropriate resources on hand to tackle any spill size.
- Minimisation of the volume and impact of any oil spill on the natural and human environment.

In order the meet these aims, Yamal LNG will develop an operations Oil Spill Response Plan (OSRP). This plan will be coordinated with the response plans of the seaport operator (Rosmorport) and shipping operators, and will include the following elements:

- The legal framework governing oil spill response (OSR)
- an environmental baseline and impacts section (with cross reference to the ESIA)
- a risk assessment
- Fate and modelling of spilled oil (including oil in ice conditions)
- OSR team organisation
- Initial response, notification and communications
- Response resources
- Response operations and strategies (including in ice conditions)
- Tracking, surveillance and forecasting
- Offshore, coastal zone, land and river response
- Wildlife management
- Waste management (with cross reference to the Waste Management Plan – see Section 9.7)
- HSE guidelines
- Training and drills.

CHAPTER 9 ANNEXES

LIST OF ANNEXES

Annex A **Noise Source Inventories**

Annex B **Air Quality Modelling Data**

ANNEX A NOISE SOURCE INVENTORIES

This annex provides a summary of the noise source inventories developed for the noise impacts assessments undertaken in:

- LNG and Infrastructure Facilities: Design Document 11-035.2-OOC-8.3.
- Seaport: Document 2030-4478-00-8.8-OOS, LLC "Eco-Express-Service" Section 8.8. Book 8.

CONSTRUCTION NOISE SOURCE INVENTORIES

Noise source levels for construction and operational equipment is based on certificate data where available. Where certificate data are not available, noise levels have been taken from the following sources:

- Designer Reference Book ‘Protection from Noise in Urban Planning’, M, Stroyizdat, 1993;
- Designer Reference Book ‘Catalogue of Noise Characteristics of Gas Transmission Equipment According to Gazprom Standard 2-3.5-041-2005’, VNIIGAZ, Moscow, 2005;
- V. B. Tupov, ‘Environmental Protection from Noise in Power Generation Sector’, Moscow, 1999;
- O. N. Rusak ‘Safety of Living’, Saint-Petersburg, 2003;
- A. Zhivotovskiy, V. D. Afanasyev ‘Protection from Vibration and Noise in Metal Mining Industry’, Moscow, 1982;
- Catalogue of Noise Sources and Protective Equipment, Voronezh, 2004;
- Catalogues of Ventilating Equipment of the Companies VEZA and INNOVENT.

The main noise sources at different project stages will be the plant process equipment, auxiliary systems of power generating complexes as well as the ground construction machinery.

LNG AND INFRASTRUCTURE FACILITIES

Various machinery are used during the construction period. Table A1 contains the list of machinery with variable sound levels, while Table A2 lists the machinery with constant sound levels.

Table A1: List of equipment noise source levels – non-constrant sound level

No.	Equipment/machinery	Quantity on the construction site	L_{Aeq} dB(A)	L_{Amax} dB(A)
1	caterpillar cranes	1	73	78
2	pneumatic wheel-mounted cranes	1	71	76
3	bulldozers	1	81	87
4	D-355S pipe-laying machine	1	71	76
5	vehicle-mounted crane	3	71	76
6	high-sided truck ZIL	1	75	80
7	dump truck, loading capacity up to 30t VOLVO	1	77	82
8	dump truck, loading capacity up to 15t KAMAZ	1	77	82
9	caterpillar mechanical shovels	2	73	81

Table A1: List of equipment noise source levels – non-constrant sound level				
No.	**Equipment/machinery**	**Quantity on the construction site**	**L_{Aeq} dB(A)**	**L_{Amax} dB(A)**
10	caterpillar cranes, loading capacity up to 25 t	1	73	78
11	asphalt compactors	1	72	77
12	high-sided trucks. Loading capacity up to 8 t, KAMAZ	1	77	82
13	hydraulic jacks	2	70	
14	lift trucks	1	92	97
15	maintenance crew bus LIAZ	1	73	78
16	special-purpose off-road vehicle	1	77	82
17	pneumatic-wheel tractors	1	71	76
18	cable-system drills and units on automobile basis	1	77	82
19	dump truck, loading capacity up to 15t KAMAZ	2	77	82
20	dump truck, loading capacity up to 30t VOLVO	1	77	82
21	caterpillar mechanical shovels	1	73	81
22	caterpillar cranes, loading capacity 10t	1	71	76
23	high-sided trucks, loading capacity up to 8 t KAMAZ	1	77	82
24	caterpillar cranes, loading capacity 40-63 t	1	73	78
25	bulldozers	1	81	87
26	high-sided trucks, loading capacity up to 5t ZIL	1	75	80
27	asphalt compactors	2	72	77
28	caterpillar cranes, loading capacity up to 25 t	1	73	78
29	pneumatic wheel-mounted cranes	1	71	76
30 s	hydraulic jack	2	70	
31	lift trucks	1	92	97
32	pipe-laying cranes	1	71	76
33	pipe-laying machines	1	71	76
34	motor graders	1	72	77
35	special-purpose vehicles of GAZ type	1	65	70
36	cable-system drills and units on automobiles	1	77	82
37	flushing machines KAMAZ	1	65	70
38	bus LIAZ	1	73	78

Table A2: List of equipment noise source levels - constant sound level											
No	**Noise sources**	**Quantity in reserve**	**Quantity on construction site**	**Sound power levels (dB), in octave bands Hz**							
				63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
1	mobile compressors	52	2	73	84	69	71	70	70	60	52
2	mobile welding unit	3	1	86	92	89	93	92	90	89	86

Table A2: List of equipment noise source levels - constant sound level

No	Noise sources	Quantity in reserve	Quantity on construction site	Sound power levels (dB), in octave bands Hz							
				63	125	250	500	1000	2000	4000	8000
3	manual-operated welding units	37	1	105	98	92	89	86	84	82	80
4	welding converters	27	2	84	85	89	84	85	80	84	85
5	mobile compressors	48	2	73	84	69	71	70	70	60	52
6	electric winches	10	1	73	84	86	87	93	85	84	72
7	pick hammers	84	2	84	80	79	76	73	69	63	56
8	manual-operated welding units	1	1	105	98	92	89	86	84	82	80
9	medium bore hammer	48	2	80	77	70	68	61	64	71	65
10	welding converters	10	2	84	85	89	84	85	80	84	85
Concrete mixing plant for adverse weather conditions											
11	pumps for chemical additives	2	2	95	87	82	78	75	73	71	69
12	compressor	1	1	73	84	69	71	70	70	60	52
13	steam generator	1	1	94	93	92	88	85	86	82	72

SEAPORT FACILITIES

The noise sources levels during the construction of the seaport are presented in Table A3 below.

Table A3: List of equipment and noise source levels during construction of the Seaport

No.	Name of machinery	No. units.	Distance (m)	L_{Aeq}, dB(A)	L_{Amax}, dB(A)
1	Boom crawler crane	4	75	72	78
2	Truck-mounted crane	7	75	77	84
3	Front-end loader	3	1	80	85
4	Grader	3	1	88	93
5	Dump trucks	15	1	90	96
6	rink	4	5	84	87
7	“Trubopletevozny” trailer	2	1	90	96
8	truck tractor	1	8	76	81
9	freight car	1	1	90	96
10	car	1	75	64	72
11	Shift bus	4	75	77	81
12	bowser	1	1	90	96
13	bulldozer	5	1	88	93
14	excavator	1	3	80	97
15	welding plants	2	1	74	74
16	diesel power plant	2	1	80	80
17	compressors Portable	2	1	78	85
18	Installation of pile drilling	1	3	92	98
19	vibrator	6	25	74	80
20	hydraulic hammer	2	75	95	101
21	concrete-mixing plant	1	5	83	85
22	water sprinkler machine	1	5	89	90
23	Cement mixer and concrete pump	6	5	83	85
24	welding transformers	2	1	74	74
25	vibropiler	2	1	80	80
26	Truck, water	1	1	78	83

27	“Samootvozny” bilge suction dredger	2	25	48	50
28	Multi-bucket dredge	2	25	84	84
29	Cutter suction dredger	2	25	48	50
30	self-propelled barge	8	25	62	62

OPERATIONS NOISE SOURCE INVENTORIES

LNG AND INFRASTRUCTURE FACILITIES

The noise sources levels during the operation of the LNG plant are presented in Table A4 below.

Table A4: List of equipment and noise source levels during operation of the LNG Plant

Name of unit	Sound power level of unit of equipment, dB, in octave-band with centre frequency, Hz									
	31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**
Mouth facilities										
Gathering station, switch valve station	27.8	27.8	36.5	48.9	59.5	59.3	57.4	57.8	54.5	64.8
Block of auxiliary rooms	24.3	24.3	31.6	54.4	63.0	60.0	58.4	53.6	52.7	65.2
Gas separation unit	91.0	91.0	89.0	85.0	93.0	89.0	87.0	86.0	78.0	94.8
Methanol regeneration unit	62.4	62.4	51.4	42.0	29.9	19.2	11.0	6.0	0.5	40.1
Condensate stabilizing unit	99.2	99.2	94.1	89.8	87.3	82.8	80.8	79.5	76.2	89.8
Methanol day tank. Methanol pumping station	95.0	95.0	87.0	82.0	78.1	75.8	74.2	71.6	69.2	82.3
Stabilized condensate storage	92.8	92.8	92.0	92.0	97.1	99.4	94.8	88.5	83.5	101.9
Gas compressor house for condensate stabilization	98.8	98.8	92.5	88.0	93.3	89.3	87.3	86.3	79.0	95.2
Flare system	93.3	93.3	91.7	87.3	93.3	89.3	87.2	86.1	78.0	95.1
LNG										
Acid gases removal unit 11	112.0	112.0	111.0	106.5	105.7	104.9	103.0	99.6	95.2	110.1
Gas drying and mercury removal unit 12-13	101.0	101.0	103.0	104.0	109.0	111.0	110.0	107.0	104.0	116.0

Table A4: List of equipment and noise source levels during operation of the LNG Plant

Name of unit	**Sound power level of unit of equipment, dB, in octave-band with centre frequency, Hz**									
	31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**
Liquefaction and refrigerating unit 14	104.5	104.5	106.1	107.3	112.1	114.2	113.4	110.2	107.0	119.2
Rectification unit 15	94.0	94.0	95.0	97.0	101.0	103.0	102.0	99.0	95.0	108.0
Flare systems	95.8	95.8	93.8	89.8	97.8	93.8	91.8	90.8	82.8	99.6
LNG storage and offloading unit 34										
Pumping house	60.5	60.5	47.6	36.0	23.4	14.6	7.7	3.5	0.0	36.8
Heating medium system	97.5	97.5	95.6	97.1	101.0	103.0	102.0	99.0	95.0	108.0
Auxiliary power plant	87.1	87.1	86.0	81.1	79.1	75.6	71.1	66.1	56.1	80.9
WWTS	55.9	55.9	49.5	46.3	46.7	53.4	52.0	50.1	52.3	58.6
WTS	54.1	54.1	47.7	46.0	46.4	53.4	52.0	50.1	52.3	58.5
Service facilities area										
Administration building	29.5	29.5	37.3	60.1	66.5	65.1	67.1	61.3	53.2	71.5
Communication hub	25.5	25.5	33.6	53.9	60.6	66.4	68.2	62.6	57.1	72.1
MRS	19.1	19.1	24.1	48.3	46.9	55.9	55.1	54.1	55.3	61.6
Materials and equipment depot	4.0	4.0	9.0	26.0	33.0	45.0	40.0	39.0	32.0	47.6
Garage-parking area	26.8	26.8	32.3	52.2	62.3	66.6	65.7	63.7	61.9	71.6
Domestic WPS	55.1	55.1	43.9	42.2	59.0	50.0	49.0	47.0	39.0	58.2
Industrial and storm water tank	52.1	52.1	40.9	42.1	59.0	50.0	49.0	47.0	39.0	58.2
Industrial and storm water tank	52.1	52.1	40.9	42.1	59.0	50.0	49.0	47.0	39.0	58.2

Table A4: List of equipment and noise source levels during operation of the LNG Plant

Name of unit	Sound power level of unit of equipment, dB, in octave-band with centre frequency, Hz									
	31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**
Fire-fighting water supply pumping station zone	52.4	52.4	46.8	41.2	43.9	41.5	47.3	48.1	51.0	54.4
Fire house and gas rescue station area										
Fire house	26.5	26.5	31.4	48.6	56.5	63.0	61.9	58.2	56.8	67.4
Gas rescue station	17.5	17.5	24.6	40.4	54.3	57.7	54.5	52.8	50.6	61.5

SEAPORT FACILITIES

The noise sources levels during the operation of the Seaport are presented in Table A5 below.

Table A5: List of equipment and noise source levels during operation of the Seaport

ID	Name	Distance (m)	LAeq, dB(A)	LAmax , dB(A)
1	The movement of the car	7.5	64.0	72.0
2	Car parking (10 parking spaces)	7.5	58.8	71.9
3	Parking of cars (14 parking spaces)	7.5	60.2	71.9
4	Approach and mooring of the vessel	25	52	72
Base fleet				
5	Tow	25	67	73
6	The dive boat	25	64	66
7	Oil clean-up sweeper	25	67	77
8	Truck Crane	8	78	84
9	Forklift	4	75	84
Garage-Warehouse				
10	Mobile repair workshop, chassis Ural	1	78	79
11	Forklift	4	75	84
12	Mini loader	1	80	85
13	Road vehicle versatile	1	88	93
14	Bulldozer	1	88	93
15	Front-end loader	1	80	85
16	Sweepers, KAMAZ	1	78	79
17	Machine with a removable body	6	73	76
18	The car vacuum trucks, chassis ZIL	5	89	90
19	Channel washing machine “ZIL”	5	89	90
20	Dump truck “KAMAZ”	1	90	96
21	On-board vehicle	1	90	96
22	Water truck	1	78	83
23	Bus	75	77	81
24	Minibus "Sable"	75	72	76

Table A5: List of equipment and noise source levels during operation of the Seaport				
Moorings building materials, receiving vessels Ro-Ro berth and large-sized modules				
25	Mobile Harbour Crane 124t	18	82	87
26	Mobile Harbour Crane 84t	15	77	89
27	Truck Crane 200t	8	78	84
28	Truck Crane 130t	8	78	84
29	Truck/tractor	8	76	81
30	Tipper truck “MAN”	1	78	83
31	Automobiles	1	90	96
32	Self-propelled modular trailer	1	78	83
33	Diesel Forklifts	1	80	85
34	Track Loader	1	88	93
35	Sweeper	1	88	93

ANNEX B AIR QUALITY MODELLING DATA (OPERATIONS)

This annex provides a summary of the meterological data and the emissions inventories used in the operation phase air quality impact assessment.

MODEL DESCRIPTION

The air quality modelling assessment has been performed with the ADMS dispersion modelling software version 5. The modelling set-up assumptions are summarised in the table below.

Parameter	**Value**
Surface Roughness (m)	0.005
Albedo (Snow Covered)	0.6 (Snow Covered)
Minimum Monin-Obukhov length (m)	1 (default)
Priestley-Taylor parameter	1 (default)

The surface albedo is set to correspond to 0.6 to reflect snow covered ground. This is the generally most appropriate assumption for the Project location. However, it is recognised that snow cover will not be present year-round and so a sensitivity analysis has been performed assuming a lower albedo of 0.23 and this is described later in this annex.

All NO_x emissions have conservatively been assumed to be released as NO_2.

SUMMARY OF METEOROLOGICAL DATA

Meteorological data of the formatted required to performance air quality assessments with ADMS is available from the Tambey meterological station only up to 1992, after which relevant data was no longer collected. The last available five years' worth of meteorological data were therefore used as part of the operational phase air quality assessment, namely from 1988 to 1992. The meteorlogical parameters used are as follows:

- Temperature
- Windspeed
- Wind direction
- Cloud cover
- Relative humidity

The windrose derived from the meteorological data in shown below.

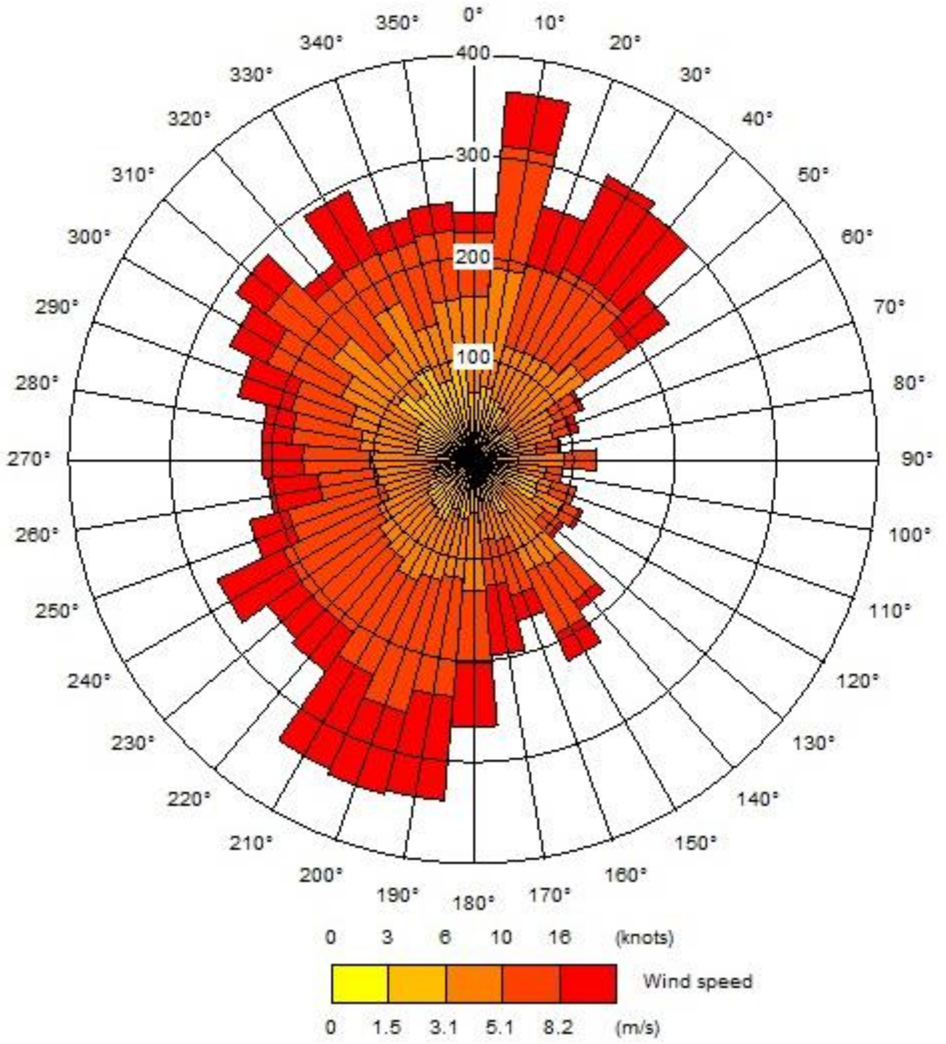

Figure B1: Windrose Based on Tambey Meteorological Data (1988 to 1992)

The available wind direction data are rounded the the nearest 10 degrees.

OPERATIONAL EMISSIONS INVENTORIES

Introduction

The assessment of operational air quality impacts is focused on the primary emission sources during operation of the LNG Complex.

Screening

The emission inventores are based on the most significant emission sources through consideration of the various potential emission sources. Emission sources screened out from consideration in the air quality assessment are as follows:

- Emissions from vessels in the seaport and and from aircraft at the Sabetta airport have been screened out based on international practice (UK guidance - Defra Technical Guidance LAQM.TG(09)) and the anticipated numbers of vessel and aircraft movements.
- Emissions associated with the flaring of overheads (predominantly methane, ethane and propane) from the methanol recovery unit (MRU). The volumetric flow rate from the MRU is 0.76 kg/h, which is small relative other sources, including purge gas, and is therefore not significant.
- SO_2 emissions. In normal operation, fuel gas is a mixture of treated (Hg removal) gas (< 40 wt % of total Fuel) and BOG. No H_2S is expected in the treated gas and the treated gas contains a maximum of 3 wt-ppm of CH_3SH, which after mixing with Boil Off Gas (BOG) dilutes to approximately 1 wt-ppm in the Fuel gas mixture. As such emissions of SO_2 from gas combustion have been screened out of the assessment.
- Particualte emissions from the combustion of gas are assumed to be small and have hence been screened out of the assessment (see below for consideration of incinerators).
- Tail gas emissions from the Acid Gas Removal Unit (AGRU) comprise 98% CO_2 (see Chapter 4 for further details of gas composition), and co-mingled with the exhaust from the refrigurant compressor gas turbines to improve dispersion[1]. Further oxidation of the tail gas is not expected and flue gas temperature is maintained above the acid dew point within the stack. No this basis, no significant air quality impacts are anticapted from this source.
- Mercury emissions. The main combustion plant will be operated on treated gas in which the mercurt levels will be less than 10ng/Nm^3 and hence mercury air quality impacts are negligible and not considered further in the air quality assessment.

Emission Scenarios

In total ten different operational states were assessed, comprising normal operations and nine maintenance/upset conditions. The emission scenarios are based on those identified at the FEED stages and reported in project Document 175700-000000-PR-LS-00008, with supplemental data obtained from Design Document 11-035.2-OOC-8.3 and reference manufacturer data for the SGT-800 gas turbines. Abnormal operating conditions were identified during the FEED stage, which included performance of HAZID/ENVID studies.

The scenarios are defined as follows:

ID	Title	Description
Normal Operations	Normal Operations	Normal operations with all three LNG trains operational
Scenario 1	Refrigurent Compressor Trip	Refrigerant Compressor String Blowdown after trip leading to release to Dry Gas Flare.
Scenario 2	3 Year Cold Weather event	3 LNG train controlled shutdown - Release to Dry Gas Flare

[1] Note that emission from the refrigerant compressor gas turbines are design to compliance with the emission standards stated in the Project Standards Document prior to co-mingling with the AGRU tail gas.

ID	Title	Description
Scenario 3	BOG Compressor Trip	Flaring of all BOG during unavailability of the BOG Compressors - with three LNG trains operating at design capacity during loading of an LNG carrier at the design rate.
Scenario 4	Depressurisation of cryogenic heat exchange and propane circuit	Scenario corresponds to simultaneous 1) Depressurisation of the Main Cryogenic Heat Exchanger and Refrigeration Emergency; and 2) Depressurisation of Propane Circuit.
Scenario 5	Planned shutdown	Planned shutdown of one LNG Train (Train 1 assumed)
Scenario 6	Offspec LNG	Cold burner emissions from offspec LNG, Train 1 down otherwise normal operations
Scenario 7	Demethaniser	Cold burner emissions from liquids from demthaniser drain, Train 1 down, otherwise normal operations
Scenario 8	BOG Compressor flaring	BOG Compressor flaring, but otherwise normal operations
Scenario 9	Warm liquid burner	Warm liquid burning of general liquids, train 1 down, otherwise normal operations

All scenarios 1 to 9 would be of finite duration but have been assessed as continuous sources for the full sequence of meteorological data in order to predict the following peak short-term ground concentrations at the relevant receptor:

- NO_x: 1 hour (99.8th percentile)
- CO:
    - 15 minute (maximum)
    - 1 hour (maximum)

The emission inventories for each of these scenarios is presented in turn below.

Table B1: Emission Inventory for Normal Operations

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
REFRIGERANT COMPRESSOR Train 1 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 1 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 1 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 1 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886

Table B1: Emission Inventory for Normal Operations								
Equipment Name	**Elevation (m)**	**Diameter (m)**	**Exhaust Velocity (m/s)**	**Volumetric flowrate (m3/s)**	**Outlet temp (ºC)**	**Pollutant**	**Mass flowrate (g/s)**	**Conc (mg/Nm3)**
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 5 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 6 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 7 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 8 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	NO2	0.002	67.9
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	CO	0.016	475.3
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	NO2	0.12	67.9
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	CO	0.841	475.3
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9

Table B1: Emission Inventory for Normal Operations								
Equipment Name	**Elevation (m)**	**Diameter (m)**	**Exhaust Velocity (m/s)**	**Volumetric flowrate (m3/s)**	**Outlet temp (ºC)**	**Pollutant**	**Mass flowrate (g/s)**	**Conc (mg/Nm3)**
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	NO2	0.002	67.9
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	CO	0.016	475.3
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	NO2	0.285	67.9
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	CO	1.994	475.3
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NO2	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NO2	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NO2	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
INCINERATOR 1	8.9	0.36	14.1	1.43	180	NOx	0.002	5
INCINERATOR 1	8.9	0.36	14.1	1.43	180	NO	0.011	10
INCINERATOR 1	8.9	0.36	14.1	1.43	180	CO	0.024	60
INCINERATOR 2	8.9	0.36	14.1	1.43	180	NOx	0.002	5
INCINERATOR 2	8.9	0.36	14.1	1.43	180	NO	0.011	10
INCINERATOR 2	8.9	0.36	14.1	1.43	180	CO	0.024	60
INCINERATOR 3	8.9	0.36	14.1	1.43	180	NOx	0.002	5
INCINERATOR 3	8.9	0.36	14.1	1.43	180	NO	0.011	10
INCINERATOR 3	8.9	0.36	14.1	1.43	180	CO	0.024	60
INCINERATOR 4	8.9	0.36	14.1	1.43	180	NOx	0.002	5
INCINERATOR 4	8.9	0.36	14.1	1.43	180	NO	0.011	10
INCINERATOR 4	8.9	0.36	14.1	1.43	180	CO	0.024	60
INCINERATOR 5	8.9	0.36	14.1	1.43	180	NOx	0.002	5

Table B1: Emission Inventory for Normal Operations

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
INCINERATOR 5	8.9	0.36	14.1	1.43	180	NO	0.011	10
INCINERATOR 5	8.9	0.36	14.1	1.43	180	CO	0.024	60

Table B2: Emission Inventory for Scenario 1

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886

Table B2: Emission Inventory for Scenario 1

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 5 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 6 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 7 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 8 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	NO2	0.002	67.9
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	CO	0.016	475.3
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	NO2	0.12	67.9
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	CO	0.841	475.3

Table B2: Emission Inventory for Scenario 1

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	NO2	0.002	67.9
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	CO	0.016	475.3
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	NO2	0.285	67.9
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	CO	1.994	475.3
DRY GAS FLARE	125	1.2	11.03	453	820	NO2	30.8	67.9
DRY GAS FLARE	125	1.2	11.03	453	820	CO	215.4	475.3
DRY GAS FLARE	125	1.2	1.47	46	820	NO2	3.1	67.9
DRY GAS FLARE	125	1.2	1.47	46	820	CO	21.7	475.3

Table B3: Emission Inventory for Scenario 2

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477

Table B3: Emission Inventory for Scenario 2

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 5 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 6 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 7 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	NO2	0.002	67.9
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	CO	0.016	475.3
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	NO2	0.12	67.9

Table B3: Emission Inventory for Scenario 2								
Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	CO	0.841	475.3
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	NO2	0.002	67.9
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	CO	0.016	475.3
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	NO2	0.285	67.9
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	CO	1.994	475.3
HVAC-HTF BACK UP FURNACE	40	3.5	0.36	71	820	NO2	2.6	37
HVAC-HTF BACK UP FURNACE	40	3.5	0.36	71	820	CO	18.4	259.3
DRY GAS FLARE	125	1.2	11.03	453	820	NO2	30.8	67.9
DRY GAS FLARE	125	1.2	11.03	453	820	CO	215.4	475.3
DRY GAS FLARE	125	1.2	1.47	46	820	NO2	3.1	67.9
DRY GAS FLARE	125	1.2	1.47	46	820	CO	21.7	475.3

Table B4: Emission Inventory for Scenario 3								
Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
REFRIGERANT COMPRESSOR Train 1 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 1 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 1 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 1 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7

Table B4: Emission Inventory for Scenario 3

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 5 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853

Table B4: Emission Inventory for Scenario 3

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 6 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 7 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 8 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	NO2	0.002	67.9
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	CO	0.016	475.3
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	NO2	0.12	67.9
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	CO	0.841	475.3
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	NO2	0.002	67.9
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	CO	0.016	475.3
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	NO2	0.285	67.9
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	CO	1.994	475.3

Table B4: Emission Inventory for Scenario 3

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
LNG TANK AND SHIP BOG FLARE	40	1.6	32.49	576	705	NO2	39.1	67.9
LNG TANK AND SHIP BOG FLARE	40	1.6	32.49	576	705	CO	273.6	475.3

Table B5: Emission Inventory for Scenario 4

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 5 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114

Table B5: Emission Inventory for Scenario 4

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
Power Plant GT 6 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 7 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 8 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	NO2	0.002	67.9
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	CO	0.016	475.3
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	NO2	0.12	67.9
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	CO	0.841	475.3
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	NO2	0.002	67.9
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	CO	0.016	475.3
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	NO2	0.285	67.9
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	CO	1.994	475.3
HVAC-HTF BACK UP FURNACE	40	3.5	0.36	71	820	NO2	2.6	37

Table B5: Emission Inventory for Scenario 4

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
HVAC-HTF BACK UP FURNACE	40	3.5	0.36	71	820	CO	18.4	259.3
DRY & WET FLARE EMERGENCY CASE	125	1.2	300.54	?	820	NO2	617.9	67.9
DRY & WET FLARE EMERGENCY CASE	125	1.2	300.54	?	820	CO	4326.9	475.3
DRY & WET FLARE EMERGENCY CASE	125	1.2	53.05	?	820	NO2	128.7	67.9
DRY & WET FLARE EMERGENCY CASE	125	1.2	53.05	?	820	CO	900.9	475.3

Table B6: Emission Inventory for Scenario 5

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886

Table B6: Emission Inventory for Scenario 5								
Equipment Name	**Elevation (m)**	**Diameter (m)**	**Exhaust Velocity (m/s)**	**Volumetric flowrate (m3/s)**	**Outlet temp (ºC)**	**Pollutant**	**Mass flowrate (g/s)**	**Conc (mg/Nm3)**
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 5 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 6 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 7 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 8 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	NO2	0.002	67.9

Table B6: Emission Inventory for Scenario 5

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	CO	0.016	475.3
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	NO2	0.12	67.9
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	CO	0.841	475.3
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	NO2	0.002	67.9
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	CO	0.016	475.3
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	NO2	0.285	67.9
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	CO	1.994	475.3
DRY GAS FLARE	125	1.2	9.43	268	820	NO2	18.2	67.9
DRY GAS FLARE	125	1.2	9.43	268	820	CO	127.2	475.3
HVAC-HTF BACK UP FURNACE	40	3.5	0.36	71	820	NO2	2.6	37
HVAC-HTF BACK UP FURNACE	40	3.5	0.36	71	820	CO	18.4	259.3

Table B7: Emission Inventory for Scenario 6

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7

Table B7: Emission Inventory for Scenario 6								
Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 5 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 6 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114

Table B7: Emission Inventory for Scenario 6

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
Power Plant GT 7 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 8 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	NO2	0.002	67.9
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	CO	0.016	475.3
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	NO2	0.12	67.9
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	CO	0.841	475.3
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	NO2	0.002	67.9
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	CO	0.016	475.3
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	NO2	0.285	67.9
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	CO	1.994	475.3
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NO2	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NO2	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NO2	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143

Table B7: Emission Inventory for Scenario 6

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
COLD LIQUID BURNER	40	0.15	2.6	575	820	NO2	39	67.9
COLD LIQUID BURNER	40	0.15	2.6	575	820	CO	273.3	475.3

Table B8: Emission Inventory for Scenario 7

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837

Table B8: Emission Inventory for Scenario 7								
Equipment Name	**Elevation (m)**	**Diameter (m)**	**Exhaust Velocity (m/s)**	**Volumetric flowrate (m3/s)**	**Outlet temp (ºC)**	**Pollutant**	**Mass flowrate (g/s)**	**Conc (mg/Nm3)**
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 5 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 6 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 7 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 8 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	NO2	0.002	67.9
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	CO	0.016	475.3
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	NO2	0.12	67.9

Table B8: Emission Inventory for Scenario 7								
Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	CO	0.841	475.3
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	NO2	0.002	67.9
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	CO	0.016	475.3
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	NO2	0.285	67.9
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	CO	1.994	475.3
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NO2	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NO2	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NO2	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
COLD LIQUID BURNER	40	0.15	1.68	334	820	NO2	22.6	67.9
COLD LIQUID BURNER	40	0.15	1.68	334	820	CO	158.6	475.3

Table B9: Emission Inventory for Scenario 8								
Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
REFRIGERANT COMPRESSOR Train 1 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 1 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7

Table B9: Emission Inventory for Scenario 8

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
REFRIGERANT COMPRESSOR Train 1 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 1 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114

Table B9: Emission Inventory for Scenario 8

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
Power Plant GT 5 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 6 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 7 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 8 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	NO2	0.002	67.9
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	CO	0.016	475.3
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	NO2	0.12	67.9
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	CO	0.841	475.3
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	NO2	0.002	67.9
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	CO	0.016	475.3

Table B9: Emission Inventory for Scenario 8

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	NO2	0.285	67.9
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	CO	1.994	475.3
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NO2	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NO2	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NO2	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
LNG TANK AND SHIP BOG FLARE	40	1.6	10.06	180	705	NO2	12.2	67.9
LNG TANK AND SHIP BOG FLARE	40	1.6	10.06	180	705	CO	85.8	475.3

Table B10: Emission Inventory for Scenario 9

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 2 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 1	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	NOx	12.75	52.8
REFRIGERANT COMPRESSOR Train 3 Stack 2	40.5	4.75	40.84	723.77	535.8	CO	4.28	17.7
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886

Table B10:Emission Inventory for Scenario 9								
Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
Power Plant GT 1 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 2 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 3 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO2	2.96	27.00837
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	NO	0.481	4.38886
Power Plant GT 4 - SGT 800 + WHRU	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 5 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 5 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 6 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 6 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 7 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 7 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO2	2.96	26.46853
Power Plant GT 8 - SGT 800	40	5	16.6692521	327.3	526	NO	0.481	4.30114
Power Plant GT 8 - SGT 800	40	4	15.4300717	193.9	210	CO	0.929	8.477
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
WET GAS FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9

Table B10:Emission Inventory for Scenario 9

Equipment Name	Elevation (m)	Diameter (m)	Exhaust Velocity (m/s)	Volumetric flowrate (m3/s)	Outlet temp (ºC)	Pollutant	Mass flowrate (g/s)	Conc (mg/Nm3)
WET GAS FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	NO2	0.002	67.9
DRY GAS FLARE PILOT	125	0.05	0.28	0.03	820	CO	0.016	475.3
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	NO2	0.12	67.9
DRY GAS FLARE PURGE	125	1.2	0.19	1.77	820	CO	0.841	475.3
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	NO2	0.001	67.9
SPARE FLARE PILOT	125	0.05	0.28	0.02	820	CO	0.008	475.3
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	NO2	0.06	67.9
SPARE FLARE PURGE	125	1.2	0.19	0.88	820	CO	0.421	475.3
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	NO2	0.002	67.9
LNG TANK AND SHIP BOG FLARE PILOT	40	0.05	0.28	0.03	820	CO	0.016	475.3
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	NO2	0.285	67.9
LNG TANK AND SHIP BOG FLARE PURGE	40	1.2	0.43	4.19	820	CO	1.994	475.3
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NOx	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NOx	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	NOx	1.336666667	1914
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
EMERGENCY DIESEL GENERATOR SET	37.5	0.4	54.45	6.842	439	CO	0.1	143
WARM LIQUID BURNER	40	0.15	0.54	134	820	NO2	9.1	67.9
WARM LIQUID BURNER	40	0.15	0.54	134	820	CO	63.7	475.3

INCINERATOR EMISSIONS

A total of five incinerators will be used by the project during operations. Emissions of CO and NO_X from the incinerators are considered as part of the the normal operations emissions inventory (see above) for these pollutants. In addition, the following additional pollutants from the incinerators are also considered in the air quality assessment:

Pollutant	Discharge rate (g/s)
Particulates (conservatively assumed as PM_{10})	0.022
Hydron chloride (HCl)	0.0039
Hydron fluoride (HFl)	0.000032

RECEPTORS

The primary receptors for human health impacts during operations are assumed to be the Sabetta accommodation camp and the LNG accommodation camp.

MODELLING RESULTS – NORMAL OPERATIONS

The predicted air quality impacts for CO and NO_2 emissions at the identified receptors during normal operations are summarised in the table below.

Pollutant	Time Period	Project Standard	Sabetta Camp	LNG Camp
NO_2 ($\mu g/m^3$)	Annual average	40	0.17	0.14
NO_2 ($\mu g/m^3$)	1 hour (99.8th percentile)	200	7.70	8.51
CO (mg/m^3)	15 minute (max)	100 *	0.01	0.02
CO (mg/m^3)	8 hour (max running)	10 *	<0.01	<0.01

* Based WHO standards.

Contours plots for the NO_2 GLC are presented for both the annual average and 1 hour average (99.8th percentile) time periods in the Figures B2 and B3 below.

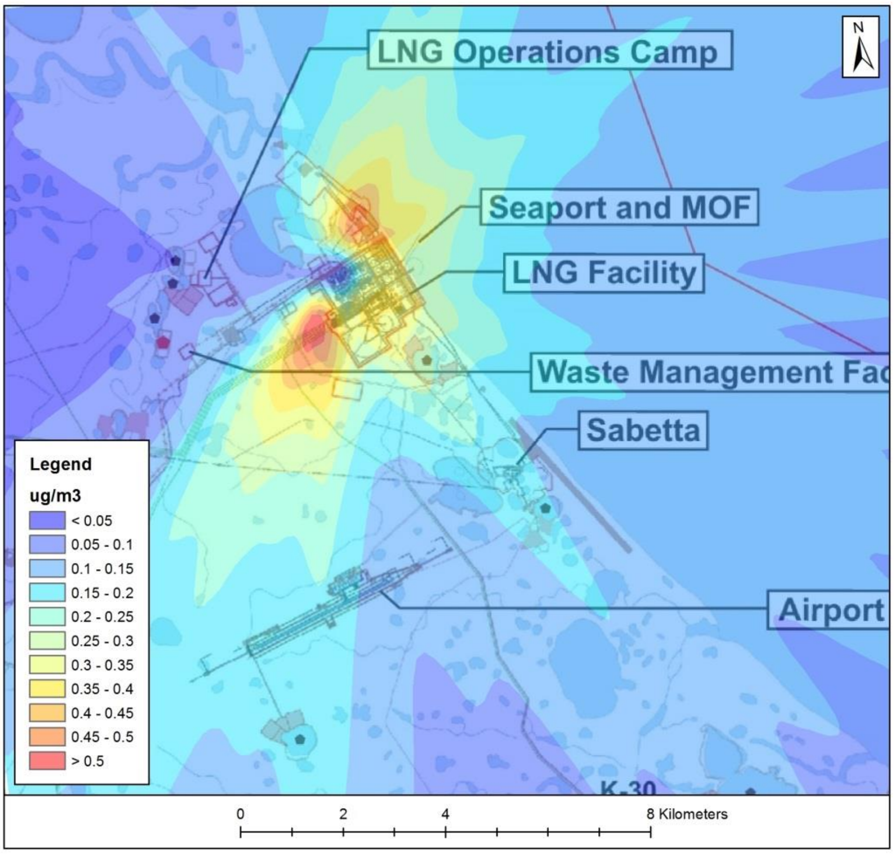

Figure B2: Predicted Annual Average NO_2 Contours During Normal Operations

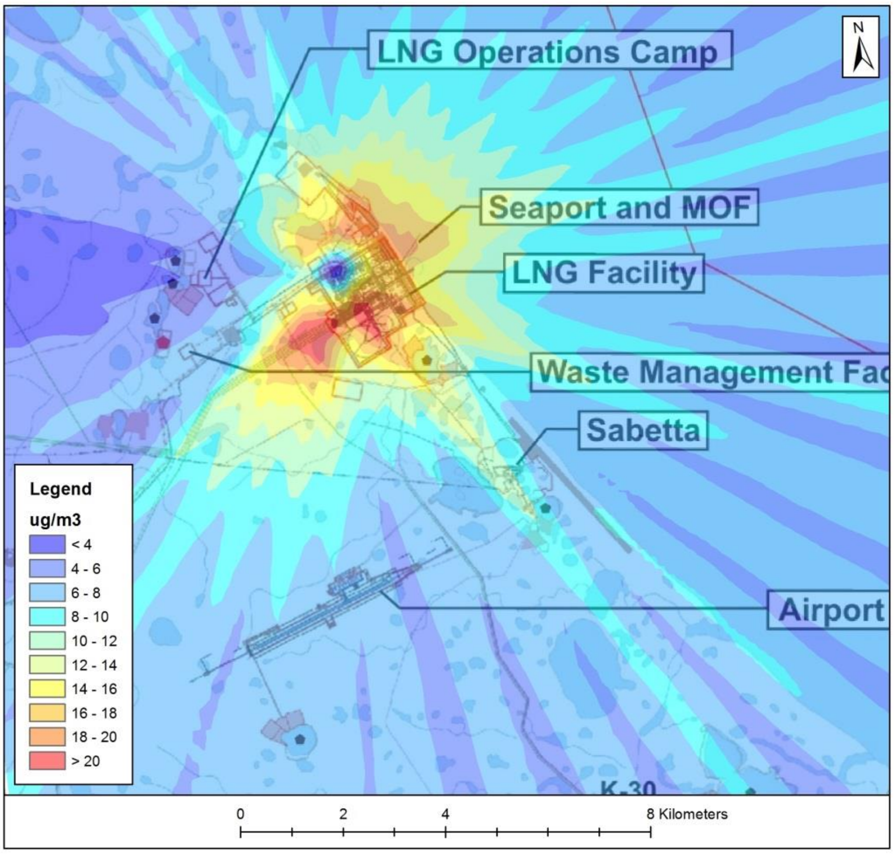

Figure B3: Predicted 99.8th Percentile 1 Hour Average NO_2 Contours During Normal Operations

MODELLING RESULTS – INCINERATOR EMISSIONS

CO and NO_2 emissions from incinerators are included in normal operations air quality impact assessment above. Modeling results (in µg/Nm^3) for the emission of PM_{10}, HCl and HF are summarized in the table below.

Pollutant	Time average	Standard	Max GLC (i.e max anywhere on the grid)	Max concentration at Sabetta Camp	Max concentration at LNG Camp
PM_{10} (µg/Nm^3)	24 hr	50	1.75	0.13	0.36
	Annual av	20	0.15	0.01	0.04
HCl (µg/Nm^3)	15 min	8000[1]	1.16	0.06	0.14
	8 hour	2000[1]	0.77	0.03	0.10

Pollutant	Time average	Standard	Max GLC (i.e max anywhere on the grid)	Max concentration at Sabetta Camp	Max concentration at LNG Camp
HF (µg/Nm^3)	15 min	2500[1]	0.01	0.00	0.00
	8 hour	1500[1]	0.01	0.00	0.00

[1] Conservatively based on occupational health limits taken from UK guidance EH-40.

All standards are comfortably met at all locations for the assessed pollutants.

MODELLING RESULTS – ABNORMAL OPERATING CONDITIONS

Predicted GLC values at the primary receptors, the Sabetta and LNG accommodation camps, are summarised in the table below.

Predicted GLC at Accommodation Camps during Abnormal Operations (NO_2 in µg/m^3 CO in mg/m^3)

Scenario	Pollutant	Time Period	Project Standard	Sabetta Camp	LNG Camp
1	NO_2	1 hour (99.8th percentile)	200 µg/m^3	31.47	33.00
	CO	15 minute	100 mg/m^3	0.37	0.65
	CO	8 hour	10 mg/m^3	0.15	0.17
2	NO_2	1 hour (99.8th percentile)	200 µg/m^3	34.61	35.01
	CO	15 minute	100 mg/m^3	0.41	0.65
	CO	8 hour	10 mg/m^3	0.17	0.18
3	NO_2	1 hour (99.8th percentile)	200 µg/m^3	31.29	28.94
	CO	15 minute	100 mg/m^3	0.35	0.65
	CO	8 hour	10 mg/m^3	0.11	0.14
4	NO_2	1 hour (99.8th percentile)	200 µg/m^3	52.12	52.97
	CO	15 minute	100 mg/m^3	0.67	0.67
	CO	8 hour	10 mg/m^3	0.38	0.28
5	NO_2	1 hour (99.8th percentile)	200 µg/m^3	33.91	30.07
	CO	15 minute	100 mg/m^3	0.41	0.65
	CO	8 hour	10 mg/m^3	0.14	0.15
6	NO_2	1 hour (99.8th percentile)	200 µg/m^3	75.63	63.81
	CO	15 minute	100 mg/m^3	1.49	2.79
	CO	8 hour	10 mg/m^3	0.38	0.46
7	NO_2	1 hour (99.8th	200 µg/m^3	51.67	45.68

Predicted GLC at Accommodation Camps during Abnormal Operations (NO_2 in µg/m^3 CO in mg/m^3)					
Scenario	**Pollutant**	**Time Period**	**Project Standard**	**Sabetta Camp**	**LNG Camp**
		percentile)			
	CO	15 minute	100 mg/m^3	0.87	1.62
	CO	8 hour	10 mg/m^3	0.23	0.29
8	NO_2	1 hour (99.8th percentile)	200 µg/m^3	21.38	23.02
	CO	15 minute	100 mg/m^3	0.15	0.14
	CO	8 hour	10 mg/m^3	0.06	0.06
9	NO_2	1 hour (99.8th percentile)	200 µg/m^3	33.47	28.70
	CO	15 minute	100 mg/m^3	0.35	0.65
	CO	8 hour	10 mg/m^3	0.10	0.13

The predicted GLC at the Sabetta and LNG accommodation camps are well within (<50% and typically very much lower) the applicable Project air quality standards.

CONSIDERATION OF UNCERTAINTIES DUE TO LIMITATIONS IN METEOROLOGICAL DATA

Two specific uncertainties arise due to limitations in relation to the available meteorological data, namely:

- The absence of more recent meteorological data since 1992 sufficient for the purposes of ADMS modelling input
- Rounding of wind direction to the nearest 10 degrees.

Each of the issues is discussed in turn below.

Absence of recent meteorological data

General characteristics of meteorological conditions at any geographic location may slowly change over the period of decades. It is therefore preferable to use the most recent available meteorological data for the performance of air quality modelling assessments. In the case of the Project Licence Area, necessary meteorological data were historically recorded at a weather station in Tamber. However, like many weather stations in the Russian Fedration, recordings ceased in the early 1990's, and therefore suitable meteorological data for the purposes of air quality modelling with ADMS is only available up to 1992. The air quality modelling assessment presented in this annex has therefore been been based on meteorological data available from Tambey between 1988 and 1992.

The use of this relatively old meteorological data represents a degree of uncertainty in the assessments results. However, the significance of this uncertainty is reduced by the fact that the predicted ground level concentrations (GLCs) at the nearest receptors locations are very much below the relevant Project standards. To illustrate this point, it is noted that during normal operations the 99.8th percentile (i.e. worst case weather conditions from an air quality perspective) of the 1 hour average NO_2 GLCs are not only smaller than the 1-hour average Project standard, but also less than 20% of the annual average standard. In other words, even if the statistically worst case hourly weather condition from 1988-1992 were to become the normal/average conditions in futre (which is hardly credible over the lifetime of the project), then the annual average project standards would still be comfortably met.

On the basis of these considersations, the uncertainties due to the age of the available meteorological data are not considered to be significant in the context of the air quality assessment.

Wind direction rounding

The rounding of the wind direction in the available meteorological data results in a ‘starring’ effect on the predicted GLC isopleths, which is inherently more prominent for the assessment of shorter time average periods (see the figures above). Statistical methods may be employed to smooth this effect. However, visual inspection of the isopleths presented above (for example considering the relative location of the identified receptors and the “starring” effects), suggests that the uncertainty represented by this effect is small (and in the case of the Sabetta camp accommodation likely to lead to over rather than under prediction of GLCs). It is therefore considered that the uncertainties due the the rounding of wind direction are not significant in the context of the air quality assessment.

ALBEDO SENSITIVOTY ANALYSIS

The potential effects of different surface albedo assumptions on the air quality predictions has been assessed by running the normal operations cases using 1992 meteorological data separately for assumed surface albedo values of:

1. Albedo of 0.6 (snow covered)
2. Albedo of 0.23 (ADMS default representing a dark surface)

The predicted GLC at the receptor locations using the two different albedo values are presented in the table below for comparsion.

Pollutant	Time Period	Albedo	Sabetta Camp	LNG Camp
NO_2 (µg/m^3)	Annual average	0.6	0.17	0.06
		0.23	0.25	0.11
NO_2 (µg/m^3)	1 hour (99.8th percentile)	0.6	7.70	3.63
		0.23	10.44	7.73
CO (mg/m^3)	15 minute (max)	0.6	0.0079	0.0141
		0.23	0.0075	0.0075
CO (mg/m^3)	8 hour (max running)	0.6	0.0035	0.0032
		0.23	0.0036	0.0035

It can be seen from the above table that a dark surface albedo would generally (although not in all cases) result in marginally higher GLCs at the nearest receptor locations, but that this effect is not significant in the context of the air quality assessment.

10 SOCIO-ECONOMIC IMPACTS, MITIGATION AND MONITORING

10.1 INTRODUCTION

This Chapter presents the analysis of potential socio-economic impacts associated with implementation of the Yamal LNG Project. The assessment identifies the impacts that are predicted to occur during the different phases of the Project: construction, commissioning, operations and decommissioning. The majority of the Project's social impacts will predominantly be of localised nature due to the following factors:

- remoteness and limited accessibility of the Project location due to the absence of a local road transport network to the Project licence area, with the air transportation being the primary means of accessing the Licence Area;
- harsh Arctic climate, characterised by the prevalence of sub-zero air temperatures during most of the year and a continuous permafrost zone, which largely prevents establishment and spread of informal settlements in the barren tundra or open-air opportunistic camps as 'satellites' to the Project development;
- formalised access restrictions to the entire Yamal-Nenets Autonomous Okrug (YNAO) due to the rigorous state border zone regulations requiring an entry permit (border pass) for non-residents/visitors;
- lack of permanent settlements (non-Project facilities) in the immediate vicinity of the main Project facilities and construction sites.

This Chapter also addresses the measures that are required to mitigate the predicted adverse impacts or to enhance the anticipated positive effects (mitigation controls and/or enhancement measures). The significance of each identified impact is therefore assessed both prior to mitigation and with the consideration of mitigation, i.e. the residual impact.

The assessment has been undertaken in line with the ESIA methodology described in Chapter 3, and with due account of the baseline socio-economic conditions in the Project Area of Influence as presented in Chapter 8. The Project Area of Influence (both direct and indirect) is described in Chapter 4.

The structure of this Chapter comprises the assessment of the potential impacts for each Project phase in relation to the following social components:

- Community health, safety and security;
- Population influx and demographics;
- Land use and traditional economic activities, including those practised by the Indigenous Peoples;
- Economy, employment and livelihoods;
- Labour and working conditions; and
- Cultural heritage.

The structure of the individual impact assessment sections consists of the following:

- Outline and description of predicted potential impact(s);

- Impact assessment prior to mitigation or enhancement (pre-mitigation impact significance);
- Description of impact mitigation/enhancement measures;
- Impact assessment post mitigation/enhancement (residual impact significance); and
- Summary table listing the predicted impacts and associated mitigation controls.

10.2 COMMUNITY HEALTH, SAFETY AND SECURITY

This section describes potential impacts on health, safety and security of the communities in the Project Area of Influence in relation to construction, commissioning, operation and decommissioning phases of the Yamal LNG Project. The section also describes the specific measures that will be implemented to eliminate, minimise, and mitigate these impacts and that will be also set out in related management plans (see Chapter 14 for further details). When identifying and assessing the likely impacts, characteristic features of the potentially affected communities have been taken into consideration, particularly their predominantly nomadic lifestyle and the regular migration with reindeer herds across remote sections of the open tundra, including parts of the Project licence area.

The aspects of the Project associated with the specific Project components and activities that are likely to give rise to community health, safety and security risks are listed in Table 10.2.1.

Table 10.2.1: Project aspects related to community health, safety and security risks

Aspect/Project Component	Potential Risk/Impact[1]
Construction Phase	
Construction Workforce Presence of the large non-local workforce in the licence area, predominantly consisting of non-resident construction contractor personnel	Increased risk of communicable and non-endemic diseases, including transmission among the workforce and to the local communities (non-workforce). Increased stress levels and associated mental effects experienced by the local population due to the arrival of large numbers of personnel from outside Yamalsky District/YNAO. Conflicts and tensions as a result of cultural variations and differing mentalities between the local communities (including Indigenous Peoples) and non-resident workforce that may be unfamiliar with the local conventions and customary modes of behaviour. Potential for increased alcohol consumption and/or substance abuse.
Ground Surface Modification and Intervention, Above-Ground Infrastructure, Utilities and Auxiliary Assets Laying of the intra-field access roads and roadways resulting in temporary excavations and formation of borrow pits, spoil heaps, presence of	Transformation of the terrain previously familiar to and well-known by the local communities and particularly migratory herders. Land surface erosion and the resultant development of hazardous landforms that may hinder safe passage of

[1] Where similar risks or impacts are expected to arise as a result of various activities, those are grouped and are presented together as related to the specific aspects or Project components.

Table 10.2.1: Project aspects related to community health, safety and security risks	
Aspect/Project Component	**Potential Risk/Impact[1]**
roadside ditches and drains, and other alterations to the ground surface. Earthworks, civil works and laying of the above-ground infrastructure, resulting in the creation of open excavations and pits and other modifications of the ground surface. Installation of the overhead power transmission line and towers. Construction and assembly of the above-ground connecting network of gathering pipelines for gas collection from the production well fields. Presence and operation of the construction and earth-moving equipment, plant and machinery (both mobile and stationery). Operation of diesel generators and boiler houses for power supply.	migratory population. Disruption on reindeer herder migratory routes traversing the licence area through creating physical impediments to nomadic herders, their reindeer and the means of transportation (sledges). Increased risk of accidents and injuries due to the altered ground conditions and on intersections with the linear infrastructure assets (linear structure crossings). Collision of migratory herders and reindeer with the above ground infrastructure and construction plant/machinery. Noise nuisance, vibration effects, dust generation, and emissions of air pollutants by construction and power generation equipment. Generation of dust and suspended solids during earthworks and ground disturbance activities. Washout of pollutants in case of uncontrolled melt/stormwater runoff contaminated with suspended solids and petroleum products (fuel & lubricants) from construction sites to the surface water bodies that are also used by the local communities. Potential littering of the water bodies with construction debris.
Well Fields Construction of well pads and drilling of production wells. Controlled non-continuous release of flare gas during the well testing studies (one flare pit per each well pad). Generation of drilling waste (drill cuttings and formation fluids) and other wastes (construction debris, oil products, chemicals) in the course of well drilling operations. Fuel storage and filling stations at the well pads	Alteration of the ground conditions/local terrain. Resultant disruption to reindeer migratory routes that traverse the licence area, through creating physical impediments to the nomadic herders and their reindeer. Noise nuisance and vibration effects from the operating drilling equipment. Uncontrolled hydrocarbon/formation spill during well drilling operations (upset conditions), with the resultant risk to surface water bodies, the groundwater environment. Localised disturbance and nuisance through smoke formation, visual and sound effects during flaring. Washout of pollutants in case of uncontrolled contaminated melt/stormwater runoff from the drilling sites to the surface water bodies that are also used by the local communities. Potential release of well testing waste or used hydrotest water into water bodies. Potential sources of air emissions. Potential risk of hydrocarbon contamination of surface water bodies due to accidental spills and leakages.

Table 10.2.1: Project aspects related to community health, safety and security risks	
Aspect/Project Component	**Potential Risk/Impact[1]**
Transportation Activities Presence of road vehicles and increased volume/frequency of vehicular movements on the intra-field access roads, including HGV[2] traffic. Use of temporary/seasonal local road network (public winter roads) that are also used by the local communities. Filing stations and vehicle parking areas. Helicopter operations for transportation of construction workforce and accessing remote construction sites within the licence area.	Introduction and intensification of local road traffic in the licence area and a resultant heightened risk of Road Traffic Accidents (RTA), involving local communities, migratory herders and their reindeer. Increased risk of collisions, injuries and fatalities. Noise nuisance, dust generation and emissions of air pollutants by road vehicles. Risk of ground surface contamination and its spread to the areas traversed by migratory herders in case of uncontrolled/accidental spills and leakages. Noise disturbance during helicopter take-off, landing and overflight, particularly in case of low flight altitude.
Seaport Use of the early seaport (MOF) for the delivery of construction materials and heavy plant/equipment by sea. Development of the main seaport and activities related to the establishment of approach and navigational channels: piling, trestle setting, dredging. Disposal of excavated (dredged) soil in the designated water areas of the Gulf of Ob. Movement of carrier and construction/support vessels.	Emission of air pollutants from dredging equipment and operating vessels. (Note that offshore fishing is prohibited)
Airport Construction of the airport and the associated ground infrastructure/airfield.	Disruption to reindeer migratory routes that traverse the licence area, through creating physical impediments to the nomadic herders and their reindeer.
Waste Products and Facilities Generation and disposal of solid and liquid construction waste, including bulky materials, sewage sludge and sanitary wastewater. Loading, unloading and compaction of construction wastes. Operation of waste incinerators.	Exposure to hazards associated with waste disposal in the areas that can be accessed by the local population (particularly nomadic herders traversing the licence area), including potential spills, leakages and the presence of hazardous wastes. Dust generation leading to nuisance and respiratory effects. Emissions of air pollutants due to the waste combustion process and the associated health risks.

[2] Heavy Goods Vehicles

Table 10.2.1: Project aspects related to community health, safety and security risks	
Aspect/Project Component	**Potential Risk/Impact[1]**
Storage Facilities Storing of hazardous materials used in the construction process (glues, paintings, solvents, chemicals etc.) Fuel and lubricant storage. Temporary storage of sanitary wastewater.	Uncontrolled runoff of contaminated stormwater/melt water from storage areas to surface water bodies that are also used by the local communities. Increased risk of accidental spillages onto the ground surface and to the water bodies.
Security Personnel The use of private security provider to guard the construction sites and assets within the licence area.	Risk of conflicts and tensions due to the presence of security services, particularly in cases where personnel are unfamiliar with the local conventions and customary modes of behaviour. Potential for disproportionate use of force or intrusive stop-and-search practices applied in relation to nomadic herders migrating through the licence area. Disruption to herder migration and traditional reindeer grazing due to access restrictions enforced by the security within the licence area.
Pre-commissioning and commissioning	
Flaring – LNG Plant and Well Fields Flaring: Non-continuous release of flare gas during commissioning and start-up of the LNG Plant and at the associated wells.	Potential risk to human health due to the air pollutants released as part of incomplete combustion, including a potential release of raw gas in case of insufficient burning through flaring. Disturbance and nuisance effects through smoke formation, thermal radiation, visual (flaring flashlight and luminosity) and sound effects during flaring.
Operations (Routine works)	
Well Fields Operation of drilling rigs at the well fields Operating network of the above-ground gathering pipelines for gas collection and transportation to the LNG Plant. Non-continuous routine release of flare gas (horizontal burners) associated with well drilling at the well pads.	Noise nuisance from drilling operations at the well pads. Disruption to reindeer migratory routes that traverse the licence area, through creating an impediment to the nomadic herders, their reindeer and means of transportation (sledges) on pipeline crossings. Disturbance and nuisance through smoke formation, odour, thermal radiation, visual (flaring flashlight and luminosity) and sound effects during flaring.
LNG Plant Operation of process trains, compressors, gas turbine generators and venting of acid gas (CO_2 and methanol) as part of the LNG production process. Operation of LNG and condensate loading facilities. Flaring during routine and abnormal operating	Potential risk to human health due to the release of air pollutants from: - Flaring - Fugitive emissions from chemical and hydrocarbon storage and handling and from process units - Combustion of hydrocarbons from power

Table 10.2.1: Project aspects related to community health, safety and security risks	
Aspect/Project Component	**Potential Risk/Impact[1]**
conditions, including but not limited to the following scenarios: – Flaring: non-continuous/periodic venting of flare gas during routine maintenance and repair shutdown (controlled routine shutdown). – Flaring: constant gas relief from the Methanol Regeneration Unit. – Flaring: pressure relief through Boil-Off Gas flare at the LNG storage and loading facilities. – A spare flare system for use during maintenance and inspection to avoid interruption to the flaring process. Operation of the LNG process equipment, including gas turbines as part of LNG liquefaction and refrigerant compression.	generators and other process units Disturbance and nuisance through smoke formation, thermal radiation, visual (flaring flashlight and luminosity) and sound effects during flaring. Noise impacts from the LNG liquefaction and refrigeration unit.
Power Supply Operation of the main Power Plant (eight gas turbines with the total output of 380MW) and back-up diesel generators.	Emissions of air pollutants and associated risks to human health. Noise impacts from the power generation activities.
Airport Presence of the airport's physical infrastructure Aircraft landing and take-off cycle, particularly in case of the large aircraft type	Emissions of air pollutants and associated risks to human health Noise disturbance from the operating aircraft
Road Transport Vehicular movement on the intra-field access roads within the licence area.	Disruption to reindeer migratory routes that traverse the licence area, through creating an impediment to the nomadic herders and their reindeer. Dust generation and emissions of air pollutants. Heightened risk of Road Traffic Accidents (RTA).
Waste Collection and Treatment	Potential bacteriological, microbiological and chemical hazards
LNG process upset conditions Failure of the LNG and condensate storage tank(s), hindered release of fluid boils and Boil-Off Gas vapours (auto-refrigeration or pressure relief/venting system failure, boil-off gas compressor trip). Storage units, including LNG storage tanks, condensate tanks, solvents and methanol stock storage.	Uncontrolled release of natural gas, condensate spillage, risk of flash fire and the explosion of LNG vapour leading to emergency impacts on the local communities, including potential injuries and fatalities. Uncontrolled release of gas condensate or accidental spillage of process liquids at industrial sites.

10.2.1 CONSTRUCTION

In summary, potential impacts on community, health, safety and security during construction activities may occur through the following:

- Heightened stress, potential for conflict, reduced sense of personal and community safety, greater incidence of communicable disease, associated with the large numbers of non-local workforce present in the Project licence area;
- Increased risk to nomadic indigenous herders traversing the Project licence area on their traditional migration routes, due to the modification of ground surface and introduction of physical impediments and other hazards associated with the installation of Project infrastructure (areal and linear) and establishment of the local transport network (access roads);
- Potential for health impacts related to air emissions, noise, generation of dust, ground contamination and pollutant run-off to the surface water resources used by the local population, which may exacerbate existing or cause new health conditions (e.g. greater predisposition to respiratory diseases);
- Risks associated with the presence of security personnel within the Project licence area.

When identifying and assessing the potential impacts, the considerable distance between the Project facilities and the nearest off-site permanent populated areas has been taken into account.

The following subsections describe the identified potential impacts in detail in terms of the nature of the impact arising, associated mitigation measures and the residual impact post-mitigation.

10.2.1.1 COMMUNITY EXPOSURE TO HEALTH EFFECTS

As described in detail in Chapter 8, the existing key healthcare issues that contribute to greater susceptibility of the local communities in the Project Area of Influence to adverse health effects are:

- Limited accessibility of prompt and full-scale medical assistance for the rural tundra population, particularly for nomadic herders who migrate in the remote areas on a regular basis and do not have constant communications coverage;
- Low level of specialist medical and preventive care (e.g. mobile diagnostics equipment), particularly for the nomadic population in the tundra;
- Overreliance of the tundra population on mobile paramedic units (that often tend to be understaffed) and on the medical aviation[3] serving medical needs of migratory households;
- Dependence of medical aviation and medical evacuation on specific weather conditions that allow safe transportation by helicopter;

[3] Air ambulance is the service provided by the state to ensure the availability of specialised medical aid, both routine and emergency, to the population in YNAO. Medical aviation services operate on the basis of the regional hospitals in Salekhard and Novy Urengoi cities and a number of territorial branches (the air ambulance bases) coordinated by the state.

- Limited bed capacity of the local public healthcare facilities and the shortage of qualified medical staff in the rural tundra areas;
- High morbidity rate (including among children) and the prevalence of respiratory infections (acute and chronic) in the population morbidity profile, primarily due to regular and prolonged exposure to very low ambient temperatures;
- Higher incidence of tuberculosis (including its active and treatment-resistant forms), with greater predisposition among nomadic population living in the remote northern areas due to challenging environmental and living conditions;
- Higher incidence of sexually transmitted infections (STIs) in Yamalsky District and the increasing HIV/AIDS trend, including the precedents of HIV occurrence among the indigenous population, likely resulting from insufficient awareness of transmission risk, limited access to the methods of protection, and with the growing labour migration from outside the District/Okrug also being a potential contributing factor;
- Emergence of non-endemic diseases atypical to the Arctic region and growing immune deficiency (suppression of immune system) due to the changing climate and environmental background in general;
- Susceptibility to alcohol, predominantly among the settled indigenous population who become detached from traditional nomadic occupations; and
- Physical and psychological daily stresses among the IPN related to the demanding challenges of maintaining a viable household in the tundra and labour-intensive traditional subsistence activities of nomadic type;

The abovementioned factors account for greater vulnerability of the local population to adverse health effects.

The potential health impacts associated with the Project's construction phase are described below:

Increased risk of communicable diseases

Description of potential impact

Communicable diseases of concern in the Yamal LNG Project Area of Influence include respiratory diseases and tuberculosis, and STIs including HIV/AIDS[4], with the latter more prevalent in the younger population (20-29 age group).

At the peak of the construction phase in 2015-2016, the total Project workforce will reach 14,000 shift-based personnel[5], comprised largely of contractor workers arriving from outside the Yamal-Nenets Autonomous Okrug (YNAO) and other regions of Russia as well as from abroad. The workers will be accommodated in the dedicated residential facility within the licence area, i.e. the Sabetta shift camp.

[4] Sexual transmission being the prevalent pathway of HIV/AIDS infection among the IPs, as compared with the YNAO as a whole where intravenous drug consumption is a more predominant pathway.
[5] Working in rotation, i.e. 7,000 construction workers present on site at any one time.

Throughout the construction phase, the presence of the sizeable workforce that are not local or native to the YNAO is predicted to increase the potential risk of transmission of communicable diseases. Taking into account the baseline conditions of public health among the Project affected communities, including the persistent tuberculosis trend and the increasing STI/HIV expansion into the indigenous population groups, these types of infections are likely to constitute the main risk of spreading between the workforce and potentially to the local population. The additional contributing risk factors are likely to be:

- the insufficiency/irregularity of STI/HIV/AIDS testing practices that are available to the local population,
- limited awareness of a need to undertake periodic testing to ensure timely detection of the infection.

Introduction of other infectious diseases through the non-local workforce may also pose a potential risk, including possible transfer of pathogen-based gastrointestinal disorders or viral infections (e.g. hepatitis). The existing municipal (i.e. non-Project) infrastructure lacks well-developed facilities for the management of sanitary waste in the expansive areas of tundra or across the inter-settlement territories typically used by the nomadic population. This emphasises the reliance of the Project workforce on the adequate on-site sanitary facilities that will be set up and operating as part of the Project within the licence area (detailed information about the Project's waste management facilities is presented in Chapter 9).

Due to the rotation work pattern and the absence of developed hospitality infrastructure in the vicinity of the Project licence area, construction personnel based in the worker-only accommodation camp will not be able to bring in families to accompany them during the shift assignments. This approach will help to avoid an uncontrolled influx of non-local population into the Project licence area and to prevent additional health risks that would have been associated with an inflow of non-resident visitors to the area and the resultant pressure on the local healthcare services. At the same time, the lack of family-orientated environment during the shift stay may lead to some workers opting to resort to informal or commercial sex services, which, in turn, would have a potential to increase the risk of contracting an STI. However, this risk is counteracted by the relatively short duration of the shifts (typically 45 days) in the personnel rotation system and is therefore intrinsically lower as compared with practices where imported/non-local workforce reside in camps for prolonged periods at a time.

Another potential pathway for transmissible diseases among personnel and further outside the Project facilities can potentially be inadequate sanitary and hygiene conditions during food handling processes as part of the catering arrangements for workers; including procurement, delivery, storage, and disposal of foodstuffs and preparation of meals. Catering facilities are provided as part of the on-site services offered to workers, with the supply of food provisions and raw ingredients (e.g. milk and fish/meat) to be organised via the main catering supplier - the company 'Partners Noyabr'sk' (as of October 2013). This company, though in cooperation with other local food suppliers of smaller scale, is responsible for purchase, transportation and storage of food in Sabetta warehouses. Yamal LNG medical department performs daily checks of food quality with registration of the results in a corresponding food-quality log; food samples are also taken 30 minutes before each meal. The Yamal LNG OHS and Administrative departments inspect compliance with the OHS standards.

EPC contractors select their catering providers through a separate tender process and bear full responsibility for catering arrangements for their employees.

Historically, infections and parasite infestations were reported to be among the main causes of mortality among local population of the Arctic and areas of the Far North, including such critical diseases as smallpox, typhus, leprosy and trachoma. The wide-scale prophylaxis measures implemented during the Soviet period had achieved a significant success in reducing the occurrence of this class of diseases. A similar achievement of the Soviet medicine was the eradication of anthrax thanks to the mass immunisation programmes that were implemented and are still regularly conducted in tundra regions.[6] Although some probability of pathological re-occurrence may remain at present, primarily due to these diseases being typically categorised as "*naturally occurring*" in the region, it is not expected that such epidemiological risk to the community will be particularly exacerbated through the arrival of the Project workforce. However, areas at the Project facilities with a potentially higher risk of vector-borne infection, i.e. where pathogens may be transmitted by wild animals and arthropods[7], can include food storage, catering and disposal at the worker residential facilities or as part of solid waste disposal (particularly organic/food wastes).

Potential exposure to and transmission of zoonotic diseases may be due to the unregulated import of dogs on the site. The main risk in such cases would be accidental import of canine rabies through non-acclimatised and non-vaccinated dogs that may be a potential vector in the virus transmission, particularly if an infected animal comes in direct contact with reindeer or people. However, the overall risk of rabies infection is considered negligible as Yamal LNG prohibits the presence of dogs onsite.

The harsh Arctic climatic conditions also significantly increase the risks of developing cold-related communicable illnesses (e.g. acute respiratory viral and bacterial infections – influenza, bronchitis, pneumonia or meningitis). This risk increases further during the lengthy cold season, and with the large numbers of construction workforce congregated within the licence area and collectively residing in compact conditions of the camp facilities, which may also be conducive to the accelerated transmission of other communicable diseases such as tuberculosis. In the absence of appropriate control measures, this could potentially translate into the development of an epidemic chain affecting workers and spreading outside the Project boundaries.

Overall, when predicting the likelihood of a potential rise in the incidence of transmissible diseases due to the Project, the following aspects should be taken into account:

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[6] The current prevailing view in the Russian public healthcare circles is that the survival capacity of anthrax bacteria is minimal at the very low temperatures in permafrost tundra conditions. Mass epidemics of the anthrax that broke out during the 1930s across Western Siberia are now largely attributed to the introduction of infection from other regions of the country, largely through the import of untreated leather. At present, vaccination of reindeer against anthrax and brucellosis is routinely conducted in YNAO.

[7] Common vectors are wolves, foxes, Arctic foxes, mosquitos and small rodents (lemmings, voles). Tick-borne encephalitis is not reported to be endemic to the tundra areas of Yamal.

- The lack of major permanent settlements in close proximity of the Project facilities, with Tambey Factoria (a village consisting of 34 residents) being the only permanently inhabited community in the relative vicinity of Project facilities within the licence area, located some 30km to the north of the LNG site;
- Limited frequency of the seasonal migrations by the local nomadic population passing *en route* through the licence area – as per the results of ethnocultural studies conducted in May-August 2013, a specific feature of the reindeer herding sector within the subject area is that the nomadic reindeer herders do not make annual migrations (*kaslaniye*) southwards, instead staying with their reindeer herds on the northern tundra;
- The lack of an easily accessible and regular transport network outside the licence area that would have enabled workers to undertake frequent trips to other settlements in the Project locality and to actively interface with local residents;
- The absence of an opportunistic practice of "camp followers", primarily due to the adherence of the local population to their traditional way of life[8] and practical impossibility to set up spontaneous informal settlements by any other non-local casual migrants in the Project vicinity due to the harsh climatic conditions and the strict border-zone state regulations; and
- The absence of a developed trucking freight industry that typically tends to attract a 'satellite' informal sector of commercial sex services and can become a conduit for the transmission of STIs and HIV/AIDS elsewhere in the world.

As the entire workforce will be accommodated in the dedicated closed-type on-site camps throughout the construction phase, the extent of potential interaction between workers and the local community will likely be minimal. Equally, any possible opportunities for casual encounters outside the working hours are also expected to be very limited.

Given all the aforementioned specifics, the risk of communicable diseases spreading outside the Project facility sites due to the presence of the Project workforce is considered to be *probable*, although of *local* extent. The duration of the associated adverse impact will be related to the entire construction phase of the Project, i.e. *medium-term*. In the absence of related mitigation measures and appropriate mechanisms of control, prophylaxis and prevention, the severity of adverse impact on the local communities is predicted to be **Moderate**.

<u>Mitigation measures</u>

Yamal LNG is aware of the challenges associated with the accessibility of qualified specialist medical care in the Project locality, along with the prevailing background morbidity trends such as tuberculosis and recently STI/HIV/AIDS. The risks identified in the preceding section will therefore be addressed through a number of preventative and control mechanisms to minimise the potential spread of communicable diseases between the workforce and off-site communities. These measures will be as follows:

[8] The local nomadic population typically establish short-term temporary camps during their migrations, with the use of traditional portable dwellings (*chums*) that are transported on reindeer-led sledges and are specially equipped to provide shelter at the very low ambient temperatures. This is the routine practice inherent to the indigenous custom of the North as it is traditionally associated with the migratory subsistence-based reindeer herding and with the life of nomadic households. This is therefore *not* considered as a newly emerging informal practice of 'camp followers' solely related to the Project development.

- **Health monitoring and disease prevention among workforce**
  - Health screening of all personnel engaged in the construction activities, undertaken upon commencement of their work assignment[9] and routine medical examination during pre-arrival shift arrangements, including contractor workforce;
  - Regular medical check-ups of rotation-based personnel when on shift;
  - Implementation of the Health programme for Project personnel, including raising the awareness of potential health risks and methods of prevention (also in relation to the vector-borne and blood-borne infections, TB and STIs);
  - TB control at the workplace and in the worker accommodation areas;
  - Regular liaison with the public healthcare and social protection authorities in Yamalsky District/YNAO (Department of Public Health, Department of Labour and Social Protection) on TB, STI and epidemic prevention;
  - Free availability of the means of individual protection (condoms) at the on-site clinic that can be dispensed to workers on as-needed basis in a discreet and anonymous manner as a method of STI prevention;
  - Availability of the primary diagnostics and quarantine arrangements for infectious illnesses at the on-site clinic, including the provision of confidential counselling on STIs and related pre-treatment to workers. Wherever possible, contact tracing will be undertaken to curb the spread of trackable infections. Referrals will be provided for full treatment at the specialised healthcare facilities in Yamalsky District (in Seyakha or Yar-Sale), or in the Okrug (Novy Urengoi or Salekhard) as necessary.
  - Record and analysis of personnel morbidity statistics (detected cases of disease) to identify prevalent trends and any incidents of illness recurrence.
- **On-site healthcare and welfare facilities for workforce**
  - Provision of the dedicated 'closed' on-site accommodation facilities[10] for all construction personnel within the boundaries of the licence area, thereby minimising the need and potential for workers to interact with local residents off-site;
  - Arrangements for the provision of on-site medical care to Project personnel (including contractors) through a dedicated 24-hour clinic located within the licence area;
  - Availability of emergency aid equipment at the clinic and personnel evacuation provisions in case of a medical emergency/epidemic;
  - Systematic sanitary and epidemiological inspections of worker accommodation facilities (residential units and other camp areas including catering) to ensure compliance with the mandatory requirements for hygiene and sanitation.

[9] This includes checks of workforce mandatory immunisation against infections: influenza, DPT, tick borne encephalitis, BCG vaccine against tuberculosis, hepatitis A for medical and catering staff and personnel servicing water treatment and sewage facilities; and immunisation against Sonne dysentery for catering staff, Hepatitis B for all medical staff and first aiders.

[10] Workers only, no unauthorised external visitors are allowed in the camp.

- **Workforce behaviour regulations**
  - Enforcement of the workforce regulations through the *Accommodation Camp Policy* (including sign-in/sign-out policies and guidance on visits to the local residential areas) and the overall *Worker Code of Conduct*, which is also applicable to the contractor personnel, particularly in relation to the worker movements outside of their working hours or in any areas beyond the designated worksites/Project licence area;
  - Encouragement for workers to promptly report any cases of ailment or illness to the respective medical facility as per the 4-level medical aid scheme described below, particularly when an infection is suspected. Whenever possible, provision of cooperation for contact tracing will also be encouraged. Workers' privacy and confidentiality will be respected in all cases, along with assurance that the detection of an infectious disease will not lead to dismissal.

As specified above, all construction workers (including contractors) will be accommodated in the on-site closed camp in the licence area which will inherently limit contact with the local community and will thus minimise an increase in incidence of communicable diseases due to the presence of the Project's workforce. Only authorised personnel will be permitted to reside or stay overnight in the worker camps. Visitors must be approved by the Camp Manager to stay on or visit the camp premises during appropriate hours.

The Project has developed a medical aid scheme which consists of four distinct levels:

- Level 1: First aid points. Such points will be set up in the remote sections of the Project licence area, primarily at some of the well pads. Maintenance of the first aid points and designation of first aiders will be within the responsibility of relevant contractors, including the decision on whether the presence of a paramedic is required. In cases when first aid treatment is not sufficient, appointed first aiders will be responsible for the following actions, as appropriate:
  - Preparation of workers in need of specialised medical care (including those with symptoms of a communicable illness) for evacuation;
  - Prompt communication with the main medical clinic in Sabetta to provide accurate information on the incident/case and patients' condition;
  - Assistance to ambulance crews with boarding patients on a vehicle or a medevac helicopter for transportation.
- Level 2: Paramedic stations (basic medical facility)
- Level 3: The main medical clinic in Sabetta; and
- Level 4: Hospitalisation to the designated municipal and regional public healthcare facilities in Seyakha and Yar-Sale villages and in the cities of Novy Urengoi or Salekhard.

The dedicated on-site medical clinic at Sabetta will have 30 beds and provide round-the-clock medical services for the Project workforce. The clinic will be operated by a specialised service provider[11] and comprises an extended number of rotation-based medical staff consisting of 4 doctors and 4 nurses/paramedics per shift (i.e. 8 staff per shift in total). The clinic will also include

[11] SOGAZ-Medservice, LLC

two intensive care wards and a quarantine section (4 beds)[12]. The clinic staff includes pre-shift medical examination of workers, wide-ranging first aid services and primary treatment for minor health conditions, as well as initial assessment of potentially severe cases; for severe cases, either emergency evacuation or routine medical evacuation is arranged via medical aviation (ambulance helicopters).

The medical clinic in Sabetta also occasionally serves the local nomadic population, mainly those that migrate in the tundra in the Project locality and may not have ready access to the public healthcare facilities available in larger settlements due to the distance. Medical conditions typically treated in such instances are minor ailments/injuries and non-specialised cases; complicated disorders are referred to the state medical institutions in Yamalsky District or elsewhere in the Okrug.

In total, four Level 2 paramedic stations are planned for the licence area at: the airport site; the seaport; near the fire depot; and at the LNG site. The responsibility for establishing and operating these stations lies with the contractors involved in the construction of those facilities. In addition, five fully equipped ambulance vehicles will be available to transfer medical cases to the first aid/paramedic stations or main medical clinic in Sabetta.

Only qualified and licenced catering staff will perform food preparation and meal service in the designated worker canteen(s). This approach will help prevent health risks related to food consumption, such as food poisoning or microbial transmission. The proper management of organic and other types of waste will be an important safeguard against the proliferation of pests and vermin that can act as infection transmission agents.

Yamal LNG enforces the '*Programme of Industrial Control and Inspection of Compliance with Sanitary and Epidemiological Regulations at the South-Tambey Gas Condensate Field*'[13] that specifically applies to the following Project facilities:

- Canteen,
- Food storage areas,
- Worker accommodation units,
- Medical clinic;
- Water treatment system;
- Car park.

The Programme includes a number of measures for:

- disinfection / sterilisation / disinsection[14]
- rodent control

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[12] Including facilities for sampling/testing in cases where a highly dangerous infection or an infection of unknown aetiology is suspected.

[13] Программа Производственного контроля за соблюдением санитарных правил и выполнением санитарно-противоэпидемиологических (профилактических) мероприятий в ЦДГиГК ЮТЛУ. Стандарт организации, Рег. № 11-П.1.0.12.67.

[14] The controlled application of insecticide for insect and disease prevention.

- strict monitoring of food delivery, labelling, storage and food preparation conditions
- specific measures to prevent infections at the on-site medical clinic.

Medical waste generated at the main clinic in Sabetta and at the contractors' first aid points/paramedic stations will be properly managed to avoid exposure to and spread of blood-borne pathogens [15], and to ensure necessary isolation precautions, thereby preventing the transmission of infectious agents. Appropriate design and medical practice controls will be implemented at the medical facilities to prevent exposure to untreated medical waste for medical staff, patients and other workers (e.g. personal protective clothing and equipment for medical staff, signage and labelling, etc.).

To minimise potential health and safety risks that may be associated with dogs, Yamal LNG enforces a strict policy that prohibits the presence of dogs onsite. This policy applies to all contractors engaged in the Yamal LNG Project, including the security provider.

Further details on the Project's approach to waste management are provided in Chapter 9. Additional details on the specific arrangements for worker healthcare and medical evacuation are provided in the section 10.4.

<u>Assessment of residual impact</u>

In summary, the presence of a large construction workforce (peaking at 14,000 personnel) will constitute an increased risk of communicable disease incidence among the workforce. At the same time, the potential for enhanced risk of transmissible diseases to the local communities will be limited due to the distances between the Project facilities (including the worker camp) and the nearest populated areas. The absence of major permanent settlements and the predominantly seasonal nomadic lifestyle of the population traversing the licence area will also be the key factor in minimising the frequency of interaction between Project personnel and the local communities.

The risk of contagion will be of a *localised* extent, i.e. primarily confined to the boundaries of the licence area and mainly the worker accommodation camps and active construction sites. The predicted adverse impact on the communities will be of *medium-term* duration as it relates to the entire construction phase. The impact is expected to be *reversible*, mainly due to the comprehensive medical service arrangements established by the Project provided by a specialist Project service provider and competent public institutions. Following implementation of the disease prevention measures described above, the severity of the residual impact is assessed as **Low.**

Stress, mental health effects, and substance abuse

<u>Description of potential impact</u>

The presence of the large, non-local construction workforce may result in increased stress levels in the communities in the Project Area of Influence. For the close-knit and small traditional

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[15] The pathogens of primary concern are the human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV).

communities present in the Project Area of Influence, this is likely to become a factor of discomfort and anxiety, particularly in situations where construction workers are not cognizant of the specific local conventions or not fully familiar with the customary norms of behaviour, including those adhered to by the IPN. A distinct source of potential stress is likely to be the interaction between the local communities and the Project's security force, which is described in a separate subsection below.

The influx of construction workers to a traditionally isolated and sparsely populated environment, could lead to a number of adverse mental effects on local communities, including:

- a sense of reduced personal and communal safety due to the influx of a construction workforce that is likely to be perceived as outsiders;
- elevated concerns about increased crime and tensions between the host community and non-resident workers;
- higher exposure of the local community to alcohol and illicit substances that may be brought in by Project personnel;
- overall psychological perception of the Project associated with environmental degradation and disruption of traditional lifestyles, and a resultant reduced sense of well-being.

Potential exposure to alcohol distribution and consumption is of particular concern, given the particular susceptibility of the indigenous population to alcohol. However, alcohol-related issues are typically found to be far less common in the nomadic population than in the settled population.

The presence of construction personnel may also lead to increased import of alcohol and other illicit substances to the area, resulting in unauthorised consumption by the workforce, or distribution of alcohol to the local communities through exchange/bartering. Some of the local population may be more inclined towards resorting to alcohol and/or other substances as a result of greater stress pressure and negative psychological effects potentially associated with the Project's presence.

However, as described above, there is a low probability of frequent interaction between the local population and the Project workforce, with interaction likely to be mainly limited to occasional encounters with nomadic herders. At the same time, interactions are more likely in the locality of Tambey Factoria, which is visited by the migratory indigenous population on a seasonal basis (mainly to procure foodstuffs and fuel). It is therefore essential that the distribution of alcohol and other prohibited substances between Project workers and local residents/visitors at Tambey Factoria is effectively prevented.

Overall, the potential impact to the local communities related to stress, mental health effects, and an increased risk of alcohol and substance abuse due to the Project's presence is considered to be probable in the localised extent, i.e. within the boundaries of the licence area. The duration of the associated adverse impact will be related to the entire construction phase of the Project, i.e. medium-term. In the absence of related mitigation measures, the severity of the predicted adverse impact on the local communities is therefore predicted to be **Moderate**.

<u>Mitigation measures</u>

Yamal LNG recognises the overriding importance of fostering a 'good neighbour' relationship with the local communities and protecting their well-being. Ensuring a high standard of behaviour and a respectful attitude among the Project workforce is the key to minimising stress effects on local residents and to maintaining a healthy environment in the Project locality. Strict enforcement of Yamal LNG's *Workers Code of Conduct* (to be developed as part of the ESMP – Labour Management Plan) will be among the main measures in this regard. Observance of the *Code of Conduct* will be ensured through:

- induction training;
- regular refresher training, as appropriate;
- control by responsible supervisors and the management of contractor companies;
- application of prescribed disciplinary measures in case of breaches of the Workers Code of Conduct, and
- investigation of the nature and causes of complaints lodged by members of the local community and other external parties via the Yamal LNG '*Stakeholder Enquiry (Grievance) Procedure*'[16] (as described in the Yamal LNG Stakeholder Engagement Plan).

Key aspects of the Workers Code of Conduct will include:

- Respectful and courteous behaviour towards local communities including migratory herders in all cases of interaction;
- Familiarity with and abide by the local norms of behaviour in deference to the traditional customs of the Indigenous Peoples;
- Refrain from distracting, excessive photographing and/or video-recording of local indigenous communities without their permission, especially during the execution of their critical activities (e.g. reindeer herd passage, visiting sacred sites etc.);
- Exercise a 'no-harm' approach towards local residents, their property and local environment;
- Exercise a neutral 'non-involvement' attitude in all cases where there is a potential for conflict;
- Hunting of wildlife, fishing activities and gathering of natural produce[17] are strictly prohibited;
- The use of dogs for any purposes is strictly prohibited;
- No harassment and hunting of reindeer is allowed, including deliberate creation of obstacles on the passage routes used by migratory reindeer herders;
- Exercise deference towards sacred sites and any other objects and features of cultural heritage, particularly those worshipped by the IPN[18].

Yamal LNG has also adopted a Corporate Social Responsibility (CSR) Policy[19] that endorses the respect for universal human rights and freedoms, culture and traditions of the local indigenous communities.

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[16] "Процедура рассмотрения обращений заинтересованных сторон ОАО «Ямал СПГ»'

[17] Berries, mushrooms, herbs.

[18] Rules of worker behaviour in relation to cultural heritage sites are described in further detail in the section 'Cultural Heritage' and in the Yamal LNG Chance Find Procedure.

[19] Политика социальной ответственности ОАО «Ямал СПГ»

All construction personnel and contractors will be housed in the licence area in dedicated accommodation camps and are required to comply with the mandatory '*Accommodation Camp Policy'* which is enforced through contractual obligations.

Cultural induction training will be provided to all construction personnel and contractors workers as well as visitors to ensure that they are:

- Familiarised with the local customs and norms of behaviour, including those practised by the Indigenous Peoples, and are briefed on the Company's commitments as per its CSR Policy;
- Fully informed of their obligations towards the local communities as per the Workers Code of Conduct, Chance Finds Procedure and disciplinary measures/sanctions that ensue in cases of infringement, and
- Able to align their conduct to local standards and benchmarks of behaviour.

Yamal LNG will require that the EPC Contractors and all other subcontractors involved in the construction activities implement the aforementioned provisions, and will also rigorously monitor behaviour of the contractor workforce towards the local communities.

The Company prohibits drugs and alcohol at all its facilities, including in the accommodation camps, and has adopted a detailed alcohol/illicit substance procedure[20] that applies to all Project personnel, contractors and visitors. According to this procedure, appearance at the workplace in the state of alcohol or substance intoxication is considered as gross misconduct. The same enforcement equally applies to rest periods between the on-site shifts, when present at Project facilities out of the working hours, and when *en route* to and from worksites on the Company's means of transport. As per the Procedure, the category of gross misconduct also applies to the following:

- storage, consumption/use, distribution and sale of alcohol-containing beverages, as well as narcotic and toxic substances;
- importation of spirits, narcotics and toxic substances to any of the Project facilities.

Means of control include the following:

- Visual inspection of shift-based personnel prior to the work assignment;
- Medical examination triggered in cases of suspected intoxication;
- Revocation of the permit-to-work, suspension, or dismissal of those found to be in breach of the Procedure.

Yamal LNG does not permit selling and buying of alcohol by the workforce from local residents. The Company's operational management on-site and the security personnel will be informed in cases of alcohol consumption and/or substance abuse within the licence area. Yamal LNG will also exercise a zero tolerance policy in relation to bribery, barter or requesting gifts in the form of alcohol or other substances from the local community.

[20] "Procedure for Determining Incidents of Alcohol and Substance Consumption at the Workplace, Appearance in the State of Alcohol, Substance and Other Intoxication and its Documentation"

The implementation of the Yamal LNG *Stakeholder Enquiry (Grievance) Procedure* in accordance with the Company's SEP allows the collection of any feedback, concerns and/or complaints from Project-affected communities and serves as a primary indicator of any non-conformities relating to the behaviour of the Project workforce and contractors. All incidents reported and logged with the use of this Procedure are reviewed and examined by the Company's designated staff to identify the underlying causes and to determine the extent to which Project personnel or Project activities were involved in creating the situations leading to an external enquiry or a complaint. The Company's response actions prescribed by the Procedure are aimed at establishing the cause of the issue and finding an effective resolution in cooperation with the person or entity that originated the enquiry. Operation of the Procedure is therefore one of the safeguards used by the Company to ensure that it is promptly informed and appropriately acts on any incidents that may be perceived as a source of stress or mental discomfort for the local communities.

<u>Assessment of residual impact</u>

The presence of the large non-local contractor workforce during construction, along with Project activities in the areas used by the indigenous population, are likely to be perceived as a source of stress and adverse psychological effects by the local communities residing or migrating in the vicinity of the Project facilities. At the same time, the potential severity of this predicted impact is limited by the fact that the entire construction workforce will be stationed within the boundaries of the licence area and will have limited and infrequent direct interaction with the local communities. The absence of large permanent populations in the licence area and the seasonal use of the inter-settlement territories by nomadic herders is another contributing factor in reducing the probability of major stressful encounters with the Project workforce.

In the absence of the appropriate mitigation measures, the potential impact associated with stress, mental effects and substance abuse is assessed as **Moderate**. The impact is expected to be of a localised extent, i.e. primarily confined to the boundaries of the licence area, mainly the areas of worker residence and the sites of active construction with the significant presence of personnel. The predicted adverse impact on the communities will be of medium-term duration as it relates to the entire construction phase and is expected to be reversible after the completion of construction. Following implementation of the measures for appropriate regulation of workers and contractors' behaviour, prevention of alcohol and substance consumption and distribution by Project personnel, and the proactive management of community feedback through the functional response mechanism, the severity of the residual impact is assessed as **Low**.

Noise and Vibration Effects

Airborne noise emissions and ground-borne vibration will result from a range of construction activities and equipment, including:

- Drilling rigs
- Road vehicles
- Mobile construction equipment
- Piling
- Loading and unloading operations
- Mobile power generators and compressors
- Flaring during well testing.

Noise disturbance can also occur during helicopter take-off, landing and over-flight, particularly in case of low flight altitude.

Assessment of noise and vibration effects on local communities from Project construction activities is presented in Chapter 9 and a brief summary of the findings of this assessment is provided below.

The absence of significant sources of natural noise in sparsely populated tundra areas, along with a lack of other major industrial or urban developments in close proximity to the Project facilities can lead to an increased sensitivity of local residents to unfamiliar industrial/construction-related noise. Nonetheless, due to the localised extent of noise nuisance contours, the temporary and intermittent nature of the noise, and the low frequency with which reindeer herders are present in the licence area, noise impacts during general construction are assessed to be **Low**. Nonetheless, a range of noise mitigation controls has been identified (see Chapter 9) that will be implemented during construction to further minimise noise impacts. The residual noise impact on local communities is assessed to be **low**.

The exception to this relates to noise impacts from helicopters used during the construction phase. As described in Chapter 9, while each noise event associated with helicopter flights will be short in duration, peak noise levels directly under the overflying aircraft will be in excess of 55dB(A) (which is assumed as a daytime noise nuisance threshold level). Although the frequency with which individual members of local community are likely to be affected by helicopter noise is low, the potential noise impacts may be **high** without additional mitigation. Such additional mitigation is described in Chapter 9 and includes adherence to minimum altitude rules and prohibition of night-time flights. With the adoption of these mitigation controls residual impacts are assessed as **moderate**.

Assessment of vibration impacts (see Chapter 9) indicates that significant surface vibration effects are not anticipated during construction and hence impacts on local communities are assess as **low**.

Thermal radiation and luminosity

<u>Description of potential impact</u>

Flaring during well testing has the potential to lead to impacts associated with thermal radiation, smoke formation and lighting effects on reindeer herders. Uncontrolled, these effects could be of **high** impact on third parties in near vicinity of the flares during testing.

<u>Mitigation measures</u>

To prevent exposure to these risks the following mitigation controls will be implemented:

- Sanitary protection zones will be developed around the horizontal burners located at the well pads
- nomadic herders that are known to pass the area on their seasonal migration routes will be notified of the planned well testing schedule. Advance notification will allow the herders a possibility of avoiding the affected areas by adjusting their routes to an extent feasible. The specific provisions for such notifications are provided in the ESMP (see Chapter 14 for further details).

Assessment of residual impact

With the implementation of the above mitigation controls, the potential impacts of thermal radiation and luminosity on reindeer herders are assessed as **low**.

Air Emissions

The air quality impacts resulting from construction-related pollutant emissions to atmosphere are presented in Chapter 9, and a brief summary of the findings of this assessment is provided below.

Air quality pollutants during construction will be generated from a variety of combustion sources and include emissions of nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO) and particulate matter. Assessment of resultant impacts on air quality show that project emissions will have a minor impact on ambient ground level concentration (GLCs) and that the GLCs are predicted to be within project standards. Overall, air quality impacts are assessed to be **low**. The exception to this is NO_2 levels, where peak concentrations around the seaport are predicted to be relatively close to project standards (for peak concentrations only), and for which impacts are therefore assessed as **moderate**. However, as the frequency of occupation of these areas around the seaport by local communities will be low, impacts specifically on local communities from NO_2 levels will be **low**.

In addition to air quality impacts, generation of dust during the implementation of construction works may potentially be a source of nuisance and disturbance to the local nomadic communities. Dust may be generated from:

- Earthworks
- Vehicular movements on unsurfaced road during the summer months
- Cement silos and concrete batching
- Loading, unloading and compaction of construction wastes.

Dust impacts will be localised but without mitigation may lead to herders avoiding affected areas. Given the localised and temporary nature of dust impacts, these impacts are assessed as **low**. Nonetheless, a range of dust suppression and control measures are identified in Chapter 9. The residual dust nuisance impacts on local communities is assessed to be **low**.

Liquid Discharges

Description of the impact

During summer migrations, the nomadic population typically use water from rivers and lakes for drinking and for other domestic household purposes. In winter, melted snow and ice along with water obtained from openings made on the frozen water bodies serve as the main source of water for nomadic herders[21]. In such conditions, it is reported that boiling of water is not widely practised by the nomadic herders, primarily with an intention to save fuel wood, which is very often in

[21] Saline water from the Gulf of Ob is used for drinking by reindeer.

shortage during the winter season. Any presence of contaminants (such as hydrocarbons and oil products, microbial pathogens, chemical substances etc.) in the surface water sources beyond the allowable safe concentrations would therefore likely to pose a risk to the health of migratory households, especially in cases where untreated or insufficiently boiled water is used for drinking purposes. The spatial extent of any such contamination of surface water is such that significant impacts on water supplies for the permanent settlements are not anticipated.

Pollution of the local surface water streams and water bodies (rivers, ponds, lakes) that are used by the local population as the sources of fresh water can take place during construction due to the following:

- Washout of pollutants in case of uncontrolled snowmelt/stormwater runoff contaminated with suspended solids, chemical substances and petroleum products (fuel & lubricants) from construction and well drilling sites;
- Accidental spills and leakages of hydrocarbons/fuel and chemicals used in the construction process;
- Littering with construction waste and debris, packaging materials, solid or liquid domestic waste;
- Uncontrolled release of untreated well testing and drilling waste or used hydrotest water;
- Uncontrolled discharge of untreated wastewater or sewage effluent/ sanitary wastewater generated at the worker accommodation facilities in Sabetta.

In the event of an uncontrolled hydrocarbon/chemical spill, particularly at the construction sites in the immediate vicinity of surface water bodies, the consequent risk to community health may be significant.

Further details on the potential impacts to surface waters during the construction are provided in Chapter 9.

In the absence of appropriate mitigation measures, the risk to the local population health related to air emissions and potential contamination of surface waters is considered to be **Moderate**. This would primarily be associated with the greater susceptibility to air pollution due to the existing predominance of respiratory illnesses[22] in the local communities, and the prevalent practice of using untreated water from natural sources by the nomadic population migrating in the Project locality.

<u>Mitigation measures</u>

A wide range of the tailored mitigation measures aimed to abate the impacts on surface waters during construction are presented in detail in t Chapter 9.

As a further precautionary measure, awareness raising among the nomadic population will be advisable to inform them of potential health risks associated with the use and consumption of raw

[22] Typically conditioned by the natural and climatic characteristics of the Arctic region.

water from the natural sources such as lakes, rivers and snowmelt, particularly in the areas that are in close proximity to the Project's construction and drilling sites. As part of the existing Compensation Agreements and where necessary, Yamal LNG will continue providing assistance with fuel supply (including firewood) to the local communities in the Project Area of Influence, particularly in winter season, as this type of assistance is recognised to be among most critical for the local population. This approach is likely to encourage nomadic herders migrating in the tundra to boil water before consumption[23].

Assessment of residual impact

The severity of residual impacts on surface water bodies has been assessed as **Low** on the basis of the tailored mitigation measures described in detail in Chapter 9. The fact that all construction works and activities will be confined to the boundaries of the licence area together with the establishment of the SPZ will also enable the spatial extent of potential adverse impacts to be minimised/localised.

10.2.1.2 COMMUNITY SAFETY

The following sections describe the aspects of community safety that may be jeopardised as a result of Project construction activities. This includes road safety, potential exposure to physical hazards in the form of the Project infrastructure, and aspects associated with reindeer crossings on the linear infrastructure facilities.

Road Safety, Risk of Traffic Incidents and Linear Infrastructure Hazards

There is currently no formal local road network in the Project locality and chartered helicopters are the principal means of transport to access the Project licence area. The use of road transport is feasible during the cold season when temporary winter roads can be constructed by snow compaction and levelling. The use of ice crossings is possible on frozen rivers and other water bodies (lakes), although Yamal LNG does not plan to utilise such ice-roads due to the safety precautions.

To ensure efficient year-round conveyance of personnel, equipment and materials within and between the various facilities within the licence area, Yamal LNG will set up supporting infrastructure in the form of intra-field access roads/link roads in the boundaries of the licence area. The road design width will be between 4 to 6 meters. Roads within the main facilities will be constructed with concrete slabs, while interconnecting roads and roads for the well pads (intra-field) will be made of earth and gravel mixtures (see also Chapter 9 for further details on road designs).

The following types of vehicles are planned to be used during the construction phase:

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[23] Herders' habit to use fuel and firewood sparingly due to the shortage during winter migrations may influence their decision not to boil water at all times prior to use.

- Crew buses for the transportation of construction workforce with the standard capacity of 16 seats, to circulate twice a day between the worker accommodation camp and the worksites;
- Heavy Goods Vehicles (HGV) for the delivery of materials/equipment and for transportation of wastes – trucks with the average maximum capacity of 8-tonne payload.

The construction activities will entail frequent commuting of the substantial numbers of workforce and transport of materials/equipment between the key sites, thereby resulting in a considerable number of light vehicles and HGV. There is a provision for some workers, mainly well drillers and well operators, to stay at satellite accommodation camps near to the well pads in order to minimise the transfer downtime. Nevertheless, there will be an introduction of road traffic on the intra-field access roads and the link roads within the licence area, with the subsequent intensification of traffic as the construction progresses.

Local indigenous communities that use the migratory routes traversing the licence area, and in particular close to the Project's access roads, will be at risk of road traffic accidents (RTAs). RTA risks include potential collisions between Project transport/equipment and herders and their reindeer, with the potential for resultant injuries and fatalities. However, the very low occupancy rates in the licence area, the predominantly nomadic type of the traditional transhumance activities, and the seasonal frequency of herder migrations, are all factors that limit the level of the RTA risk. In order to assess the potential significance of the community safety risk associated with RTAs, the following factors are taken into account:

- Frequency of the nomadic herders' movements on their migratory paths across the Project licence area; and
- Number of the nomadic individuals/households and an average size of reindeer herds passing on these migratory routes.

Herders' movements over the territory of the licence area are predominantly seasonal. At the same time, most of the individual migratory paths tend to be well-established and are closely aligned with the neighbouring routes, thereby considerably reducing the potential flexibility for shifting the current migratory patterns in order to avoid road crossings.

The safety risk can also be increased due to the fact that indigenous herders will most likely be unaccustomed to the need for adjusting their traditional herding practices and the migration routes or camping points on account of the construction traffic that was not previously a typical element of the tundra landscape. In general, increased risk of traffic incidents may stem from:

- Environmental factors such as fog, dust (including construction-related dust), and limited daylight hours during winter;
- Driver fatigue and/or alcohol consumption affecting driver alertness;
- Operation of non-roadworthy vehicles;
- Speed exceedances on the roads and other violations of the driving regulations/unsafe driving practices;
- Faults in the road surface conducive to accident-prone conditions;
- Lack of caution and observation during driving, affecting drivers' reaction rate;
- Drivers' insufficient familiarity with the local specifics of migratory reindeer herding and limited knowledge of the existing migration routes;

- Unauthorised practices of waste dumping or discarding garbage, used tyres or oil along the roads, leading to the creation of additional hazards to other road users and herders;
- Lack of courtesy and/or unwillingness to observe the reindeer herders' priority right-of-way, especially in cases where herds of a considerable size are preparing to cross[24];
- Herders' crossing of the roads at dusk or during the night in the absence of warning lights or signs.

Any accidents involving transport carrying the supply of fuel, lubricants, chemicals and any other hazardous materials used in the construction process as well as hazardous wastes could also result in spillage of the contents into the environment or on the road surface, thereby resulting in an extra risk.

Another aspect of safety risk for nomadic herders is associated with the laying of the Project's linear above-ground infrastructure, particularly the connecting network of gas collection pipelines and the installation of power transmission towers. The resultant impact is likely to be manifested as a greater potential for collision of herders with the above- ground structures and an increased risk of accidents and injuries on intersections with the linear infrastructure assets (i.e. linear structure crossings). This may be particularly exacerbated in the conditions of poor visibility or limited awareness of the locations of linear infrastructure assets.

The overall level of unmitigated impact is assessed as **High**. Although the adverse safety effects related to the Project roads, traffic and linear infrastructure facilities are predicted to be of localised extent, the potential risks are likely to be considerable mainly due to the local nomadic communities' sensitivity towards such impacts. The communities' greater vulnerability stems from their lack of exposure to this type of safety risks and the absence of previous experience of interfacing with the industrial infrastructure. The impact is predicted to be of medium-term duration, i.e. spanning the entire constriction phase. The reversibility of the impact is expected to be limited given that the transportation activities will continue to constitute a core element of the Project, although the intensity and volume of traffic operations will be reduced after the completion of construction works. The sensitivity of the impact receptors is also taken into account when assessing the unmitigated negative impact, in view of the local indigenous communities' lack of exposure to the permanent networks of over-ground transportation and other linear facilities.

<u>Mitigation measures</u>

The potential impacts related to road safety will be mitigated through a range of measures as described below.

All the intra-field and link roads set up for the Project purposes within the licence area will have sealed surfaces to minimise generation of dust and to avoid hazardous conditions typically characteristic of dirt tracks. The roads will be suitable for the safe operation of predicted traffic volumes and the size of HGVs used for Project-related transportations (in terms of capacity and

[24] Anecdotal evidence shows that it may take up to 30-45 minutes for an average-sized herd of reindeer accompanied by a number of migratory herder households on a train of sledges to cross a road.

load-bearing). Regular maintenance and repair of the road surface will be implemented to ensure suitable conditions for safe driving. Driving will only be permitted on designated road routes to minimise any off-road driving and to prevent the resultant risks of collision in areas that are not fit for vehicles or where traffic is not expected. As the natural condition of the ground in the tundra does not allow unimpeded driving in the absence of appropriate road infrastructure, the likelihood of off-road driving will be very low, particularly with the ground conditions during warmer season.

The key features aimed to ensure road safety in relation to the local communities include:

- Enforcement of the maximum speed limits on Project roads in relation to weather/visibility conditions and the location of sensitive receptors such as crossing points for reindeer herders (herder crossings). Yamal LNG implements the transport safety policy that stipulates the required speed limit at 20 km/h. The Project's EPC Contractor and any other subcontractors involved in the delivery of materials during construction will be required to comply with the permissible speed limits.
- Installation of appropriate safety signage tailored to the road conditions and accident blackspots, and marking the locations of herder crossing points on the roads;
- Installation of traffic-calming features (e.g. speed humps) in vicinity of the herder crossing points;
- Rigorous driver training to ensure high standards of safe and attentive driving in different weather/visibility conditions, together with drivers' awareness of the indigenous migratory herding practices and the knowledge of herder crossing points on the Project roads. Among the main requirements applied to drivers are careful observation and giving priority to herders and their reindeer when approaching the designated crossing points.
- Regular assessment and monitoring of drivers' performance;
- Fitting safety equipment on all Project vehicles, e.g. safety belts, speed control systems (e.g. speed governors), lights, labelling (in case of transporting hazardous materials), spill response and first aid kits;
- Regular inspection of the vehicles and road conditions, and prompt maintenance and repair as necessary;
- Project's contribution to maintenance and repair of the public temporary winter roads if used by Project vehicles;
- Transportation of construction materials and supplies as well as hazardous substances and wastes to be primarily scheduled for daytime hours due to safety reasons, wherever feasible;
- Enforcement of appropriate procedures for the transportation and handling of hazardous materials. Yamal LNG will also require that the EPC contractor provide specialist training to drivers involved in the haulage of hazardous materials and collection/removal of hazardous wastes.

Whenever a collision or a serious traffic incident takes place, especially in cases with severe consequences or multiple fatalities, Yamal LNG will trigger the emergency response and/or medical evacuation procedure with the use of medical aviation, as appropriate. The capacity of Project's on-site medical clinic in Sabetta is sufficient for non-specialised emergency treatment and first aid, as well as for patient stabilisation and preparation for further transportation to the established public healthcare facilities in Seyakha, Yar-Sale, Salekhard or Novy Urengoi.

Yamal LNG operates the '*Procedure for Conducting Pre-Trip and Post-Trip Driver Check-Up* to ensure timely identification of drivers who are unfit for journey due to medical conditions and cannot therefore be allowed to undertake the trip on account of the safety precautions. Pre-departure check-ups are mandatory, while post-trip examinations are mostly of an advisory nature and are conducted on drivers who remain within the boundaries of the licence area. Any examinations under this Procedure:

- are carried out only by the appropriately licensed and qualified medical staff on the premises of the on-site medical clinic; and
- apply to all entities and individuals that operate the means of transport within the Yamal LNG licence area.

In addition to a general health and fitness check, the pre-trip and post-trip medical examination of drivers also includes breath test and the analysis of bodily fluids[25] for alcohol and any illicit substances (narcotics and psychotropic agents). Based on the overall results of the examination, drivers will not be granted clearance in the following cases:

- when exhibiting symptoms indicating driver's temporary incapacity to work;
- positive alcohol and/or substance test;
- when any visual signs of alcohol or narcotic intoxication are manifested;
- when exhibiting symptoms which indicate the consumption of medicines or other substances that may affect driving ability and attention/concentration span.

The results of drivers' medical examinations are logged to enable tracking of non-clearance cases. Detection of any form of intoxication triggers Yamal LNG's '*Procedure for Determining Incidents of Alcohol and Substance Consumption at the Workplace, Appearance in the State of Alcohol, Substance and Other Intoxication and its Documentation*' described above.

Providing the effective implementation of the mitigation measures described above, the residual adverse impact associated with traffic risks is predicted to be of **Moderate** severity.

Reindeer herder crossings over Project's linear infrastructure facilities as part of mitigation

As the Project roads and other infrastructure are being constructed, the establishment of appropriate crossing points allowing nomadic herders and their reindeer the safe passage across the liner facilities is essential to ensure that the safety of the local indigenous communities is not compromised. Prior to construction, Yamal LNG undertook the preliminary identification of critical locations at Project's linear infrastructure where herder/reindeer crossing points are deemed necessary, including the above-ground network of connecting gas pipelines, roads and near the power transmission towers. The preliminary layout of the proposed crossings has been agreed with the Head of the Municipal reindeer breeding enterprise MOP 'Yamalskoye' that is the principal land user in the Project Area of Influence. Prior to giving approval to Yamal LNG's proposed crossing locations, the Head of MOP Yamalskoye checked with heads of communities if the locations are

[25] Blood sampling is not permitted for the purposes of the Procedure.

sufficient for all of them. This procedure was approved in December 2012 during Yamal LNG's meeting with all key local stakeholders, including MOP Yamalskoye, Valama, SOH Yamal, Tusyada and Ilebts. However, in the midst of 2014 owing to some changes in project design the process of clarification of crossing locations has been started. Wide consultations with reindeer herders are planned to be held in September-October 2014 when all heads of communities will be available. Development of the specific design for the crossings is currently underway.

The proposed locations and engineering solutions for the crossings are discussed in detail and agreed with the herders that migrate in the Project locality and that may be affected through the establishment of the Project's linear infrastructure. Yamal LNG plans to continue this type of consultation as part of the engagement related to the preparation of an Indigenous Peoples Development Plan (IPDP).

The important aspects and features that are expected to be part of the crossings' design and related procedures are as follows:

- Setting up flat-gradient berms on the roadsides to allow unhindered approach of the reindeer and herder sledges and their easy transfer onto the main surface of the road;
- Application of temporary traffic control measures at the crossings points on Project roads (flagmen, temporary traffic lights) whenever heavy traffic is anticipated;
- Supervised regulation and stopping of traffic flow on the road sections at a safe separating distance from the crossing points (at least 5 m to nearest vehicles) for the entire duration of a cross-over. Reindeer and the herders must not be disturbed, harassed, hastened or in any way distracted during the cross-over process, and the undisrupted passage at their usual speed must be allowed. Excessive photographing, video-recording, honking and making other loud sounds shall not be used during the cross-over in order not to frighten the reindeer and also in deference to herders' tradition. Drivers are advised to switch off vehicle engines while awaiting the passage to complete, in order to avoid extra air emissions and noise;
- Provision of a geotextile fabric cover on the road surface immediately prior to the actual cross-over to enable gliding effect as well as to prevent friction and a resultant damage to herder sledges, particularly when sledges are laden with migratory households' possessions;
- Advance coordination of the timings for herders' passage across the roads to ensure the presence of Project representative(s) supervising and assisting with the cross-over process as necessary;
- Provision of safety signage on the Project roads warning of the crossing locations and giving instructions on the applicable regulations (i.e. speed limit, herders' priority right-of-way);
- Creation of crossing ramps – i.e. fixed and flat-gradient embankments will be erected over the ground-level (or buried) sections of the pipe to aid the passage. The embankments will be made of suitable material (e.g. earth fill) to ensure stability of the structure and proper drainage, as well as to allow ready passage of the reindeer and herder sledges. The ramp surface will be vegetated with suitable grass cover;
- Provision of visible markings at the crossing points on the Project's linear infrastructure facilities to aid their noticeability. The crossing points will also be marked on the local maps and on the licence area plans (including the road route maps) to ensure the awareness of such features both by Project personnel, drivers and the nomadic herders traversing their area as part of their traditional migrations.

Assessment of residual risks

Given the extensive mitigation measures described above and providing the effective implementation of the requirements associated with the herder crossings, the residual impact assessment for the road and linear infrastructure safety and is assessed as **Moderate.**

Community Exposure to Project Hazards

Description of the Impact

The construction of Project facilities will involve land preparation and grading, installation of storage tanks and other supporting infrastructure, presence and movement of equipment and machinery within the Project construction sites.

The hazards associated with the Project's construction works include:

- Exposure to uncontrolled spillages of hazardous materials used in the course of construction and also hazardous wastes, including the transportation of such materials;
- Accidents involving road tankers transporting fuel or other flammable and explosive materials and leading to the risk of fire/exposure of chemicals;
- Physical safety issues arising from the transportation of heavy equipment and structures;
- Operation of construction equipment, plant and machinery;
- Earthworks and ground intervention activities.

Although the Yamal LNG Project is being implemented in the sparsely inhabited area of Yamalsky District, the licence area is traversed by the nomadic herders on their seasonal migration routes. As the major construction activity related to the Project development is a novelty to the area, local herders that have traditionally been migrating across unobstructed expanses of the tundra are unlikely to be accustomed to the safety aspects and adjustments required to avoid potential hazards. Alteration of the local terrain through the earthworks/excavations, establishment of Project facilities, utilities, communication and power transmission lines, the presence of mobile and stationary equipment and machinery, will create additional physical impediments to the nomadic herders and their reindeer that may result in the disruption to the migratory routes. Transformation of the local landscape can also lead to a removal and loss of natural features that typically serve as reference points to herders for their spatial orientation and navigation in the open tundra (e.g. ground elevations, small hills etc.).

These activities could result in collisions as a result of local herders' interaction with construction equipment on-site, particularly in situations where the equipment is left unfenced or unsupervised by the Project contractors. There is therefore a potential for increased traumatism among herders as well as the risk of injury to and/or the loss of their animals in the absence of effective security and safety measures.

There may also be a localised risk of exposure of nomadic herders passing through the licence area to various hazardous materials and substances used in the construction process, e.g. solvents, paints, oils, fuel and cleaning agents in cases of accidental leaks and spillages. It is not expected that the local populations will be directly exposed to hazardous substances due to their infrequent movement within the license area.

The current location of the seaport in Sabetta was historically utilised for fishing activities by the local indigenous communities, however, offshore fishing is now prohibited by the local authorities.

Overall, the unmitigated impact is assessed as **Moderate**

Mitigation Measures

Control measures to minimise community safety risks during construction will include a combination of physical/engineering controls, safe work procedures, and community awareness raising through regular interaction with the population directly affected by Project development.

To prevent accidents and consequent injuries, the following measures will be employed:

- The Company will inform the local population, including residents of Tambey Factoria and migratory herder households/communities, about potential safety risks within the Project licence area as well as about any material changes in the locations of Project worksites and the construction techniques used;
- Safety barriers and fencing equipped with warning signage will be installed at the worksites and particularly around the areas where herder migratory routes may intersect with the Project facilities;
- Local reindeer herders and indigenous communities that have traditionally used the land within the licence area will continue to be consulted, to further ascertain their requirements for ensuring access and the right of passage within the Project boundaries;
- Construction traffic warning signs will be positioned at the intra-field road crossings and other appropriate locations as determined by the Project, e.g. along access routes;
- Transportation of heavy construction equipment will be subject to speed restrictions, particularly when passing in the vicinity of the reindeer herder crossing points;
- Only designated routes will be used for carrying sizeable and heavy loads;
- Road transportations of hazardous materials will only be undertaken by operators licensed for the specific material/type of shipment, with the use of appropriately sealed and labelled containers and marking/placarding of the delivery trucks;
- Vehicles carrying hazardous materials will be equipped with fire extinguishers and adequate means of fire prevention that are appropriate for the shipment. Transport manifests will be maintained in accordance with the relevant Russian regulations;
- Yamal LNG will continue regular interface with the local nomadic community via the community chiefs and through a locally based Senior Liaison Officer whose responsibilities include coordination of local recruitment processes on the ground.
- The Company has developed a Spill Response Plan that will apply in case of accidental spillage of oils and chemicals. The Plan specifies: Responsibilities;
- Response equipment;
- Hazard assessment (before attempting a clean-up);
- Notification and response actions, including waste disposal;
- Record keeping and reporting; and
- Training requirements.

Further details on the development of oil spill response plans are provided in Chapter 9.

All plant and machinery will be secured/made safe or removed from the construction worksites overnight. Public access to the zones of active construction will be restricted and such areas will be equipped with appropriate warning signage to alert migratory herders to the associated hazards.

Yamal LNG has conducted negotiations with representatives of the local "Ilebts" community that used the Sabetta Factoria in the past (including as a base for fishing activities), in order to establish the most suitable option for relocation of this trading station. Based on the agreement reached with the "Ilebts" community and consent from the community leadership obtained in December 2011, the relocation of the Sabetta Factoria has been arranged to two separate sites located 20 km south and 35 km north-west from the original site, respectively. It was relocated in February 2012. The southern site is situated in proximity to the coast, in the area rich with fish, and is presently manned by one person. The north-western site is a seasonal factoria and does not include permanent human habitation.

<u>Assessment of residual impact</u>

Although the consequence of the safety impacts associated with the Project-related hazards may be severe, the likelihood of such impacts is minimal given the low population density in the Project licence area and the measures put in place to protect the nomadic community members, as described above. The residual risks associated with exposure to project hazards are therefore assessed as **Low**.

10.2.2 PRE-COMMISSIONING, COMMISSIONING AND OPERATION

The following activities are considered to be the main sources of potential adverse impact on community health, safety and security during the Project's pre-commissioning, commissioning and operations:

- Well field operations and the above-ground network of gathering pipelines;
- Gas relief flaring at the well fields and the LNG Plant;
- LNG process operations;
- LNG and condensate storage and loading facilities;
- Power generation activities;
- Airport and seaport operations; and
- Road transport (within the Licence Area).

The following sections present a description and assessment of the potential impacts specific to the above activities, together with relevant mitigation measures.

Well Field Infrastructure and Pipelines

The sources of impact associated with the well fields include operation of the drilling rigs and the connecting network of gas pipelines to the LNG Plant. These activities are predicted to lead to the following impacts:

- Noise nuisance from the drilling operations;
- Disruption to the migratory routes that traverse the licence area, through creating physical impediments to nomadic herders, their reindeer and sledges.

The potential noise effects are expected to be similar to those predicted for the Project's construction phase and described in section 10.2.1.1 above. The analogous mitigation measures will therefore be applied for the abatement of noise effects (also described in detail in Chapter 9), which will allow the level of impact on the off-site communities to be reduced from **Moderate** to **Low**.

The safety risks associated with the operation of the above-ground pipeline network will be mitigated through the establishment of crossing points for the migratory reindeer herders. The locations and design specifications of the crossings will be agreed in consultation with the affected communities and individuals, as described in section 10.2.1.2. With the effective implementation and maintenance of the crossing points and the related awareness raising of the crossing facilities among the local communities and Project personnel, the residual safety risks associated with the physical infrastructure will be reduced from **High** to **Moderate**.

Gas Flaring

Flaring will be undertaken during pre-commissioning, commissioning and operation phases of the Project. Gas flare systems for the following main purposes:

- Commissioning and start-up of the LNG Plant and the associated wells;
- Routine purge flaring at the LNG site; and
- Flaring at the LNG Plant and well fields during upset and emergency scenarios.

Possible adverse effects associated with flaring include:

- Risk to human health due to the release of air pollutants (see Chapter 9 for impact assessment);
- Localised disturbance and nuisance effects through smoke formation, thermal radiation, visual (flaring flashlight and luminosity) and noise generation, particularly in case of flaring during the night-time.

Such effects are expected to cause temporary localised disturbance to nomadic herders that pass on the migratory routes in the immediate vicinity of the LNG Plant. Long-term exposure is not predicted due to the lack of residential areas in close proximity to the site and herders' infrequent movements that are largely seasonal. The operational activities such as flaring and power generators could result in noise emissions mainly during upset conditions (Chapter 9, see section on noise). However, the extent to which the local populations will be disturbed by noise emissions will depend on their proximity to the plant operations. The severity of noise disturbance is expected to be higher during the night time. However, it is unlikely that noise levels could cause major local concern mainly due to the infrequent movement of the local populations and lack of permanent settlements in the immediate vicinity of the Project operational sites.

Lighting impacts from flaring, particularly during the nights could lead to local nuisance and disturbance. The effects of the lights are expected to cause temporary disturbances to local herders that pass migratory routes in the immediate vicinity of the LNG Plant. However, there will not be any long term local disturbances due to the lack of residential areas in close proximity to the Project site. Based on this, the unmitigated lighting impact associated with flaring is assessed as **Moderate**. The Project will reduce the impact to **Low** following implementation of the mitigation measures described in the section "Thermal radiation and luminosity" above.

Detailed analysis of the air quality impacts associated with flaring and the description of related mitigation measures are presented in Chapter 9.

Other Air Quality Effects

In addition to flaring, the main sources of impact on air quality during the Project operations phase will be as follows:

- Fugitive/venting emissions from chemical and hydrocarbon storage and handling and from the LNG process units; and
- Combustion of hydrocarbons from power generators (including the Power Plant turbines and the back-up diesel generators) and other process units.

Further details on the air quality impacts and the associated mitigation measures are described in Chapter 9.

The Project has established a Sanitary Protection Zone (SPZ) around the Project operating facilities for the protection of air quality in relation to human health. The results of the air quality assessment described in Chapter 9 show that the peak air quality standards are predicted to be met at the edge of the SPZ for all pollutants.

Road traffic safety

During the operations phase, road safety risks are expected to be considerably lower as compared with the RTA risks predicted for the construction period. The construction personnel will be demobilised from the licence area and the Project operations workforce will be accommodated in close proximity to the LNG Plant. As a result, there will be fewer numbers of vehicular movements to and from the Project facilities. This is considered in conjunction with the mitigation measures aimed to decrease the overall road safety risks, as described in detail in section 10.2.1.1 above.

However, the risk of disruption to reindeer migratory routes that traverse the licence area, through creating an impediment to the nomadic herders, their reindeer and equipment (sledges) due to the road network will remain. Yamal LNG recognises that the susceptibility of the local nomadic communities to traffic-related risks will be higher in the locations of reindeer herder crossings, which may represent a significant concern unless appropriately managed. The rigorous measures to ensure road safety at the herder crossing points will therefore continue to apply throughout the operations phase, similarly to the construction period.

All operations contractors involved in the Project-related freight and transportations by road will be required to implement emergency response plans in line with the Yamal LNG procedures. Yamal LNG will continue to collaborate with the regional and local authorities overseeing the emergency response regulations on the road safety aspects.

The residual impact of operational activities associated with RTAs is assessed as **Low**.

Airport operations

Operation of the airport and its associated infrastructure will also be the potential source of adverse impacts on the community health and safety, primarily due to the following:

- Noise disturbance from the operating aircraft, i.e. the landing and take-off cycle, particularly in case of the large aircraft type;
- Disruption to the reindeer herder migratory routes that traverse the licence area, through creating physical impediments to the nomadic herders and their reindeer.

Chapter 9 presents a range of mitigation measures related to the predicted noise impacts as a result of the airport operations. The aspect of potential disruption to the migration routes will be addressed through the establishment of the crossing points as discussed in the preceding sections.

Providing the implementation of the planned mitigation measures, the residual adverse impacts are expected to be localised and of **Low** significance.

10.2.3 PRESENCE OF SECURITY PERSONNEL

Yamal LNG will contract out its security services to an external service provider both during the construction and operations phases. Security arrangements will be provided for 24/7 for the entire licence area and will be essential to ensure the safety and security of the Project personnel and assets, as well as the public. The aspects related to the presence of security personnel are therefore considered jointly for the Project construction and operation phases.

The security service present on Project sites comprises 245 guards (including employees of State Security services). The licence area is also subject to regular patrolling conducted by designated security officers. All security guards are unarmed except for employees of State Security services. Perimeter fencing is provided for the LNG plant and auxiliary plant sites, the seaport and the airport, Sabetta shift workers camp and EPC contractors' camps, as well as for the upper fuel and lubricant depot and solid domestic waste storage site. The engineering and technical means of protection to be used include checkpoints, gate system, equipment for forced transport stop, 24/7 security. All objects with perimeter fencing are equipped with access control and security lighting.

As a result, local herders and other land users may experience difficulty with accessing sections of the licence area traditionally used for reindeer grazing and migrations. Yamal LNG's current policy is not to prohibit the local nomadic herders and reindeer from their traditionally used lands within the licence area. Any unjustified restriction of access is therefore likely to lead to the disruption of herding and grazing practices and tensions between the local nomadic communities and the Project security personnel. This negative aspect is likely to be exacerbated by the fact that the herders are not accustomed to the spatial limitation of their traditional migratory activities and can therefore perceive the security regulations as disruptive to their mobility. If such sensitive issues are poorly managed or in case of abuse of power or insufficient discretion exercised by security guards, the security arrangements could lead to more aggravated conflicts.

Other risks to community safety may also occur if there are conditions for an excessive use of force by the Project's security, especially if rules in relation to the licence area boundaries are not clear or are breached. Without strict regulation, the use of security personnel has a potential to lead to abuses against members of the public under the guise of Project security requirements.

Without appropriate mitigation measures, the potential impact on the local communities resulting from the presence of security within the licence area is therefore assessed as **Moderate**, primarily taking into account the susceptibility of the indigenous population and their previous inexperience with security regulations on traditional migration areas. The localised extent of the impact, i.e. confined only to the boundaries of the licence area, and the fact that the nomadic herders will continue to retain their right of access and passage through the license area are also considered.

Mitigation Measures

In accordance with its CSR Policy, Yamal LNG is committed to ensuring the protection of human rights in compliance with international good practice.

Specific mitigation measures to achieve this in practice will include:

- The security company providing services to the Project is a properly licensed and authorised security firm regulated by the relevant requirements of the Russian law. No guards will be armed or linked to the military (except for employees of State Security services). Yamal LNG requires that the security guards be well trained and do not have a previous criminal records;
- The appropriate Code of Conduct for security personnel is to be developed in 2014;
- For the ease of identification, all security staff are attired in the appropriate uniform and are required to display a photographic ID tag at all times while on duty;
- All criminal-related incidents and/or threats that come to the notice of security guards shall immediately be reported to the Police;
- Yamal LNG will provide human rights induction training to the security personnel, including the requirements for avoiding disproportionate response and unwarranted use of force;
- A formal report on any breaches of the Code of Conduct by security personnel (also lodged via the Yamal LNG *Stakeholder Enquiry (Grievance) Procedure*) will be raised in order to bring an incident to the attention of responsible staff who will ensure prompt follow up and/or corrective action. A management reporting format will be implemented to ensure that Yamal LNG management are always aware of all security developments;
- Yamal LNG will conduct regular auditing of the existing security management system, including reviews of the contractor security service providers to ensure appropriate compliance with contractual and all other applicable requirements/standards.

The Yamal LNG Stakeholder Enquiry Procedure will continue to be used to monitor community concerns about security personnel arising during the Project implementation. The Company's Stakeholder Engagement Plan includes a copy of the Enquiry Procedure and explains different categories of complaints that may be recorded. This Procedure will continue to be available to local communities residing and migrating in the Yamal LNG Project Area of Influence. The Environmental Department within Yamal LNG's internal structure will be involved in the tracking and resolution of any issues related to Project security and local communities.

The residual impact significance after the application of the mitigation measures both during the construction and operations phases is assessed as **Low.**

The summary of the predicted impacts and associated mitigation measures is presented in Table 10.2.2 below.

10.2.4 SUMMARY IMPACT TABLE

Table 10.2.2: Summary of Community Health, Safety and Security Impacts and Mitigation Measures

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
Increased risk of communicable diseases	Project workforce and the local communities in the Project Area of Influence	Construction Operations	• The Company will develop a Camp Management Plan to be adhered to by the contractors. The Plan will include the Worker Code of Conduct. • Enforcement of the Worker Accommodation Camp Policy. • Provision of on-site healthcare and welfare facilities for Project workforce and contractor personnel, including a dedicated 24-hour clinic in the licence area. • Implementation of the 4-tier medical aid scheme: first aid points - paramedic stations - Sabetta medical clinic – municipal public hospitals outside licence area. • Availability of emergency aid equipment at the clinic and personnel evacuation provisions in case of a medical emergency/epidemic. • Provisions for emergency evacuation or routine medical evacuation with the use of medical sanitary aviation (air ambulance). • Health screening, monitoring and disease prevention among workforce, including immunisation against infections that are most prevalent in the Project area. • Regular medical check-ups of rotation-based personnel when on shift. • Implementation of the “Health” programme, including awareness raising for workers regarding the risks associated with communicable diseases and the related prevention measures (STIs, TB, vector-borne and blood-borne infections, etc.) • TB control at the workplace and in the worker accommodation areas. • STI prevention through free availability of the means of individual protection (condoms) at the Sabetta on-site clinic, primary diagnostics, confidential counselling, pre-treatment to workers, as well as contact	Low

Table 10.2.2: Summary of Community Health, Safety and Security Impacts and Mitigation Measures

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			tracing wherever possible. • Encouragement for workers to promptly report any cases of illness to the on-site medical facility. • Record and analysis of personnel morbidity statistics. • The Company will liaise with relevant authorities on TB, STI and epidemic prevention. • Systematic sanitary and epidemiological inspections of worker accommodation facilities. • Requirement for all construction contractors to formally report all medical treatment cases to the main medical unit in Sabetta , including related periodic statistical data provided in a disaggregated format (by type of illness). • Only qualified and licenced catering staff will be permitted to perform food preparation and meal service in the designated worker canteen(s). • Proper management of organic and other types of waste to prevent proliferation of pests and vermin within licence area. • Proper management of medical waste to avoid exposure to and spread of blood-borne pathogens and prevent transmission of infectious agents. • Implementation of the Yamal LNG 'Programme for Industrial Control and Inspection of Compliance with Sanitary and Epidemiological Regulations at the South-Tambey Gas Condensate Field'. • Enforcement of a strict policy that prohibits the presence of dogs onsite to minimise health and safety risks.	
Stress, mental health effects, and substance abuse	Local communities in the Project Area of Influence,	Construction Operations	• Strict enforcement of the Yamal LNG Worker Code of Conduct, including induction and regular refresher training for all personnel, control by responsible supervisors and the management of contractor companies, and application of prescribed disciplinary measures in case of breaches. • Investigating the nature and causes of complaints lodged by the local	Low

Table 10.2.2: Summary of Community Health, Safety and Security Impacts and Mitigation Measures				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
	including migratory herders		community via the Yamal LNG '*Stakeholder Enquiry (Grievance) Procedure'*. • Hunting of wildlife, fishing activities and gathering of natural produce by workforce will be strictly prohibited. • The use of dogs for any purposes is strictly prohibited, including for hunting, entertainment and/or intimidation. • No harassment and hunting of reindeer, including deliberate creation of obstacles on the passage routes used by migratory reindeer herders. • Deference and respect must be exercised towards sacred sites and any other objects and features of cultural heritage, particularly those worshipped by the IPN. • 'No-harm' approach towards local residents, their property and local environment. • 'Non-involvement' attitude in all cases where there is a potential for conflict. • Demonstrate respectful behaviour towards local communities residing within the licence area (Tambey Factoria) and outside it, as well as towards migratory herders that pass through the licence area, in all cases of interaction. • Implementation of the Yamal LNG Corporate Social Responsibility (CSR) Policy. • Cultural induction training will be provided to all construction personnel and contractors workers as well as visitors. • EPC Contractors and all other subcontractors involved in the construction activities will rigorously monitor behaviour of their workforce towards the local communities. • Prohibition of drugs and alcohol at all its facilities within the licence area, including in the accommodation camps, as per the Yamal LNG "Procedure for Determining Incidents of Alcohol and Substance	

Table 10.2.2: Summary of Community Health, Safety and Security Impacts and Mitigation Measures				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
			Consumption at the Workplace, Appearance in the State of Alcohol, Substance and Other Intoxication and its Documentation". • Implementation of the Yamal LNG Stakeholder Enquiry (Grievance) Procedure. • Implementation of the Yamal LNG Cultural Heritage Chance Finds Procedure.	
Noise and vibration effects	Local communities in the Project Area of Influence, including migratory herders	Construction	• Detailed mitigation measures and controls are presented in Chapter 9 "Environmental Impact Assessment"	Low (general construction works) Moderate (noise impacts from helicopters)
Thermal radiation and luminosity	Local communities in the Project Area of Influence, including migratory herders	Construction	• Development of sanitary protection zones around the horizontal burners located at the well pads. • Advance notification of the planned well testing schedule will be issued to nomadic herders that are known to pass the area on their seasonal migration routes.	Low
Air emissions, including dust	Local communities in the Project Area of Influence, including migratory	Construction Operations	• A range of tailored mitigation measures to abate the impacts on air quality, including dust suppression and control, are presented in Chapter 9.	Low (overall air quality) Moderate to Low (NO_2)

Table 10.2.2: Summary of Community Health, Safety and Security Impacts and Mitigation Measures

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
	herders			
Liquid Discharges	Local communities in the Project Area of Influence, including migratory herders	Construction Operations	• Further details on the potential impacts to surface waters during the construction are provided in Chapter 9. • Awareness raising among the nomadic population to inform them of potential health risks associated with the use and consumption of raw water, particularly in the areas in close proximity to the Project's construction and drilling sites. • Continued provision of assistance with fuel supply (including firewood) to local communities in the Project Area of Influence as part of the existing Compensation Agreements.	Low
Road safety, and risk of traffic incidents and linear infrastructure hazards	Local communities in the Project Area of Influence, including migratory herders	Construction Operations	• Project's intra-field and link roads will be sealed to minimise generation of dust and to avoid hazardous conditions. • All Project roads will be suitable for safe operation of predicted traffic volumes and the size of HGVs used by the Project (in terms of capacity and load-bearing). • Regular maintenance and repair of the road surface to ensure the suitable conditions for safe driving. • Driving will only be permitted on designated road routes to minimise any off-road driving. • Enforcement of the maximum speed limits on Project roads in relation to weather/visibility conditions and the location of sensitive receptors such as crossing points for reindeer herders (herder crossings). The Project's EPC Contractor and any other subcontractors involved in the delivery of materials during construction will be required to comply with the permissible speed limits. • Installation of appropriate safety signage tailored to the road conditions and accident blackspots, and marking the locations of herder crossing points on the roads;	Moderate

Table 10.2.2: Summary of Community Health, Safety and Security Impacts and Mitigation Measures

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			• ; • Rigorous driver training to ensure high standards of safe and attentive driving in different weather/visibility conditions, together with drivers' awareness of the indigenous migratory herding practices and the knowledge of herder crossing points on the Project roads. • Regular assessment and monitoring of drivers' performance; • Fitting safety equipment on all Project vehicles, e.g. safety belts, speed control systems (e.g. speed governors), lights, labelling (in case of transporting hazardous materials), spill response and first aid kits; • Regular inspection of the vehicles and road conditions, and prompt maintenance and repair as necessary; • Project's contribution to maintenance and repair of the public temporary winter roads if used by Project vehicles; • Transportation of construction materials and supplies as well as hazardous substances and wastes to be primarily scheduled for daytime hours due to safety reasons, wherever feasible; • Enforcement of appropriate procedures for the transportation and handling of hazardous materials. EPC contractor will be required to provide specialist training to drivers involved in the haulage of hazardous materials and collection/removal of hazardous wastes. • Emergency response and/or medical evacuation procedure with the use of medical aviation will be triggered whenever necessary. • Implementation of the Yamal LNG 'Procedure for Conducting Pre-Trip and Post-Trip Driver Check-Up'. • Establishment of reindeer herder crossings over Project's linear infrastructure facilities, including roads and pipeline network. Locations and engineering solutions for the crossings are discussed in detail and agreed with the herders that migrate in the Project locality.	

Table 10.2.2: Summary of Community Health, Safety and Security Impacts and Mitigation Measures

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			Crossings' design and related procedures will be as follows: • Setting up flat-gradient berms on the roadsides to allow unhindered approach of the reindeer and herder sledges and their easy transfer onto the main surface of the road; • Application of temporary traffic control measures at the crossings points on Project roads (flagmen) whenever heavy traffic is anticipated; • Supervised regulation and stopping of traffic flow on the road sections at a safe separating distance from the crossing points (at least 5 m to nearest vehicles) for the entire duration of a cross-over. • Reindeer and the herders must not be disturbed, harassed, hastened or in any way distracted during the cross-over process, and the undisrupted passage at their usual speed must be allowed. Excessive photographing, video-recording, honking and making other loud sounds shall not be used during the cross-over in order not to frighten the reindeer and also in deference to herders' tradition. • Drivers are advised to switch off vehicle engines while awaiting the passage to complete, in order to avoid extra air emissions and noise; • Provision of a geotextile fabric cover on the road surface immediately prior to the actual cross-over to enable gliding effect as well as to prevent friction and a resultant damage to herder sledges; • Advance coordination of the timings for herders' passage across the roads to ensure the presence of Project representative(s) supervising and assisting with the cross-over process as necessary; • Provision of safety signage on the Project roads warning of the crossing locations and giving instructions on the applicable regulations (i.e. speed limit, herders' priority right-of-way); • Crossing ramps will be erected over the ground-level (or buried) sections of the pipe to aid the passage. The embankments will be made of suitable material (e.g. earth fill) to ensure stability of the structure and	

Table 10.2.2: Summary of Community Health, Safety and Security Impacts and Mitigation Measures				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
			proper drainage, as well as to allow ready passage of the reindeer and herder sledges. Provision of visible markings at the crossing points on the Project's linear infrastructure facilities to aid their noticeability. The crossing points will also be marked on the local maps and on the licence area plans (including the road route maps) to ensure the awareness of such features both by Project personnel, drivers and the nomadic herders traversing their area as part of their traditional migrations.	
Community exposure to project hazards	Local communities in the Project Area of Influence, including migratory herders and local fishermen		• The Company will inform the local population, including residents of Tambey Factoria and migratory herder households/communities, about potential safety risks within the Project licence area as well as about any material changes in the locations of Project worksites and the construction techniques used; • Safety barriers and fencing equipped with warning signage will be installed at the worksites and particularly around the areas where herder migratory routes may intersect with the Project facilities; • Local reindeer herders and indigenous communities will continue to be consulted, to further ascertain their requirements for ensuring access and the right of passage within across the Project boundaries; • Construction traffic warning signs will be positioned at the intra-field road crossings and other appropriate locations as determined by the Project, e.g. along access routes; • Transportation of heavy construction equipment will be subject to speed restrictions, particularly when passing in the vicinity of the reindeer herder crossing points; • Only designated routes will be used for carrying sizeable and heavy loads; • Road transportations of hazardous materials will only be undertaken by operators licensed for the specific material/type of shipment, and with the use of appropriately sealed and labelled containers that are appropriate for the material being shipped, including proper sealing and labelling of	Low

Table 10.2.2: Summary of Community Health, Safety and Security Impacts and Mitigation Measures

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			the containers and marking/placarding of the delivery trucks; • Vehicles carrying hazardous materials will be equipped with fire extinguishers and adequate means of fire prevention that are appropriate for the shipment. Transport manifests will be maintained in accordance with the relevant Russian regulations; • Yamal LNG will continue regular interface with the local nomadic community via the community chiefs and through a locally based CLO (Community Liaison Officer) that will act as the main focal point. • Implementation of the Yamal LNG Spill Response Plan in case of accidental spillage of oils and chemicals (see also Chapter 9). • All plant and machinery will be secured/made safe or removed from the construction worksites overnight. Public access to the zones of active construction will be restricted and such areas will be equipped with appropriate warning signage to alert migratory herders to the associated hazards. • Yamal LNG will continue to consult with the regional and local authorities overseeing the emergency response regulations on the road safety aspects	
Presence of security personnel	Local communities in the Project Area of Influence, including migratory herders	Construction Operations	• The security provider is a properly licensed and authorised security firm regulated by the relevant requirements of the Russian law. All guards are not armed (except for employees of State Security services). Yamal LNG requires that the security guards be well trained and that none of them have a previous criminal record. • All security personnel will be required to follow the appropriate Code of Conduct developed by Yamal LNG in 2014 • All security staff are attired in the appropriate uniform and are required to display a photographic ID tag at all times whilst on duty; • All criminal-related incidents and/or threats that come to the notice of security guards shall immediately be reported to the Police;	Low

Table 10.2.2: Summary of Community Health, Safety and Security Impacts and Mitigation Measures

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			• Yamal LNG will provide human rights induction training to the security personnel, including the requirements for avoiding disproportionate response and unwarranted use of force; • A formal report on any breaches of the Code of Conduct by security personnel (also lodged via the Yamal LNG Stakeholder Enquiry (Grievance) Procedure) will be raised to ensure prompt follow up and/or corrective action. A management reporting format will be implemented to ensure that Yamal LNG management are always aware of all security developments; • Yamal LNG will conduct regular auditing of the existing security management system, including reviews of the contractor security service providers to ensure compliance with the contractual and other requirements and that relevant standards. • The Yamal LNG Stakeholder Enquiry Procedure will continue to be used to monitor community concerns.	

10.3 POPULATION INFLUX

'Influx' or 'population inflow' is defined as a phenomenon related to the arrival of considerable numbers of personnel (migrant workforce) from areas other than Yamalsky District. The influx may result in demographic changes within the host community, such as an increase and altered composition of the population, and may lead to intercultural conflicts and add extra pressure on social infrastructure in the recipient community.

This section examines potential impacts on the population demographics that may be associated with the influx of the workforce into the Project Area of Influence during construction, commissioning and operation phases and the related mitigation measures that will be adopted by Yamal LNG to reduce the adverse effects.

The aspects of the Project that are likely to affect the current demographic situation in the Project Area of Influence are described in Table 10.3.1.

Table 10.3.1: Project aspects related to population demographics/ influx

Aspect/Project Component	Potential Risk/Impact
Construction	
Construction Workforce Presence of the Project and construction contractor personnel, predominantly consisting of non-resident / migrant workforce	Potential for competition, conflicts and tensions between the local host community in Yamalsky District and Project's non-local workforce/contractor personnel. Potential gender imbalance as the workforce largely consists of male workers unaccompanied by their families. Increased possibility of issues related to the observance of the law and public order, as well as alcohol/substance consumption and a risk of resorting to commercial sex services due to the prolonged separation of workers from their families (in case of non-local shift-based personnel). Accentuated cultural and income differences between the host community and non-local workforce. Potential tensions/conflicts between employees coming from different areas of the Russian Federation or other countries due to ethnical, cultural and religious differences Potential negative effects on the local infrastructure capacity.
Commissioning and Operations	
Operations Workforce Presence of the Project's operations personnel, largely consisting of non-resident / migrant workforce	Associated risks of cultural conflict and tensions between the host community and Project's non-local personnel. Observance of the appropriate behavioural standards by workforce. Potential social issues related to the prolonged separation of workers from their families (in case of non-local shift-based personnel). Job competition between the local resident population and Project's non-local workforce.

When assessing potential impacts related to the presence of the workforce, the following baseline factors are taken into consideration (as described in detail in Chapter 8):

- The strict border zone regulations imposed by the internal affairs and immigration[26] and Federal Security Service authorities in the entire YNAO and Yamalsky District and comprehensive checks enforced on all points of entry by any type of transport. Only registered residents/Russian nationals and external visitors with authorised passes are permitted to enter the territory of YNAO and Yamalsky District;
- The current trends of in-migration to YNAO from abroad (international migration), from other regions of the Russian Federation (inter-regional migration), and within the Okrug (intraregional migration), with labour migrants comprising a larger part in all types of migration due to the intensified industrial development in YNAO as a whole;
- Local sensitivities associated with the in-migration and the presence of foreign workers.

10.3.1 CONSTRUCTION PHASE

International industry experience shows that unregulated in-migration can be associated with major industrial projects as a result of the mass inflow of people seeking employment or attempting to exploit economic opportunities associated with a project. However, it is unlikely that the development of the Yamal LNG Project will lead to significant unplanned opportunistic migration to the licence area (i.e. a spontaneous influx of migrants apart from the planned mobilisation of the Project's workforce), principally due to the following reasons:

- Remote location of the Project in a sparsely populated area that is a considerable distance from the nearest permanent settlements;
- The lack of established networks of road transport from the settlements located inside and outside the licence area (Tambey Factoria and Seyakha village, respectively), with chartered helicopters being the main means of transportation in the Project locality;
- Rigorous controls on the entry to YNAO implemented by the authorities as part of the state border zone regulations, which minimises a risk of unrestricted access to the District;
- The strictly defined quotas for foreign personnel permitted to work in YNAO, in line with the Okrug's labour requirements;[27]
- Harsh climatic conditions of the Arctic that prevent the establishment and spread of informal settlements in the barren tundra or open-air opportunistic camps as 'satellites' to the Project development; and
- The absence of an opportunistic practice of "camp followers" among the local population, primarily due to the adherence of the indigenous communities to their traditional way of life.

Based on the above, the probability of spontaneous and opportunistic economic migration, i.e. not related to the Project workforce, is considered to be minimal. It is therefore predicted that the main

[26] Administration of the Ministry of Interior and Administration of the Federal Migration Agency for Yamal-Nenets Autonomous Okrug.

[27] The annual quotas for foreign workforce are formally stipulated by the YNAO Department for Employment, based on the approval of the RF State Commission for foreign labour regulations. In 2013, the foreign manpower quota is 42,111 workers for the entire YNAO.

adverse impact will result from the arrival of the large number of non-resident (migrant) workforce during the Project's construction phase, represented mainly by the construction contractor personnel.

10.3.1.1 INTERACTION BETWEEN PROJECT WORKFORCE AND HOST COMMUNITIES

Description of the Impact

At the peak of the construction phase (in 2015-2016), the Project will engage up to 14,000 skilled personnel working in rotation, i.e. 7,000 construction workers will be present on site at any one time. These will mainly consist of the non-resident (shift-based) personnel supplied by Yamal LNG's construction contractors.

The main potential adverse impacts induced by the influx of the construction workforce are:

- Heightened risk of social/inter-cultural conflict, including possible tensions between the host community of Yamalsky District and the Project's non-resident personnel. This aspect may be accompanied by a growing sense of individual and communal insecurity among the host population, disruption of the established lifestyles, and dissatisfaction with opportunities limited by the competition and qualification requirements for Project jobs;
- Accentuated wealth differences between the host community and imported workers; and
- A potential for breakdown of law and order, including increased crime and illicit activities, e.g. unauthorised fishing and hunting, demonstration of inappropriate behaviour or a lack of respect towards the local communities, or spontaneous spread of violence/disorder on-site and off-site.

The presence of non-local personnel is likely to result in the escalation of tensions and a greater possibility of conflict between workers and the host population, given that the local community may perceive the arrival of migrant workforce as intrusion and a threat to the traditional lifestyle, culture and the customary norms of conduct. This is likely to be exacerbated in situations where some members of the workforce are not sufficiently familiar with the local cultural imperatives, indigenous lifestyle and the specific standards of behaviour that are normally acceptable in the local context.

Further tensions may also arise as a result of unmet expectations of the local population residing in the Project Area of Influence with respect to gaining tangible benefits from the Project, such as employment or other economic opportunities. Local indigenous individuals who do not possess relevant skills and qualifications required for the Project construction positions and whose traditional livelihoods and subsistence activities may be affected by the Project, may feel further discontent from the influx of external workforce. This can in turn translate into the potential instability in the worker-host community relations.

Although the impact is expected to be localised, i.e. it will be manifested within the boundaries of the licence area, the overall duration will be throughout the construction phase and the sensitivity of the recipient community is considered to be high. To this effect, the unmitigated impact associated with the inflow of Project manpower during construction is assessed as **High**. The Project will aim to reduce this impact through a range of the mitigation measures as described below.

Mitigation measures

Worker Accommodation

Among the primary methods of mitigation will be the provision of designated on-site accommodation for construction personnel, which will ensure that the contact between the host population in the nearby settlements (Tambey Factoria and Seyakha village) and the Project workforce is minimised and the need for lodging outside the licence area is avoided. Construction workers will be housed in the dedicated autonomous full-service camp at Sabetta as well as in a number of temporary mobile camps situated within the licence area. Consequently, there will be no need for workers to utilise the community infrastructure.

The on-site camp facilities are self-contained and will offer the catering, cleaning, sanitary and laundry services that are necessary for maintaining an appropriate standard of accommodation as well as recreational facilities that can be used in workers' leisure time[28]. This approach will help eliminate the need for workers to seek those services elsewhere outside or to visit local communities in search of staple goods. Furthermore, construction workers accommodated in the camps will not be permitted to leave the licence area for recreational purposes, which will minimise possibilities of disturbing the local population or of developing a casual practice of soliciting commercial sex services. All the camps are intended for workers only and will not allow extra provisions for the accommodation of workers' family members or any other unauthorised persons. Workers residing in the camps will have designated security passes and the security measures will be in place to ensure that unauthorised persons are not allowed on the camp premises.

This approach will help regulate the numbers of arrivals into the Project licence area by limiting them primarily to the construction personnel themselves, rather than encouraging an inflow of accompanying relatives or members of the external public.

Due to the lack of road transport networks in the Project locality, chartered helicopters will be the primary means of transportation for the non-resident construction personnel, thereby minimising a need to resort to the public transport systems that may be used by the local community (such as temporary winter roads, ice crossings, or shipping via the Gulf of Ob).

Yamal LNG will liaise closely with the Municipal District and Okrug authorities to manage any unplanned in-migration to Yamalsky District in case of any noticeable trends of the Project-induced influx.

The mitigation measures related to the risks of increased alcohol/substance consumption and the use of commercial sex services are described in section 10.2.1.1.

Workforce Code of Conduct

Upon commencement of employment (or at the beginning of a scheduled rotation), all construction personnel, including contractors, will receive mandatory induction training in community/cultural awareness. This training will provide introductory orientation and workers' familiarisation with key

[28] Yamal LNG will follow the recommendations contained in the Guidance Note by IFC and the EBRD on Workers' accommodation: processes and standards (to the extent that they are applicable to arctic conditions)

aspects of the indigenous lifestyle and the norms of appropriate behaviour in case of interactions with the local population.

In addition, Yamal LNG already enforces the *'Accommodation Camp Policy'* which applies to the contractor personnel, particularly in relation to the movements of personnel outside their working hours or in any areas beyond the designated worksites/Project licence area (see also 'Workforce behaviour regulations' in section 10.2.1.1 'Community Exposure to Health Effects' above).

In conjunction with the Worker Code of Conduct (Code of Conduct is to be developed as part of the Labour Management Plan), the Camp Policy will serve as the main reference for the workforce in maintaining good employee and camp relations, and in guiding all personnel (including Project contractors) on the standards of professional behaviour. Project personnel to be accommodated at the camps, including workforce supplied by the contractors, are provided with a copy of the Accommodation Policy prior to moving into the residential facility to ensure that the camp residents are fully conversant with the rules of appropriate behaviour. Familiarisation with the Worker Code of Conduct will be implemented as part of the general induction training for workers. Copies of the Policy and the Code will also be made available at the Project's key construction and administrative sites within the licence area.

The Worker Code of Conduct will specifically cover, *inter alia,* the following aspects:

- Demonstration of respect to the local indigenous culture, traditional lifestyle and the customary standards of behaviour;
- Prohibition of hunting, fishing and gathering practices by the workforce, including any harassment and disturbance of reindeer;
- Refraining from any activity that may be detrimental to the host community and from any types of behaviour that may be disruptive to their traditional practices;
- Exercising neutral attitude of non-engagement and the prevention of disagreement in cases of potential conflict;
- Disciplinary measures to be applied in cases of infringement of the Code's requirements, proportionately to the gravity of the contravention.

Yamal LNG will duly investigate all breaches of the Worker Code of Conduct among the Project's employees and the construction contractor personnel. The Company's external *Grievance Procedure* represent an important indicator and the source of information on workers' deviant behaviour that may be reported by the local communities or by any other members of the external public.

The aspects related to the Company's policies on alcohol and substance use and on the prohibition of dog-keeping onsite are described in detail in section 10.2.1.1.

Demobilisation of Construction Workforce

Yamal LNG will require that all construction contractors demobilise their workforce in an organised and structured manner upon completion of the planned construction works. This requirement will not only stipulate the need for the coordinated demobilisation of manpower from the licence area, but also the repatriation of non-local workers at the end of the assignment to their place of origin/domicile or to a location of their initial recruitment. This approach will help avoid uncontrolled congregation of workers in the Project locality after their contractual assignments come to an end, e.g. to remain in the area in search for alternative employment opportunities.

Recruitment Regulations

When identifying the specific manpower requirements for the Project and assessing the characteristics of the local labour market, Yamal LNG takes into consideration the current limitations associated with the availability of skilled workforce locally and the resultant necessity to source a substantial proportion of qualified construction personnel from outside Yamalsky District/YNAO, i.e. mainly from other regions of Russia. To overcome the local labour shortages, the Project will therefore retain considerable numbers of skilled non-local contractor workforce.

At the same time, Yamal LNG is committed to contributing to the professional/vocational capacity-building of local labour resources and ensuring access to the Project-related employment for local communities through its 'Program for recruitment and professional training' which is to be developed by the end of 2014.

To minimise potential opportunistic influx into the Project Area of Influence, the Company will prohibit all informal or casual hiring practices at the worksites or the camps in the licence area[29]. All recruitment is subject to detailed advance planning and coordination by the Yamal LNG Department for Recruitment and Personnel Development, and is undertaken through the formal employment bureaus/job centres run by the state in Yamalsky District or through the YNAO Department for Employment. This approach will help to prevent unregulated and speculative recruitment practices in the Project locality and to deter an inflow of migrants seeking informal recruitment.

Wherever feasible and without jeopardising the Project delivery requirements, Yamal LNG will aim to prioritise recruitment from Yamalsky District/YNAO[30] and will continue to liaise with the relevant authorities on the local and regional levels to optimise the local employment and training strategy. This will in turn contribute to the following objectives:

- Minimise the potential for speculative influx of opportunistic economic migrants from outside the District/Okrug;
- Reduce a possibility of competition-based tension and conflicts between the local population neighbouring the Project and newcomers from other areas/regions; and
- Maintain secure and safe worksites within the licence area by outsourcing the recruitment to the formal employment centres operated by the relevant state bodies.

<u>Assessment of residual impact</u>

Taking into account the mitigation measures described above, the residual adverse impact associated with the interaction between Project workforce and the host communities is assessed as **Moderate**, despite being localised in extent. This is because the predicted adverse impact relates to the highly sensitive receptor (i.e. the indigenous communities that have not been previously exposed to prolonged presence and great numbers of external personnel in their traditional, largely isolated and customary environments, and who are therefore likely to experience substantial difficulties with adjusting to the new demographic settings created by the Project).

[29] Also generally known in the international practice as "no hire at the gate" policy.

[30] Equally taking into consideration the existing limitations of the local labour market, as described in the section "Economy, Employment and Livelihoods" below.

The arrival of the external workforce is also likely to have a potentially beneficial effect for the remote local community which can be manifested as an opportunity for an expanded world-view and improved linkages and access to the outside world and markets. Another positive aspect is also related to possible reversal of recent out-migration trends from Yamalsky District, including the return of educated, entrepreneurial and business-orientated individuals who had previously opted to move to the regional centres of YNAO (Salekhard, Novy Urengoi) or to other regions of the Russian Federation. Enhanced opportunities for skilled employment as a result of the Project's demand for qualified expertise are expected to be a contributing factor in this potential reversal of out-migration.

10.3.1.2 POTENTIAL CONFLICTS WITHIN THE WORKFORCE

The presence of a significant number of non-local employees arriving from different parts of the Russian Federation and other countries, and their close accommodation together on site, may impose the risk of possible tensions/conflicts between employees of different ethnical, cultural and religious background. This risk is inherently limited by the relatively short duration of the shifts (typically 45 days) in the personnel rotation system and is therefore intrinsically lower as compared with practices where imported/non-local workforce reside in camps for prolonged periods at a time. Nevertheless, without appropriate mitigation measures, this risk is assessed as **Moderate.**

<u>Mitigation measures</u>

The Project will adopt the following mitigation measures:

- Potential for separate accommodation for the employees with significantly divergent background as necessary;
- Provision of workers of different religious affiliation with equal access to the appropriate religious facilities;
- Induction training on cultural/religious differences (i.e. between Christians' and Muslims' religious practices and lifestyle);
- Regular refresher training, as appropriate;
- Control by responsible supervisors and the management of contractor companies on site;
- Application of prescribed disciplinary measures in case of breaches of the Workers Code of Conduct that will include, *inter alia*, the following requirements:
    - respectful and courteous behaviour towards colleagues with different cultural background and religious beliefs;
    - exercising a 'neutral' attitude in all cases where there is a potential for conflict,
    - zero-tolerance to harassment motivated by ethnical/racial, gender, age, religious, cultural and social hatred, etc.
- Investigation of the nature and causes of complaints lodged by employers via the Yamal LNG 'Employees (Grievance) Procedure'.

<u>Assessment of residual impact</u>

Taking into account the mitigation measures described above, the residual adverse impact associated with Potential tensions/conflicts between employees coming from different areas of RF or other countries due to ethnical, cultural and religious differences is assessed as **Low.**

10.3.1.3 EFFECTS ON COMMUNITY INFRASTRUCTURE AND SERVICES

Description of potential impact

The presence of the large workforce can have a secondary impact on the host communities in the form of extra pressures on the capacity of local infrastructure and services. Greater demand for infrastructure and utilities such as access to electricity, heating, water, transportation and medical services would lead to an unregulated increase in the use of the underdeveloped infrastructure in Yamalsky District, and negative effects on the ability of such facilities to deliver their required functions.

Road transport infrastructure

At present, the entire Yamalsky District is characterised by poorly developed over-ground transport infrastructure. To enable the unhindered conveyance of personnel, materials and equipment within the Yamal LNG licence area, the Project design provides for the construction of intra-field access roads. However, the use of temporary/seasonal local road network (i.e. public winter roads) which is normally set up and maintained by the municipal authorities for the benefit of the local communities is also envisaged. This may lead to an additional pressure being exerted on the limited road infrastructure (temporary/seasonal road network) in the Project locality.

Water resources

The main sources of water supply for the Project needs are freshwater (from an existing water supply from Lake Glubokoye during the initial stages of construction) and marine surface water bodies (the Gulf of Ob) and these are described in detail in Chapters 4 and 9.

The natural sources of water such as lakes are typically used by nomadic herders during their migrations. Water supply in the permanent settlements is mainly based on the use of the local and centralised water treatment systems. The Project will not tie-in with the existing communal/municipal facilities and negative impacts on this type of infrastructure will not occur. The impacts related to water quality in the local surface water bodies are described in the section 10.2.1.1.

Taking into account the substantial size of the construction workforce, there is a theoretical risk of overusing the existing water resources by the Project, especially given with typically low water levels in local lakes during winter and summer. As nomadic herders largely rely on surface water resources during migrations, any Project-related decrease in water availability may render them vulnerable. An associated secondary impact may be a resultant need for herders to identify alternative water sources or restricted access to the existing sources. However, significant impacts of this nature are not expected as water abstraction from Lake Glubokoye is unchanged from the current usage and as construction progresses, abstraction from Lake Glubokoye will cease and the abstraction will instead be from the Gulf of Ob.

Power supply

The Project will be self-sufficient in terms of power supply during the construction phase, using mobile and static diesel power generators set up within the licence area. No uptake of the municipal /communal infrastructure is planned and no adverse impact on the local power generation capacity is therefore predicted.

Housing

All construction workers will be accommodated in self-sufficient accommodation camps in the licence area. As a result, no impact on local or regional housing infrastructure is expected.

Health facilities

As described in the section 10.2.1.1, Yamal LNG has the healthcare provisions in place for the Project workforce, although specialised medical facilities will not be available on-site. The capacity for major emergency response (with the use of air ambulance)[31] and specialised medical care is therefore outsourced to the state-run hospitals in the cities of Novy Urengoi and Salekhard and in the settlement of Yar-Sale. The medical facility in Seyakha village, which is the nearest to the Project licence area, will only be used for most critical cases requiring urgent treatment as the capacity and staffing at this facility are limited.

Yamal LNG has also set up an agreement with the Salekhard regional clinical hospital for the provision of medical consultations and specialist counsel on diagnostics remotely, i.e. with the use of video transmission equipment (also known as ‘telemedicine’).

The existing capacity of the abovementioned state-run medical institutions is considered sufficient to provide health services to the current population of Yamalsky District. The presence of 7,000 Project construction personnel and the associated medical needs of the workforce are likely to exert extra strain on the existing local hospitals. However, the Project plans to resort to these medical facilities outside the licence area only in emergency situations, as the routine medical support and first aid services are provided at the on-site clinic and the paramedic stations. It is also taken into account that, unlike during operations, the probability of a major incident with mass casualties occurring in the course of construction is lower.

Given the specifics of the project design described above, the overall significance of unmitigated adverse impacts on the community infrastructure and services during Project construction is considered to be **Moderate to Low**. This is mainly due to the localised extent of the predicted negative effects and the Project’s capability to rely largely on its own facilities established within the licence area, and owing to the limited scale of the Project’s tie-in with the existing municipal utilities and services.

<u>Mitigation measures</u>

Yamal LNG will further reduce the predicted adverse impacts on the community infrastructure and services through the implementation of the following mitigation measures.

- Road transport infrastructure:
  - Establishing dedicated auxiliary infrastructure in the form of intra-field access roads will help minimise an extra load on the temporary public roads (winter tracks). The establishment of the road network will result in improved accessibility of the areas in the Project locality
  - Provision of assistance with the setting-up and maintenance of public winter roads that are also used for the Project purposes (through the existing channels of cooperation with the Yamalsky District municipal authorities and the local communities in Seyakha and Tambey);
  - Advance notifications to be issued to the relevant authorities in cases when the road transportation of oversized heavy cargo loads is planned;

[31] As per Yamal LNG’s Medical Emergency Response Plan

  - The continued reliance on chartered helicopters for the transportation of imported personnel to the Project licence area and the import of construction equipment and materials, including oversize modules, via sea (MOF), thereby avoiding a need for over-ground transport;
  - Where feasible, provision of complimentary transportation assistance to the local communities with the use of Project-chartered helicopters (e.g. for various urgent needs of the local public).
- Water resources:
  - Operation of the water supply and effluent discharge systems at the worker accommodation camp in Sabetta, and the provision of bottled drinking water to personnel;
  - Measures to limit over-consumption of the available freshwater resources during initial stages of construction, and the future use of abstraction from the Gulf of Ob as construction progresses. (see Chapter 9 for further details on the mitigation of impact on water supply);
  - The installation/upgrade of the municipal facilities for water supply and water treatment in Seyakha village as part of the 'Programme for Seyakha Settlement Development for 2011-2015' that is implemented by the Foundation for Development of Yamal Rural Territories and is aimed at modernisation of the Seyakha rural settlement (see the Yamal LNG SEP for further details on the Programme).
- Power supply:
  - The Project's reliance on its own power generating equipment within the licence area, i.e. mobile and static diesel power generators and boiler houses;
  - Construction of a diesel power station with 5.6 MW capacity and a boiler plant with 12 MW capacity in Seyakha village as part of the 'Programme for Seyakha Settlement Development for 2011-2015'.
- Housing:
  - The provision of self-contained, purpose-built and fully serviced accommodation facilities for Project construction personnel within the licence area;
  - Operation of the on-site camp facilities as 'worker only', to prevent an inflow of the accompanying family members and resultant pressure on the social infrastructure facilities in the settlements within the Project Area of Influence;
  - Construction of over 20,000 m^2 of housing stock in Seyakha village as part of the 'Programme for Seyakha Settlement Development for 2011-2015'.
- Health facilities:
  - Provision of on-site medical aid facilities available to all construction personnel within the Project licence area;
  - Ad-hoc services will be available to the local nomadic population at the Project's medical clinic in Sabetta (basic medical advice and non-specialised treatment for minor ailments)
  - Liaison with the relevant health authorities and local medical institutions in accordance with Yamal LNG's medical emergency and evacuation procedures (Medical Emergency Response Plan);
  - An upgrade of the Seyakha local hospital, the polyclinic and the ambulance as part of the 'Programme for Seyakha Settlement Development for 2011-2015'.

Assessment of residual impact

The implementation of this range of mitigation measures and the beneficial effects related to the communal infrastructure upgrade in Seyakha will allow the residual adverse impact on the infrastructure and services is assessed as **Low.**

10.3.1.4 INFORMAL SETTLEMENTS

Description of potential impact

As described earlier, the potential for unregulated development of improvised informal settlements set up by itinerant job seekers and other economic migrants is considered to be very low in the Project's context. The aspects that define this low probability are as follows:

- The Project's remote location and the very limited accessibility of the area due to the undeveloped permanent networks of road transport;
- The harsh climatic conditions of the Arctic with the sub-zero temperatures and limited daylight during most part of the year and the prevalence of the permafrost zone which prevents the establishment of temporary open-air settlements;
- Challenges of physiological adaptation and acclimatisation to the Arctic conditions typically experienced by non-local visitors to the area, particularly for a longer term duration of stay;
- Small and dispersed domestic population and the lack of permanent habitation in the open expanses of the Arctic tundra;
- The absence of appropriate infrastructure in the uninhabited inter-settlement territories and the very limited/obsolescent infrastructure that exists within the licence area (non-Project facilities at Tambey Factoria);
- Strong adherence of the local indigenous population to their traditional way of life and the associated seasonal migration activities, as well as the absence of an established practice of camp followers and a lack of experience of informal 'camp support';
- The predominance of established businesses based on the traditional economies (reindeer breeding, fishing) that require the indigenous knowledge and the experience in traditional skills, and the subsidisation of the traditional economic activities by the state. This limits a possibility of spontaneous development of major informal spin-off businesses not related to the traditional settings that would have attracted external public from outside the Yamalsky district;
- Strict entry regulations exercised by the authorities as part of the Russian state border zone, which prevents uncontrolled migration from outside YNAO;
- The out-migration trends that have largely prevailed among the population of Yamalsky District.

Due to the Project characteristics listed above, the probability of a major influx of opportunistic economic migrants (i.e. non-workforce) to the licence area is considered to be unlikely. The possibility that Tambey Factoria (the only permanent settlement in the Project licence area) will be targeted by a small number of external migrants is also predicted to be low, primarily due to the very limited basic infrastructure that is available at the Factoria and its main function as a transient hub for the indigenous reindeer herders.

To this effect, the unmitigated adverse impact associated with the development of informal settlements induced by the Project is assessed as **Low**.

Mitigation measures

The following measures will be implemented to prevent a spontaneous opportunistic (i.e. non-workforce) influx into the Project licence area and to avoid an unregulated settlement sprawl:

- Provision of the worker-only, closed-type camp facilities for Project construction personnel with the strict regulation of access on site. Rotation-based work pattern and no accompanying family members are allowed at the Project facilities;
- The preferential recruitment of unskilled and low-skilled labour from the local population to prevent an inflow of economic migrants from outside Yamalsky District. All recruitment and hire are implemented as per the Project's defined plans for manpower demand and through the formally established job centres/employment bureaus run by the state authorities, i.e. the practices of informal 'hire at the gate' are not allowed. Applications for employment will only be considered if submitted via the Company' official recruitment procedure;
- Yamal LNG will take into account relevant commercial and business considerations, including the preferential procurement and purchase of goods and services within Yamalsky District/YNAO (wherever possible and without compromising the Project's rigorous quality standards) and other parts of Russia.

Assessment of residual impact

Providing the effective implementation, the aforementioned measures will help pre-empt an inflow of informal job seekers and will thereby further reduce the intrinsically low probability of improvised, unplanned communities developing around the Project worksites or outside the licence area. The residual adverse impact is predicted to be of a very localised extent, with the **Low to Negligible** severity.

10.3.2 COMMISSIONING AND OPERATION

Description of potential impact

The construction workforce, including the contractors, will be demobilised from the licence area in an organised manner after the completion of construction. The operations phase personnel will work in rotation, i.e. two shifts each of approximately 1,500 workers. It is not expected that there will be a significant impact as a result of uncontrolled in-migration during the Project's operations phase, as the demand for non-skilled/non-qualified general labour services will be very limited. The influx of non-workforce migrants from outside the Project Area of Influence is not anticipated to be of a major scale as a considerable proportion of job positions during the operations will require trained staff with relevant competencies and skills. The number of non-skilled economic migrants arriving in Yamalsky District in search of opportunities for general labour employment is therefore likely to be within a minimal range. Therefore, the unmitigated impact of in-migration during the operations phase is assessed as **Moderate.**

Mitigation measures

The range of mitigation measures to be applied during Project operations will be similar to those described for the construction phase. Specific mitigation measures will also include:

- The provision of dedicated residential facilities for operations personnel, including the accommodation camp that will be constructed in close proximity to the LNG Plant. The operations phase field camp will be designed to accommodate 1,050 workers during each shift;
- Expatriate/non-local personnel will be stationed at the on-site camp, based on the fly-in-fly-out ('FIFO') rotation using the Project's own airport infrastructure;
- Power supply through the dedicated 380MW power plant located within the territory of the LNG Plant, and the emergency power arrangements to be provided by back-up diesel generators. Distribution of generated power to the various Project facility areas via the overhead transmission lines to be installed within the licence area. No intake of municipal infrastructure or communal power generation capacity is envisaged.

Assessment of residual impact

Due to the low demand for non-qualified labour during the operations phase and the Project's self-sufficient infrastructure, the residual impacts on demographics due to uncontrolled in-migration is expected to be **Low**.

10.3.3 SUMMARY IMPACT TABLE

Table 10.3.2: Summary of Population Influx Impact and Migration Measures				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
Interaction between Project Workforce and Host Communities	Project workforce and the local communities in the Project Area of Influence	Construction Operations	• Provision of designated on-site accommodation (dedicated autonomous full-service camps) for Project' and contractor personnel. • The on-site camp facilities will be self-contained and will offer the catering, cleaning, sanitary and laundry services as well as recreational facilities for workers. • Workers accommodated in the camp will not be permitted to leave the licence area for recreational purposes. • During operations, expatriate/non-local personnel will be stationed at the on-site camp, based on the fly-in-fly-out ('FIFO') rotation using the Project's own airport infrastructure; • All the camps are workers only and will not allow extra provisions for the accommodation of workers' family members or any other unauthorised persons. • Workers residing in the camp will have designated security passes and the security measures will be in place to ensure that unauthorised persons are not allowed on the camp premises. • Yamal LNG will liaise closely with the Municipal District and Okrug authorities to manage any unplanned in-migration to Yamalsky District in case of any noticeable trends of the Project-induced influx. • Enforcement of the Yamal LNG Worker Code of Conduct, including for contractor personnel. Mandatory induction training in community/cultural awareness. • Enforcement of the Yamal LNG 'Accommodation Camp Policy' to	Moderate

Table 10.3.2: Summary of Population Influx Impact and Migration Measures

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
			regulate movements of personnel outside working hours or in any areas beyond the designated worksites/Project licence area. • Yamal LNG will investigate all breaches of the Worker Code of Conduct among the Project's employees and the construction contractor personnel. • Implementation of the Yamal LNG Grievance Procedure to monitor and address issues related to workers' behaviour. • Yamal LNG will require that all construction contractors demobilise their workforce in an organised and structured manner upon completion of the planned construction works. • The Company will not allow any informal or casual hiring practices at the worksites or the camps in the licence area. • Wherever feasible and without jeopardising the Project delivery requirements, Yamal LNG will prioritise the recruitment and hiring from Yamalsky District/YNAO, and will continue to liaise with the relevant authorities to optimise its local employment and training strategy.	
Potential conflicts within workforce	Project workforce	Construction	• Potential for separate accommodation for the employees with significantly divergent background as necessary; • Provision of workers of different religious affiliation with equal access to the appropriate religious facilities; • Induction training on cultural/religious differences (i.e. between Christians' and Muslims' religious practices and lifestyle); • Regular refresher training, as appropriate; • Control by responsible supervisors and the management of contractor companies on site; • Application of prescribed disciplinary measures in case of breaches of the Workers Code of Conduct that will include, inter	Low

Table 10.3.2: Summary of Population Influx Impact and Migration Measures				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
			alia, the following requirements: ○ respectful and courteous behaviour towards colleagues with different cultural background and religious beliefs; ○ exercising a 'neutral' attitude in all cases where there is a potential for conflict, ○ zero-tolerance to harassment motivated by ethnical/racial, gender, age, religious, cultural and social hatred, etc. • Investigation of the nature and causes of complaints lodged by employers via the Yamal LNG 'Employees (Grievance) Procedure'.	
Effects on Community Infrastructure and Services	Local communities in the Project Area of Influence	Construction	• Road transport infrastructure: ○ Dedicated auxiliary infrastructure in the form of intra-field access roads to minimise an extra load on the temporary public roads (winter tracks). ○ Provision of assistance with the setting-up and maintenance of public winter roads also used for Project purposes; ○ Advance notifications to be issued to the relevant authorities in cases when the road transportation of oversized heavy cargo loads is planned; ○ Where feasible, provision of complimentary transportation assistance to the local communities with the use of Project-chartered helicopters (e.g. for various urgent needs of the local public). • Water resources: ○ Operation of the water supply and effluent discharge systems at the worker accommodation camp in Sabetta, and the provision of bottled drinking water to personnel;	Low

Table 10.3.2: Summary of Population Influx Impact and Migration Measures				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
			◦ Measures to limit over-consumption of the available freshwater resources during the initial stages of construction and the future use of abstraction from the Gulf of Ob as construction progresses. (see Chapter 9 for further details on the mitigation of impact on water supply); ◦ Installation/upgrade of the municipal facilities for water supply and water treatment in Seyakha village as part of the 'Programme for Seyakha Settlement Development for 2011-2015'. • Power supply: ◦ The Project's reliance on its own power generating equipment within the licence area, i.e. mobile and static diesel power generators and boiler houses during construction; ◦ During operations, power supply through the dedicated 380MW power plant located within the territory of the LNG Plant, and the emergency power arrangements to be provided by back-up diesel generators. ◦ Construction of a diesel power station with 5.6 MW capacity and a boiler plant with 12 MW capacity in Seyakha village as part of the 'Programme for Seyakha Settlement Development for 2011-2015'. • Housing: ◦ The provision of self-contained, purpose-built and fully serviced accommodation facilities for Project construction personnel within the licence area (Sabetta camp); ◦ Operation of the on-site camp facilities as 'worker only', to prevent an inflow of the accompanying family members and resultant pressure on the social infrastructure facilities in the	

Table 10.3.2: Summary of Population Influx Impact and Migration Measures				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
			settlements within the Project Area of Influence; o Construction of over 20,000 m2 of housing stock in Seyakha village as part of the 'Programme for Seyakha Settlement Development for 2011-2015'. • Health facilities: o Provision of the on-site medical aid facilities available to all construction personnel within the Project licence area; o Ad-hoc services to local nomadic population at the Project's medical clinic in Sabetta (basic medical advice and non-specialised treatment for minor ailments) o Liaison with relevant health authorities and local medical institutions in accordance with Yamal LNG's medical emergency and evacuation procedures (Medical Emergency Response Plan); o An upgrade of the Seyakha local hospital, the polyclinic and the ambulance as part of the 'Programme for Seyakha Settlement Development for 2011-2015'.	
Informal Settlements	Local communities in the Project Area of Influence	Construction	• Provision of the worker-only, closed-type camp facilities for Project construction personnel with the strict regulation of access on site. Rotation-based work pattern and no accompanying family members are allowed at the Project facilities; • Preferential recruitment of unskilled and low-skilled labour from the local population. • All recruitment and hire implemented as per the Project's defined plans for manpower demand and through the formally established job centres/employment bureaus run by the state authorities. • Yamal LNG will take into account relevant commercial and business considerations, including the preferential procurement and purchase of goods and services within Yamalsky	Low to Negligible

Table 10.3.2: Summary of Population Influx Impact and Migration Measures				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
			District/YNAO (wherever possible and without compromising the Project's rigorous quality standards) and other parts of Russia.	

10.4 LABOUR AND WORKING CONDITIONS

This section discusses the potential impacts on labour and working conditions for the Project workforce during the construction and operation phases and the associated mitigation measures that will be adopted by the Company.

Detailed assessment of Occupational Health and Safety (OHS) is outside of the scope of this ESIA and hence is not addressed here. Nonetheless, a brief overview of the Project approach to OHS issues and contract conditions is provided in the relevant subsection below.

Other specific elements of labour and working conditions are discussed in more detail below:

- Acclimatisation and adaption of the immigrant workforce to the harsh climatic conditions and remote location of the Project and the potential to impact on workers':
  - Health
  - Fitness to work
  - Psychological and physiological well-being
- Issues associated with the accommodation facilities, including;
  - Control of sanitary and hygiene risk
  - Adequacy of provided dormitories and amenities

10.4.1 OCCUPATIONAL HEALTH AND SAFETY

10.4.1.1 CONSTRUCTION

There will be a wide range of general and activity-specific OHS risks associated with all stages of construction. These risks will vary between different construction activities and also over time. To manage these risks Yamal LNG is developing a comprehensive health and safety management system (HS-MS) that is compliant with OHSAS 18001. The management system is design to ensure that OHS risks associated with all construction activities are appropriately identified and controlled. Yamal LNG also operates the collective agreement with its employees which stipulates the requirements for the following:

- working conditions and occupational health,
- hours of work and rest, overtime and leave,
- labour remuneration, including for hazardous work and during night shifts/rotation as well as when working in conditions of the Far North,
- retrenchment and redundancies,
- social benefits.

10.4.1.2 COMMISSIONING AND OPERATION

Risks associated with commissioning and operation of the Yamal LNG project will continue to be managed under the Company's HS-MS. This will include specific requirements for initial commissioning and operation when it is likely that final elements of construction are still ongoing (so-called 'SIMOPS').

In addition, control of OHS risks associated with both routine operations and major accident hazards has also been considered as an integral part of the evolving Project design. This has been achieved through the performance of, *inter alia*, the following studies, all of which have been updated through the design lifecycle:

- Hazard identification exercises (i.e. HAZID/ENVID studies)
- Quantitative risk assessments (QRAs) for all phases of operation, including SIMOPS
- Detailed studies into potential on-site impacts of, *inter alia*, noise, air emissions and thermal radiation.

The results of these studies have input in to the finalisation of the design, layout and zoning of the Project facilities.

10.4.2 ACCLIMATISATION AND ADAPTATION EFFECTS

Description of potential impact

The harsh climate of the Arctic, the predominance of the sub-zero temperatures throughout the year, limited duration of the daylight (especially in autumn-winter months), very low levels of atmospheric humidity[32], coupled with remoteness of the Project location may lead to a range of negative effects on workers' health and mental well-being. These adverse impacts associated with greater health vulnerability are expected to be more pronounced among non-local personnel that come from outside the YNAO and are not adapted to the local climatic and geographic settings.

The following negative health effects are likely to be experienced by the workforce in conditions of the Arctic environment:

- Hypoxemia[33] and 'Arctic asthma', often resulting from the deleterious effects of the climate of the Far North on human physiology and particularly on the respiratory system[34] (natural adjustments as a result of the adaptation syndrome);

[32] The low content of water vapour in the atmosphere is typical for the areas of high latitude and the Far North. The average annual moisture content in the air of the Polar regions is lower than in the desert, mainly due to the moisture elimination/freezing at the sub-zero temperatures. In the areas of cold climate, low absolute humidity is typical not only for the outdoor environment but also for residential, office and indoor workspace and the dry air becomes a constant factor in the conditions of human habitat. Recent studies show that the low humidity/dryness of cold air affects the conditions of gas exchange in human lungs, resulting in the 'Arctic asthma' syndrome. *Source: Boris Velichkovsky, Academic of the Russian Academy of Medical Sciences, Professor of the Russian State Medical University: "Arctic asthma", The Oil of Russia – Information and Analytical Portal, No.3, 2006.* http://www.oilru.com/sp/12/534/oilru.com

[33] Decreased concentration of oxygen in the arterial blood. Oxygen deficiency is exacerbated by the cold environment in the conditions of the Far North/Arctic and is a consequence of the disrupted diffusion of O_2 and CO_2 gases through the lung membrane. Prolonged hypoxemia increases the amount of free radicals (known to cause cellular damage) and decreases the amount of antioxidants (molecular agents that blockade free radicals' damage to cellular components), mainly due to the deficit of vitamins C and E that are consumed by the body at an increased rate as part of the natural adaptation mechanism. *Source: Boris Velichkovsky, Academic of the Russian Academy of Medical Sciences, Professor of the Russian State Medical University: "Arctic asthma", The Oil of Russia – Information and Analytical Portal, No.3, 2006.* http://www.oilru.com/sp/12/534/oilru.com

[34] Structural and functional changes in the respiratory organs are manifested in the increased area of alveolar surface of the lungs (*alveoli* are responsible for oxygen exchange) by 24% on average, and the

- Hypothermia[35] and an increased risk of frostbite when working outdoors during prolonged periods of time at the extremely low ambient temperatures with the wind-chill factor;
- Increased proneness to fatigue, tiredness and reduced concentration span, even when carrying out habitual routine tasks of standard duration;
- Greater predisposition to illnesses induced by the cold environment and the reduced body resistance, and an increased risk of disease transmission due to the congested living conditions as the considerable numbers of construction workers are concentrated at the on-site accommodation facilities;
- Seasonal Affective Disorder (SAD)[36] and disrupted sleep patterns, likely to result from the prolonged deficit of the sunlight[37] in the conditions of the Polar night (that spans up to 60 days a year), also known as the 'Polar stress syndrome';
- Psychological disorders resulting from an increased sense of isolation due to the Project's remote location with limited accessibility and the lack of established human habitations in the Project licence area, as well as the inability to bring in accompanying partners or family members;
- Propensity to mental and physical stress, a sense of anxiety and inability to cope, decreased fitness and capacity to work under pressure of the Project's round-the-clock delivery requirements (long working hours and intense physical activity, largely outdoors, or during night shifts);
- A risk of delayed medical evacuation in case of unfavourable weather conditions that may disrupt the air ambulance services.

Taking into account the large scale of the planned construction activities and the sizeable construction workforce in conjunction with the challenging conditions of the Arctic natural environment, the unmitigated impact associated with occupational health and safety risks during construction is assessed as **High.**

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increased volume of lung capillaries (by 39%). The pulmonary artery systolic pressure also increases above 30 Mmhg. Recent studies show that such symptoms of human adaptation to the extreme conditions of the Far North/Polar regions result from the effects of cold dry air on gas exchange/ventilation mechanism in the lungs. *Source: Ibidum.*

[35] A potentially fatal condition occurs when body temperature falls below 35°C.

[36] SAD, also known as "winter depression" is an affective, or mood disorder. The associated depressive symptoms and seasonal mood variations are believed to be related mostly to daylight, not temperature. Lack of light causes increased production of Melatonin (the hormone that triggers sleep at night), and a reduction of Serotonin, the lack of which causes depression. Prolonged periods of overcast weather can also exacerbate SAD. Residents of the Arctic region are particularly susceptible due to the effects of polar nights. SAD is a serious disorder, sometimes triggering dysthymia or clinical depression. *Source: Science Reference, ScienceDaily, http://www.sciencedaily.com/articles/s/seasonal_affective_disorder.htm and 'About Seasonal Affective Disorder' http://www.sad.org.uk/*

[37] On average, only 20% of the annual biological demand for ultraviolet is fulfilled in the Arctic conditions. *See also: 'The Man and the North — The Polar Stress Syndrome', http://kb-83.ru/publ/r_s/6*

Mitigation measures

To mitigate adverse health effects on the workforce resulting from the Arctic environment and in order to reduce the associated impacts of extra stress, the Company will implement the following set of measures:

- Limiting the duration of the rotation pattern (45-day period in the construction phase) and regulating the duration of the on-site workshift (10 hours per shift);
- Authorised regular breaks during the workshift, including scheduled meal and rest breaks;
- Regular monitoring of workforce health at the on-site medical clinic (pre-shift and mid-shift medical check-ups) and the identification of chronic conditions that may hinder the processes of natural adaptation, including among contractor personnel;
- Implementing the preventative measures of prophylaxis through the dedicated 'Health' programme that is aimed to provide health awareness raising and a range of tailored measures for adaptation and acclimatisation for the Project workforce, including contractors;
- The provision of leisure, sports and recreation facilities to alleviate the physical and psychological pressures at the workplace;
- Ensuring optimal levels of ambient temperature and humidity in the residential units and in the buildings;
- Provision of PPE that is customised to the climatic conditions of the Arctic, including the means of respiratory protection;
- Availability of medical consultation and counselling from the staff at the on-site medical clinic;
- Provision of balanced (vitamin and protein-fortified) diet at the Project's catering facilities
- Availability of SAD Light Therapy at the on-site medical clinic;
- Arrangements for the medical emergency evacuation to the hospitals of Novy Urengoi, Salekhard, Yar-Sale or Seyakha; In case air ambulance is unavailable due to weather conditions patients will be temporary stabilised at the Sabetta medical unit, intensive care will be provided;
- Regular liaison with the public healthcare institutions – the clinical hospitals in Novy Urengoi, Salekhard and Yar-Sale – whenever specialised medical counsel is required;
- Implementation of the Company's *Employee Grievance Procedure* which allows the communication of concerns and complaints related to the workplace and working conditions (to be developed in Q1 2014)

Assessment of residual impact

The Project will reduce the predicted adverse impact on workforce health and safety to **Moderate** severity following the implementation of the aforementioned mitigation measures.

10.4.3 GENERAL CAMP ISSUES (CONSTRUCTION AND OPERATIONS)

Description of potential impact

This section describes general risks associated with the worker accommodation facilities both during construction and operations phases of the Project, including:

- The Sabetta accommodation camp, with the total design capacity of 5,200 construction workers per shift (the Sabetta camp will also be used during the operation phase)
- Satellite camps operated by construction contractors
- The LNG operations camp to accommodate 1, 500 workers during each shift and to be situated in the close proximity of the main LNG site

The potential adverse impacts related to the worker accommodation camps are described in the following sections below.

Hygiene and Sanitation

Poor hygiene and sanitation practices at the camps, including in relation to food preparation, are the key factors that may jeopardise workers' health if not properly managed. These risks are likely to be exacerbated by the significant numbers of personnel accommodated at the camps. The potential risks may stem from the conditions at the general living facilities/residential quarters, sanitary units, canteen and cooking facilities, and food safety.

Given the considerable numbers of personnel both during the Project's construction and operation, the level of unmitigated impacts associated with the quality of accommodation facilities is assessed as **Moderate.** (This assessment of the unmitigated impact takes into account intrinsic elements in the camp design[38]).

Mitigation measures

The design of the camp facilities has taken into account fire safety, emergency and sanitary and hygiene requirements in accordance with the Russian Federal law and the specific industry specifications as required for the climatic settings of the Project's location. Yamal LNG will operate the workforce accommodation camps in compliance with the applicable Russian regulations. In addition, consideration will be given to the IFC/EBRD Guidance Note 'Worker Accommodation. Processes and Standards' to the extent that this is appropriate and practicable to Project location. The accommodation services will be provided to all workers engaged in the Project licence area, including contractor personnel, on a fair and non-discriminatory basis.

[38] Due to the remote location of the Project and the environmental conditions of the Arctic, all utilities and services required to support worker accommodation will be purpose built, including boilers for heating, water supply and wastewater treatment, solid waste management, power supplies (gas powered), fire fighting system, fire tenders and personnel, canteen and link roads with the main site and accommodation/welfare facilities. This approach is considered to be the mitigation through design.

The main camps for construction and operations workers will provide the following facilities for the workforce:

- Dormitories/residential quarters
- Transition galleries
- Community centre
- Dedicated canteen/ messing facility
- Health and recreation module
- Sanitary units
- Personal storage
- Warehouse for food and non-food products
- Enclosed parking area
- Checkpoint
- Auxiliary buildings
- Communication facilities

Sanitary effluents from the accommodation facilities will be managed in appropriately designed local wastewater system prior to removal to wastewater treatment facilities at Sabetta for final treatment and disposal (see Chapter 9 for further details on wastewater treatment).

The specifics of camp management for the prevention of communicable diseases and alcohol/substance abuse among the workforce are described in section 10.2.1.1. The Company' standards for the management of workforce behaviour as part of the 'Accommodation Camp Policy' and the Worker Code of Conduct are presented in section 10.3.1.1. All the accommodation facilities will be operated as 'dry closed' camps in order to avoid uncontrolled access and aberrant behaviour. These regulations will help minimise the risks of conflicts escalating on the camp premises.

Assessment of residual impact

With effective implementation of the identified mitigation measures, the residual adverse impacts associated with the workforce camps are predicted to be of **Low** severity.

10.4.4 SUMMARY IMPACT TABLE

Table 10.4.1: Summary of Population Influx Impact and Migration Measures

Impact	Receptor	Phase	Design and Mitigation Actions	Residual Impact
Acclimatisation and adaptation to the Arctic environment	Project's and contractor workforce	Construction Operations	• Limiting the duration of the rotation pattern (45-day period in the construction phase) and regulating the duration of the on-site workshift (10 hours per shift); • Authorised regular breaks during the workshift, including scheduled meal and rest breaks; • Regular monitoring of workforce health at the Sabetta on-site medical clinic (pre-shift and mid-shift medical check-ups) and the identification of chronic conditions that may hinder t natural adaptation, including among contractor personnel; • Implementing preventative measures as part of the Yamal LNG 'Health' programme; • Provision of leisure, sports and recreation facilities for workforce; • Ensuring optimal levels of ambient temperature and humidity in the residential units and in the buildings; • Provision of PPE customised to the climatic conditions of the Arctic, including the means of respiratory protection; • Availability of medical consultation and counselling from the staff at the on-site medical clinic; • Provision of balanced (vitamin and protein-fortified) diet at the Project's catering facilities ; • Availability of SAD Light Therapy at the on-site medical clinic; • Arrangements for the medical emergency evacuation to the hospitals of Novy Urengoi, Salekhard, Yar-Sale or Seyakha. In case air ambulance is unavailable due to weather conditions patients will be temporary stabilised at	Moderate

Table 10.4.1: Summary of Population Influx Impact and Migration Measures				
Impact	**Receptor**	**Phase**	**Design and Mitigation Actions**	**Residual Impact**
			the Sabetta medical unit, intensive care will be provided; • Regular liaison with the public healthcare institutions – the clinical hospitals in Novy Urengoi, Salekhard and Yar-Sale – whenever specialised medical counsel is required; • Implementation of the Company's *Employee Grievance Procedure* that allows communication of concerns and complaints related to the workplace and working conditions (to be developed in Q1 2014).	
Safety risk associated with abnormal operations (flash fires and explosions)	Project's and contractor workforce	Commissioning and Operation	Installation of gas detectors at the LNG operations worker camp to ensure early identification of any uncontrolled hazardous emissions and harmful pollutant concentrations in ambient air; Provision of appropriate PPE to all operations personnel; Accident and emergency awareness training and regular drills for all operations personnel; Provisions for the emergency medical evacuation in case of mass casualties.	
General camp issues	Project's and contractor workforce	Construction Operations	The camp design is based on fire safety, emergency and sanitary and hygiene requirements of Russian Federal law and the specific industry specifications for the cold regions. Yamal LNG will operate the worker accommodation camps in compliance with the applicable Russian regulations and IFC/EBRD Guidance Note "Workers Accommodation. Processes and Standards" to the extent that tis appropriate and practicable to Project location. The quality accommodation services will be provided to all workers, including contractor personnel, on a fair and non-discriminatory basis. All accommodation facilities operated by the Project will be 'dry closed' camps with the regulations of access.	Low

10.5 ECONOMY AND EMPLOYMENT

This section examines direct impacts (positive and negative) associated with employment by Yamal LNG and its contractors, together with indirect impacts resulting from secondary/induced employment through the provision of goods, supply of services and other types of support to the Project.

The aspects of the Project that could influence the economy and employment trends are described in Table 10.5.1

Table 10.5.1: Project aspects leading to impacts on economy and employment

Aspect/Project Component	Potential Impact
Construction	
Project manpower demand and labour requirements	Direct and indirect employment opportunities and related beneficial effects on the economy.
Project demand for materials and services	Procurement of local goods and services and associated spin-off effects of business stimulation and development
Workforce demobilisation post-construction	Loss of related jobs
Commissioning and Operations	
Project manpower demand and labour requirements	Direct and indirect employment opportunities and related beneficial effects on the economy.
Project demand for materials and services	Procurement of local goods and services and associated spin-off effects of business stimulation and development

When conducting the assessment, the following baseline conditions in the Project Area of Influence have been taken into consideration:

- Dependency of YNAO and Yamalsky district economies on the oil and gas sector which overall accounts for over 88% of industrial production, including strong budget reliance on taxes paid by industrial companies operating in the area;
- Well-developed small and medium business sector despite the specific “northern” character and predominantly single-industry nature of the YNAO economy;
- Low level of official unemployment in both YNAO and the Yamalsky District (less than 1% of the population size in 2012);

- General lack of sufficiently qualified labour resources and technical skills required for the industrial sector, and the resultant need for employers in YNAO to attract skilled workforce from outside the region;
- The lack of technical vocational institutions that provide specialised training required for the oil and gas industry;
- Low labour mobility in the YNAO, i.e. limited tendency among the local population for geographical (intra- and inter-regional) and occupational (i.e. inter-sectoral) movement of workers. Moreover, oral consultants have indicated that the local population tend to demonstrate low willingness to undertake rotation-based jobs;
- The prevalence of the traditional agricultural economy among local community (primarily reindeer breeding and herding as well as fisheries and fish processing) that largely relies on customary skills of the indigenous population;
- The strong adherence of the indigenous population to their traditional occupations and customary lifestyle, and thus, typically seasonal employment of the rural population, particularly among indigenous reindeer herders.

10.5.1 CONSTRUCTION PHASE

10.5.1.1 DIRECT EMPLOYMENT

Description of the Impact

YLNG workforce

Table 10.5.2. Dynamics in the YLNG employees number

	Number of employees as per the business plan for 2013	2014	2015	2016	2017	2018
Total number of YLNG employees	708	1 271	1 852	2 198	2 306	2 324
Moscow	445	798	807	825	837	840
Sabetta	250	461	1 033	1 361	1 457	1 472
Salekhard	10	7	7	7	7	7
Yar-Sale	1	2	2	2	2	2

Table 10.5.2. Dynamics in the YLNG employees number

	Number of employees as per the business plan for 2013	2014	2015	2016	2017	2018
Noviy Urengoy	2	3	3	3	3	3

The construction phase on-site personnel will work in rotation, i.e. in two 12-hours shifts (10 hours with 2 hour break); duration of each shift is 45 days.

The hiring of labour will conform with the RF labour legislation, ILO standards and IFC Performance Standards' requirements.

Yamal LNG intends to hire local workers where possible. However, due to the low level of unemployment, the demand for labour consistently exceeds supply which results in a significant shortage of local skilled workers. Yamal LNG has comprehensive recruitment and internal training procedures designed to maximize local recruitment at all levels and skill requirements. Nevertheless, in view of local workforce shortages, it is necessary to engage workers from outside of the local district.

At present Yamal LNG is searching for candidates through the following channels:

- Monitoring of internal candidates database;
- Regular interaction with local educational institutions of different levels (incl. regular provision them with the lists of candidates in demand in short- and long-term perspectives, as well as presentations of the Project performed by Yamal LNG representatives);
- Collaboration with YNAO and the Yamalsky district Departments of Employment, with local job centres;
- Collection of queries from the Yamal LNG local branches, Project public reception offices and public enquiries email box;

  Publications of available job positions in media and on the Company's website http://www.yamalspg.ru/.

Candidates can apply for vacancies in Yamal LNG via:

- visiting Company's local branches (Salekhard, Yar-Sale);
- writing an email / a paper letter to the Company;
- filling in the job application form on the Company website http://www.yamalspg.ru/;
- filling in the Public Enquiry Form available in the Project public reception offices (Salekhard, Yar-Sale, Seyakha, Sabetta);
- contacting local job centres; or

- contacting Yamal LNG Senior Liaison Officer based in Yar-Sale responsible, inter alia, for coordination of local recruitment on the ground

A Training Plan implemented by the Company includes theoretical and practical courses for recent graduates of educational institutions and candidates without previous work experience, as well as further vocational training for current Yamal LNG employees. Theoretical course provided in cooperation with the local secondary vocational schools (e.g., in Salekhard and/or Labytnangy) consists of classroom lectures (English language, engineering science, OHS) and training on simulators. Students of the practical course will take part in pre-commissioning and commissioning operations, as well as receive practical guidance and advice from their personal workplace mentors.

According to the preliminary 'Program for recruitment and professional training', Yamal LNG will hire and train 240 employees in 2015, of whom 112 people are expected to have experience in oil and gas industry and the rest to have general education with further training to be provided. The final version of the Program covering all recruitment procedures, types of training offered by the Company, as well as exact employment targets, is to be developed and approved by the end of 2014.

Contractors' Workforce

Procurement of construction and engineering services for the Yamal LNG Project will be implemented through a number of 'engineer, procure and construct' ('EPC') contracts, as well as several construction contracts covering basic large-scale work scopes. In total 14 direct contractor/EPC companies are expected to be on site during the construction phase. Contractor companies will be selected through a multi-factor tender process, where the local provenance of the bidder will be considered as an advantage (under otherwise equal conditions). The selected companies may, in turn, attract specialised subcontractors for implementation of certain ad hoc assignments.

The peak total Project contractors' workforce (in 2015) will reach 14,000 shift-based personnel working in rotation, i.e. 7,000 construction workers present on site at any one time, comprised largely of workers arriving from outside the Yamal-Nenets Autonomous Okrug (YNAO), other regions of Russia and from abroad. As of the end of October 2013, 2722 contractors' employees were present on site.

Yamal LNG contractors are responsible for formalization of work relations with their personnel and provision the appropriate working conditions in strict compliance with the RF labour legislation. Labour contracts for most of the on-site construction personnel will clearly stipulate the duration of their contractual assignment and temporary nature of the construction phase (except for those workers who are employed on permanent contract).

Other possibilities for direct employment will include jobs with contractors providing small-scale auxiliary services (i.e. medical support, maintenance, laundry, catering, security, cleaning, road and environmental maintenance, etc.).

Employment of the Local and Indigenous Population

Yamal LNG's recruitment process will include preferential status for the local population (including indigenous peoples) with due account to the level of skills required for a certain position. Preferential employment of indigenous peoples will be primarily guaranteed by use of a dedicated database of local candidates. Those local people who are willing to work for the Project can register their interest either through the employment centres or by contacting Yamal LNG directly. Yamal LNG's Human Resources department accumulates information on local candidates in a database and when a vacant position becomes available indigenous candidates are contacted on a first-priority basis. If a local person is rejected from being hired by the Company, the reason is recorded in the database and communicated to the candidate. As of July 2014, there were 48 local candidates in the database, nine of which had been already employed by Project contractors.

However, while considering recruitment of indigenous population several factors are taken into account, as follows:

- the prevalence of the traditional agricultural economy among the local community (primarily reindeer breeding and herding as well as fisheries and fish processing) that largely relies on customary skills of the indigenous population;
- the lack of qualified labour resources among indigenous population with the required technical skills;
- Indigenous Peoples can often demonstrate ambivalent attitudes towards full-time work for the Project and may struggle to adapt themselves to routine working hours.

Extensive recruitment of indigenous peoples by the Project may pose a number of risks/impacts to both the IP community and the Project. Such risks include erosion of the traditional IP lifestyles in the area, and also difficulties in individual indigenous people adapting successfully to regular work patterns. This latter issue can lead to both:

- stress to individual indigenous people as they strive to adapt to an unfamiliar lifestyle; and
- low retention of IP workers (e.g. if they return to traditional seasonal activities) leading to increasing training costs and impacts on schedule.

For the abovementioned reasons, as well as taking into account the existing background settings, Yamal LNG will adopt the following approach to recruitment:

- *Qualified* local workers are considered for Project employment on a first priority. Those locals who are available and willing for full-time qualified employment can apply for a position in Yamal LNG using a range of application channels (see above), they are added to the database and then contacted;

- *Semi-, low- and unqualified*[39] local workers from the nearest settlements (Tambey, Seyakha, Yar-Sale) still have a priority over imported workers to fill positions which do not require high level of skills (transport works, sanitary and domestic services, electricians, plumbers, mechanics, etc.). Such positions are not typically available directly with Yamal LNG during construction, but jobs of this type are more available within the contractors' workforces. The Company is not formally able to require contractors to hire local (including indigenous) people, but the Company uses various incentive mechanisms to encourage them to do so. For instance, use of local candidates' database is a very helpful and efficient tool employed by both YLNG and its contractors in order to increase the number of local workers.
- Yamal LNG will aim to *only hire indigenous population* for those activities which do not conflict with the traditional lifestyle (positions with flexible working hours and possibilities for long-distance traverse across the license area - e.g., control of reindeer crossings' use, environmental and cultural heritage monitoring, working as guides during execution of further field research in the area, etc.). Non-indigenous population will be considered for such roles *only* in the event when it is impossible to hire IP with the sufficient level of capabilities.
- In order to provide host community representatives willing to work for the Project with necessary skills to perform more complex work assignments Yamal LNG intends to create opportunities for professional training in specialized educational institutions of both the Yamalsky district and YNAO. This will contribute to the prevention of potential competition-based conflicts between the local population and economic migrants who offer skilled services. A comprehensive 'Program for recruitment and professional training' is to be developed by the end of 2014.

Employment of Disabled People

Under the RF legislation, disabled people should make up a minimum of 2% of each company's total headcount.

The currently agreed annual quota for disabled people employment by Yamal LNG for 2013 is a minimum 2 workplaces.

Since the construction site uses rotational work patterns and the majority of job positions are of a potentially hazardous nature performed in harsh climatic conditions, it is planned to provide workplaces for disabled persons in other third party companies in YNAO through appropriate employment creation agreements that include provisions for social benefit packages similar to those offered by Yamal LNG. To this end, Yamal LNG regularly cooperates with the Yamalsky District Job Centre.

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[39] Semi-, low- and unqualified job positions are those which, as opposed to skilled work, do not require a candidate to have a higher education.

Taking into account that in October 2012 only 5 disabled persons were registered as unemployed in Yamalsky District (see Chapter 8 for details), the Company's contribution to employment of disabled is substantial.

Enhancement Measures

Employment impacts associated with the Project are generally assessed as **beneficial**. To reinforce this positive influence, the following enhancement measures will be implemented:

- Development and regular update of the 'Program for recruitment and professional training' covering all recruitment procedures, types of training offered by the Company, as well as the exact employment targets set for the short- and long-term prospects of the Project implementation;
- Preferential recruitment of employees from the local population, including indigenous population, guaranteed by use of a local candidates' database before interviewing any non-local candidate;
- Provision of vocational/skills training and professional development opportunities for the local workforce (especially youth) to build and strengthen their capabilities and reinforce their competitive position;
- Interaction with YNAO and the Yamalsky District educational institutions for cooperation in professional training provision and engagement with recent graduates;
- Development of a mechanism to encourage contractors to recruit locally for semi-, low- and unqualified positions;
- Primary employment of indigenous population on those work positions which do not conflict with the traditional lifestyle (e.g., control of reindeer crossings' use, environmental and cultural heritage monitoring, working as guides during execution of further field research in the area, etc.). Non-indigenous population will be considered for such roles only in the event when it is impossible to hire IP with the sufficient level of capabilities;
- Appointment of a dedicated person (Senior Liaison Officer) within the Company who is based in Yar-Sale and whose responsibilities include coordination of local recruitment processes on the ground, including assistance in interaction between various institutions involved in the process (such as local job centres, Project liaison offices, and contractors' HR departments) and potential candidates;
- Annual employment of disabled – not less than 2% of the Company's total headcount.

Assessment of Residual Impact

Yamal LNG Project will have a **Beneficial** impact on direct employment primarily thanks to the high demand for construction manpower and the Company's special emphasis on recruiting local (incl. indigenous) population where possible and without compromising the Project's rigorous quality standards.

10.5.1.2 INDIRECT EMPLOYMENT AND SPIN-OFF EFFECTS

Description of the Impact

The construction phase of the Yamal LNG Project is expected to have a long-term positive influence on the local economy and the creation of indirect job opportunities through a number of mechanisms:

- *Financial inflow into the RF State budgets at different levels (local/regional/Federal) from Yamal LNG tax payments*.

  Significant amount of taxes will be paid to the district and regional budgets. Taking into consideration the generally low levels of industry and associated tax generation in the YNAO and Yamalsky District, the positive economic impact of the Yamal LNG Project is substantial.
- *Cooperation with local/regional suppliers*. In accordance with Yamal LNG policies, selection of goods and services suppliers is performed through a tender process. The main criteria taken into consideration are technical and manufacturing capabilities, pricing and origins of the bidder company (local/regional/Federal/foreign). However, under otherwise equal conditions, preference is given to local/regional suppliers[40]. A general intention to use local businesses is also enforced by the Yamal LNG Policy on Social Responsibility[41]. This approach serves to positively impact the local and regional economies and stimulate development of local markets;
- *Creation of indirect job positions by implementation of the Program for Seyakha Settlement Development for 2011-2015.* As part of this modernisation initiative, a range of social and municipal infrastructure facilities will be constructed in Seyakha (including power and water facilities, transport infrastructure, bakery store, a trade/retail unit, a sports centre and a bath-house), which will be operated and maintained by representatives of local population;
- *Support of the local medium and small business sector* as part of the 'Engagement and Support Program for Indigenous Population of the Yamal District' (in cooperation with the Municipal Administration of Yamal District and the Yamal District Public Association of Indigenous Minorities of the North "Yamal"). The Program covers construction of facilities for processing products of the traditional economy (e.g. a new factoria, fish processing plant, meat processing workshop and trade units) and purchase of reindeer meat and fish from local manufacturers for the needs of the Project workforce.

Enhancement Measures and Assessment of Residual Impact

Given that Yamal LNG continues implementation of its declared intentions and execution of commitments undertaken, additional enhancement measures in this field are not envisaged. Overall Project impact on local economy and indirect job creation is considered **Beneficial.**

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[40] It should be noted though that participation of local businesses is often limited as substantial part of materials and equipment in not manufactured in the Russian Federation, especially locally.

[41] Политика социальной ответственности ОАО «Ямал СПГ».

10.5.1.3 POST-CONSTRUCTION WORKFORCE DEMOBILISATION

Description of the Impact

As the Yamal LNG Project moves towards its full operations phase in 2019, there will be a rapid decrease in the workforce requirement from a peak of nearly 14,000 workers in 2015-2016 during construction (including both the Yamal LNG workforce and the contractors' employees) to 1,500 full-time workers during the operation phase. This decrease will largely involve demobilisation of construction contractor personnel.

Yamal LNG will require that all construction contractors demobilise their workforce in an organised and structured manner upon completion of the planned construction works. This requirement will not only stipulate the need for the coordinated demobilisation of manpower from the license area, but also the repatriation of non-local workers at the end of the assignment to their place of origin/domicile or to a location of their initial recruitment. This approach will help to avoid uncontrolled congregation of workers in the Project locality after their contractual assignments come to an end (e.g. to search for alternative employment opportunities in the area).

Taking into account the pre-planned nature of demobilisation, and at the same time the limited timescale in which a large workforce is to be demobilised, the unmitigated impact is assessed as **Moderate**. The Project will aim to reduce this impact through a range of mitigation measures as described below.

Mitigation Measures

The following measures will be implemented to ensure controlled and effective workforce demobilisation at the end of the construction phase:

- Construction workers' labour contracts will clearly stipulate the duration of their contractual assignment and that demobilisation will be implemented upon completion of the assigned works. This will enable the workers to plan in advance and to make alternative arrangements where necessary;
- As part of demobilisation, construction personnel will be provided with air transport from the Project site to the nearest transport hub to facilitate their return back to their designated places of origin and also to discourage them from remaining on the Project site or in the local communities in search of other possible job opportunities;
- Yamal LNG intends to avoid Collective Dismissals (as defined in the IFC Performance Standard 2) and to ensure that large numbers of workers are not retrenched simultaneously where possible; and
- The construction workforce will be demobilised from the licence area in an organised manner after the completion of construction.

Assessment of Residual Impact

Taking into account the mitigation measures described above, the residual adverse impact associated with post-construction workforce demobilisation is assessed as **Low.**

10.5.2 COMMISSIONING AND OPERATIONS

10.5.2.1 DIRECT EMPLOYMENT

Description of the Impact

YLNG workforce

The operation phase of the Project is characterized by a noticeably increased demand in highly qualified workforce. Nevertheless, the nature of the Project impact on direct employment during the operation stage will be generally similar to the construction stage. Throughout the operation phase and through to decommissioning, Yamal LNG will:

- Maximize the proportion of local recruitment where possible by use of a local candidates' database before interviewing any non-local candidate;
- Continue applying its labour management, hiring/recruitment and training policies and procedures as described above;
- Hire labour in strict compliance with the RF labour legislation, ILO standards and IFC Performance Standards' requirements.

Contractors' Workforce

During the operation phase Yamal LNG will cooperate with a number of contractors providing small-scale auxiliary services (e.g. medical support, maintenance, laundry, catering, security, cleaning, road and environmental maintenance, etc.). This will result in the creation of limited additional job positions, mainly of a semi- and low-skilled nature.

Similar to the construction phase, Project contractors during the operation phase will be selected through a multi-factor tender process, where the local provenance of the bidder will be considered as an advantage (under otherwise equal conditions).

Yamal LNG is currently formally unable to require contractors and suppliers to preferentially hire local (including indigenous) people. However, the Company uses various incentive mechanisms to encourage them to do so and this is expected to be functioning by the operation phase.

Employment of Indigenous People and Disabled

Due to the increased Project demand in highly skilled workforce in the operation phase and the lack of qualified labour resources among the local (especially indigenous) population, extensive local recruitment is not expected.

However, the local population will still receive preferential treatment in filling semi-, low- and unqualified job positions. Similar to the construction phase, preferential employment of indigenous peoples will be guaranteed by use of a special database of local candidates before recruitment of any non-local person. In addition, relevant training opportunities will be provided to those locals who are willing to perform more complex Project work assignments in future. Certain job positions which do not conflict with the traditional lifestyle (positions with flexible working hours and possibilities for long-distance traverse across the license area - e.g., control of reindeer crossings' use, environmental and cultural heritage monitoring, working as guides during execution of further field research in the area, etc.) will be offered solely to indigenous representatives. Non-indigenous population will be considered for such roles only in the event when it is impossible to hire IP with the sufficient level of capabilities.

Workplaces for disabled people will also continue to be provided throughout the whole Project life cycle in the number of minimum 2% of the Company's total headcount.

Enhancement Measures

Most of the enhancement measures applied to reinforce the positive Project impact on direct employment during the operation phase will replicate those employed during the construction phase, as follows:

- Preferential recruitment of employees from the local population, including the indigenous population guaranteed by use of a local candidates' database before interviewing any non-local candidate;
- Interaction with YNAO and the Yamalsky District educational institutions for cooperation in professional training provision and engagement with recent graduates;
- Provision of vocational/skills training and professional development opportunities for the local workforce;
- Use of incentive mechanisms to encourage contractors to recruit semi-, low- and unqualified workers locally;
- Primary employment of indigenous population on those work positions which do not conflict with the traditional lifestyle (e.g., control of reindeer crossings' use, environmental and cultural heritage monitoring, working as guides during execution of further field research in the area, etc.). Non-indigenous population will be considered for such roles only in the event when it is impossible to hire IP with the sufficient level of capabilities;
- Annual employment of disabled – not less than 2% of the Company's total headcount.

Assessment of Residual Impact

The Project impact on direct employment on the operation phase is assessed as **Beneficial**, however with due account to a lower number of staff being in demand by both Yamal LNG and its contractors, as well as a stronger requirement for high-skilled workforce.

10.5.2.2 INDIRECT EMPLOYMENT AND SPIN-OFF EFFECTS

Description of the Impact

During the operation phase Yamal LNG will continue implementation of activities that are expected to have a positive long-term influence on both the local economy and creation of indirect job positions, as follows:

- Regular tax payments to the local and regional State budgets;
- Collaboration with the local businesses (small-scale supplies of goods and services) - wherever feasible and without jeopardising the Project delivery requirements;
- Purchase of reindeer meat and fish from local manufacturers for the needs of the Project workforce.

In addition, the positive impact resulted from the development of social and municipal infrastructure facilities in Seyakha, as well as facilities for processing and realization of products of traditional economy during the construction phase will also persist during the whole Project life-span.

Assessment of Residual Impact

The residual Project impact on the regional economy and indirect employment during the operation phase is assessed as **Beneficial**, though it will be more prolonged but less intense in its nature compared to the construction phase.

10.5.3 SUMMARY IMPACT TABLE

Table 10.5.4: Summary of Economy and Employment Impacts and Mitigation/Enhancement Measures

Impact	Receptor	Phase	Design, Mitigation and Enhancement Actions	Residual Impact
Direct Employment	Project workforce and the local communities in the Project Area of Influence	Construction	• Development of the 'Program for recruitment and professional training'; • Appointment of a person (Senior Liaison Officer) within the Company whose responsibilities include coordination of local recruitment process on the ground.	Beneficial
Direct Employment	Project workforce and the local communities in the Project Area of Influence (incl. indigenous people and disabled)	Construction / Operation	• Preferential recruitment of employees from the local population (including indigenous population) guaranteed by use of a local candidates' database before interviewing any non-local candidate; • Interaction with YNAO and the Yamalsky District educational institutions for cooperation in professional training provision and engagement with recent graduates; • Provision of vocational/skills training and professional development opportunities for local workforce; • Development and use of incentive mechanisms to encourage contractors to recruit semi-, low- and unqualified workers locally; • Primary employment of indigenous population on those work positions which do not conflict with the traditional lifestyle (e.g., control of reindeer crossings' use, environmental and cultural heritage monitoring, working as guides during execution of further field research in the area, etc.). Non-indigenous population will be considered for such roles only in the event when it is impossible to hire IP with the sufficient level of capabilities;	Beneficial

Table 10.5.4: Summary of Economy and Employment Impacts and Mitigation/Enhancement Measures

Impact	Receptor	Phase	Design, Mitigation and Enhancement Actions	Residual Impact
			• Annual employment of disabled people – not less than 2% of the Company's total headcount.	
Post-Construction Workforce Demobilisation	Project workforce	Post-Construction	• Construction workers' labour contracts will clearly stipulate the duration of their contractual assignment and the fact that demobilisation will be implemented upon completion of the assigned works; • As part of demobilisation, construction personnel will be provided with air transportation from the Project site to the nearest transport hub; • Yamal LNG intends to avoid Collective Dismissals (as defined in the IFC Performance Standard 2) and to ensure that large numbers of workers are not retrenched simultaneously where possible; • The construction workforce, including the contractors, will be demobilised from the licence area in an organised manner after the completion of construction.	Low

10.6 LAND USE

Land use in the Licence Area and surrounding area is described in Chapter 8, and primarily includes use by nomadic indigenous peoples for reindeer herding, fishing and gathering. The nature of the potential Projects impacts on these land use activities is summarised in Table 10.6.1 below.

Table 10.6.1: Project aspects leading to impacts on land

Aspect/Project Component	Potential Impact
Construction Phase	
Land take for Project facilities	Physical loss of pasture lands and gathering areas
Reinstatement of legacy waste and contamination	Return of areas to reuse by indigenous peoples
Installation of linear Project features	Reduced access to pasture lands, fishing and gathering areas Blockage of migration routes Physical loss of pasture lands and gathering areas
Construction activities (including water abstraction, sand dredging and river crossings) in the vicinity of freshwater bodies	Damage to fish stocks
Operational Phase	
Land take for Project facilities	Physical loss of pasture lands and gathering areas
Installation of linear Project features	Reduced access to pasture lands, fishing and gathering areas Blockage of migration routes Physical loss of pasture lands and gathering areas
Air emissions during operation of site facilities	Nitrogen deposition and air quality impacts on lichen pasture lands

In addition to the aspects identified above, the Project also has the potential to impact indigenous peoples using the licence area in terms of the following aspects, all of which are assessed in other sections of this Chapter or other relevant ESIA chapters and are therefore not discussed further in this section:

- The Licence Area includes a number of sites of cultural and spiritual importance to the indigenous peoples that use the area. Potential Project impacts on these cultural aspects are assessed in Section 10.7.
- The health, safety and security aspects of interactions between Indigenous Peoples/their reindeer and Project facilities, construction activities and Project workers are assessed in Section 10.2.

- The economic and employment impacts (positive and negative) that the Project may have on the indigenous peoples that utilise the lands in the Licence Area are assessed in Section 10.5.

A description of the ecosystem services upon which local population's wealth and individual well-being depends is provided in Chapter 7. Impacts on these ecosystem services are described in this chapter, including:

- Provisioning services, including:
  - Livestock (i.e. reindeer – see below)
  - Capture fisheries (including informal fishing – see 'land use for fishing and gathering' below)
  - Wild foods (including gathering of berries - see 'land use for fishing and gathering' below)
  - Hunting (see 'land use for fishing and gathering' below)
- Regulating services:
  - Water regulation - see Section 10.3.1.3 above
- Cultural services – these are assessed in Section 10.7.

10.6.1 CONSTRUCTION PHASE

Description of the impact

Key usage of the Licence Area by nomadic indigenous peoples comprises (see Chapter 8 for further details):

- Each autumn reindeer communities migrating south toward the slaughter facilities in Seyakha[42]. Two of these routes cross the Licence Area (see Figure 10.6.1):
  - Route #1, which runs roughly north-south through central portion of the Licence Area
  - Route #2 on the westerly edge of the Licence Area
- The Licence Area covers portions of pasture areas used by Ilebts community. The pasture areas are indicated on Figure 10.6.1, which also shows the typical circular migrations undertaken. In total 56 indigenous families use the Licence Area as part of their reindeer herding pastures.
- In addition to reindeer herding, some reindeer herders come to this area for seasonal fishing during the autumn. Reindeer herders also use the area for gathering of waterfowl eggs, wild berries and mushrooms in the summer-autumn seasons.

[42] See also chapter 8 and Figure 8.28 for more information on migration patterns.

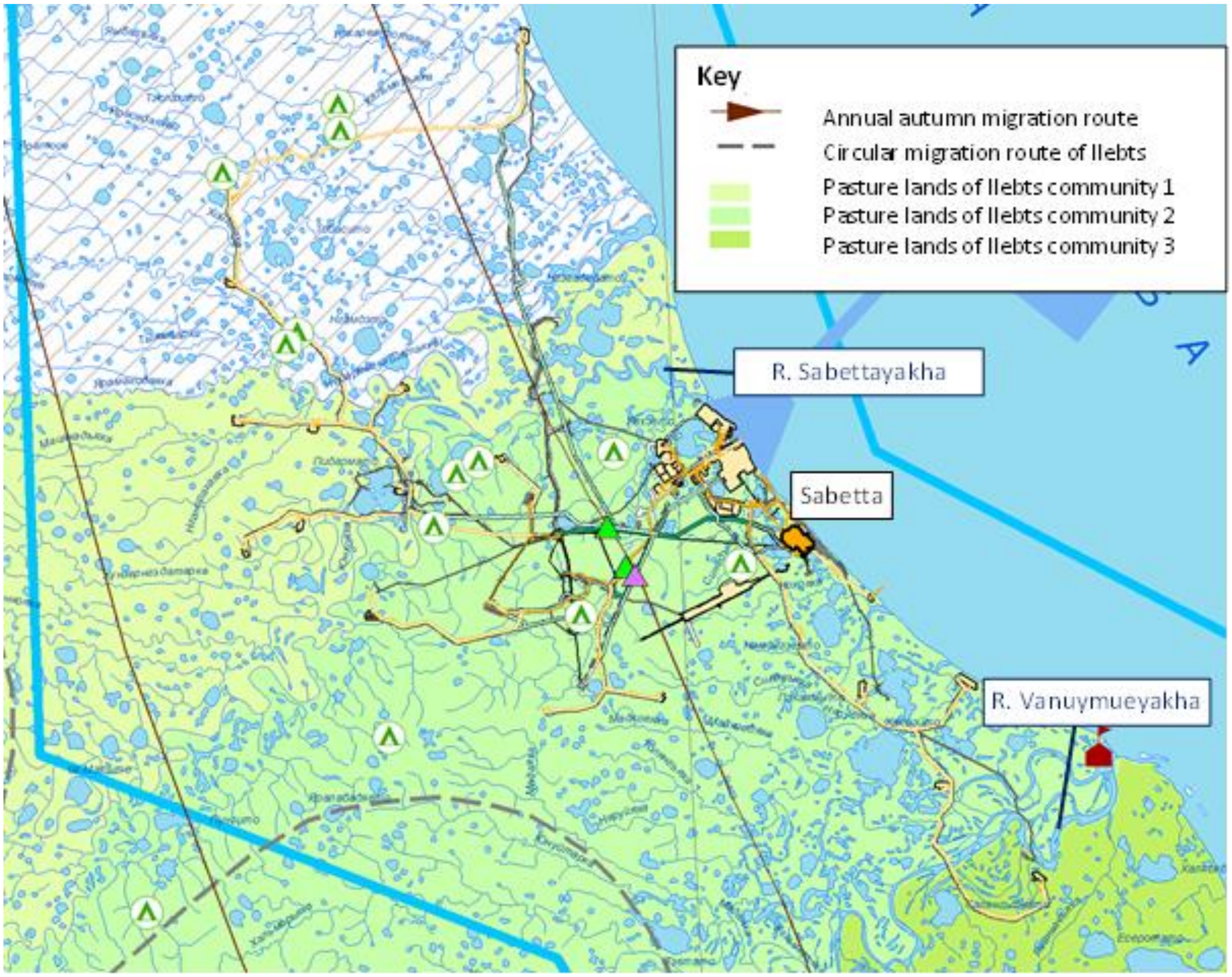

Figure 10.6.1: Land Use by Indigenous Peoples in the Licence Area

The potential impacts on each of these land use types are assessed in turn below.

<u>Annual autumn migrations (Routes #1 and #2)</u>

The annual autumn migration on Route #1 could be significantly affected where linear project facilities cross and block the main migration route. In this event, herders would need to alter their migration routes westward in order to progress to the slaughter facilities in Seyakha. This would lead to longer migration times, which in turn could lead to:

- Delays in reaching the slaughter facilities
- The reduced condition of the reindeer on reaching the slaughter facilities (due to the additional migration period and potential reduction in food resources en route – see also below)
- The potential for increased pressure on pasture grazing land to the west of the Project facilities – for example on lands already used by reindeers on migration Route #2.

Migration Route #2 is distant from the Project facilities and would therefore not be directly affected by the construction of Project facilities. However, indirect effects could occur in the event that migration Route #1 was diverted westward towards Route #2 as described above.

Without mitigation, these impacts could potentially be **High**.

Ilebts Pasture Areas

The use of the Licence Area by the Ilebts communities (1, 2 and 3 – see Figure 10.6.1) will be affected by both the physical loss of pasture land and potentially blockage of access by linear facilities (leading to increased distances being required to reach certain pastures areas as the reindeer will need to be routed around such facilities). The portion of the pasture lands used by these communities is small relative to their total pasture areas (especially communities 1 and 3) and the total number of families and reindeer using the area is low. Nonetheless, without mitigation these impacts could be potentially **moderate**.

Land use for fishing and gathering

Commercial[43] and offshore fishing is prohibited in the Yamalsky district. However, indigenous peoples continue to fish without formally designated fishing grounds or special fishing permits. Reliable baseline information on these informal fishing practices is difficult to ascertain. According to the results of ethnological field studies conducted during the period from May through August 2013[44], traditional non-commercial fishing is focused on the estuaries of the rivers Sabettayakha and R. Vanuymueyakha. Reportedly, local people (exact numbers are unknown but roughly assessed as a few tens of individuals) come to these areas for autumn fishing. The research revealed that this type of fishing is not a subsistence activity (whereas reindeer herding is), but performed by locals mainly for diversification of their diet. Access to the Sabettayakha and Vanuymueyakha rivers will be retained, although without mitigation the pipelines could result in detours being necessary to access some portions of these rivers. Fishing may also be affected by any impacts to fish stocks resultant from Construction activities (including water abstraction, sand dredging and river crossings) in the vicinity of freshwater bodies.

Use of the Licence Area for wild plants gathering can be impacted by reduced access issues similar to those described above for reindeer herding. However, it is noted that berry-gathering habitats are wide spread across the licence area.

Overall, without mitigation the impacts on fishing and gathering are assessed as **Moderate**.

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[43] Ilebts commune used to have permits for commercial fishing for two certain areas but these permits are expired now. Currently such permits for commercial fishing are not issued in Yamal'skiy District by the State.

[44] “Research of Traditional Nature Use and Ethno-Cultural Environment within the Area of Influence of the South Tambey Gas Condensate Field Development Project. South Tambey License Area”, "Yamal LNG" JSC, Moscow-Sabetta-Petersburg 2013, prepared by FRECOM

Mitigation

The primary measures to mitigate the impacts of reduced access are:

- Installation of reindeer/herder crossing points at strategic locations along linear facilities that will allow safe passage of both herders and reindeer. Specific aspects of the design of crossing points to ensure the safety of reindeer and herders are described in Section 10.2. In total 13 crossing locations were preliminarily proposed and their indicative locations are shown in Figure 10.6.2 below. The location of crossing points was discussed with MOP Yamalskoye (as the main land user and an umbrella organisation for all local communities, and which provides direct or indirect employment for all of them). Prior to giving approval to Yamal LNG's proposed crossings locations, the Head of MOP Yamalskoye checks with heads of communities if the locations are sufficient for all of them. This procedure was approved in December 2012 during Yamal LNG's meeting with all key local stakeholders, including MOP Yamalskoye, Valama, SOH Yamal, Tusyada and Ilebts. However, in the midst of 2014 owing to some changes in project design the process of clarification of crossing locations has been started. Wide consultations with reindeer herders are planned to be held in September-October 2014 when all heads of communities will be available.
- Local reindeer herders and indigenous communities will continue to be consulted, to further ascertain their requirements for ensuring access and the right of passage within across the Project boundaries.
- The foot print of the Project facilities will be minimised (see also Chapter 9)
- Reinstatement of legacy waste and contaminated areas within the Licence area (see also Chapter 11) will return previously unusable areas within the Licence Area back into potential use by indigenous peoples.

Potential impacts to fish stocks from construction activities are mitigated through the application of good construction practices as described in Chapter 9, which include:

- Use of filters on water abstraction pipes
- Treatment of all discharge waters to meet discharge standards for fishery waterbodies
- Erosion control practices to prevent sedimentation inflows into water bodies
- Use of single-span bridges over rivers to avoid the need for construction works within the water bodies.

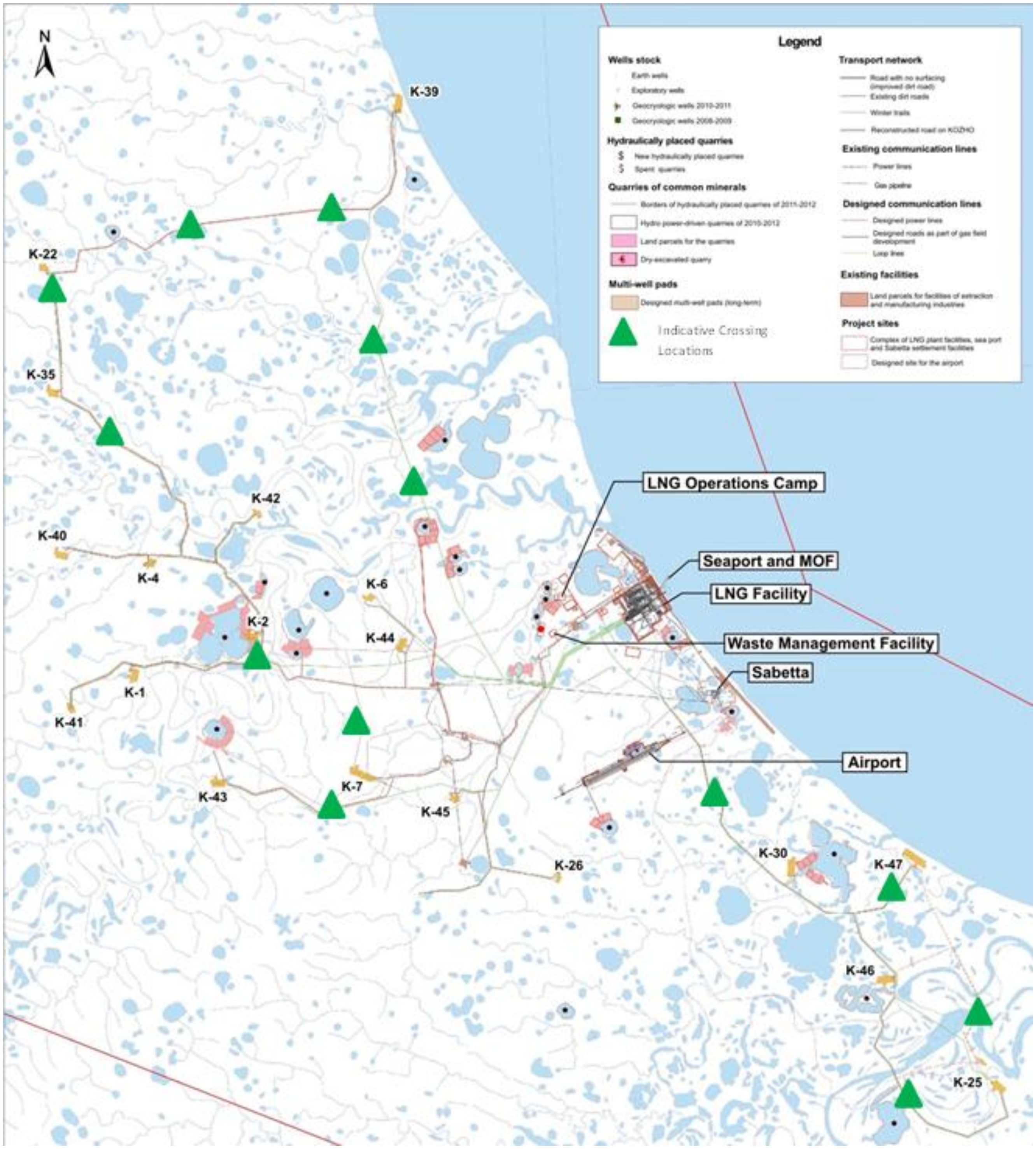

Figure 10.6.2: **Indicative location of proposed crossing locations**

Residual Impact

With the adoption of the above mitigation controls, access to reindeer herding/migration, fishing and gathering are assessed as **Low**.

10.6.2 COMMISIONING AND OPERATION

Impacts associated with access to herding, fishing and gathering areas during operation will be similar to those during construction and hence the residual impacts are assessed as **Low**.

However, during operation, air emissions also have the potential to impact on reindeer pasture lands through increased levels of ambient NO_x and associated nitrogen deposition, both of which can adversely affect lichen. These impacts have been assessed in detail in Chapter 9, which assessed the impacts as **Low** based on the predicted low NO_x air concentrations and nitrogen deposition rates in comparison to Project air quality standards and critical nitrogen loads respectively.

10.6.3 APPLICABILITY OF THE INVOLUNTARY RESETTLEMENT AND ECONOMIC DISPLACEMENT METHODOLOGICAL FRAMEWORK

According to the IFC PS5, involuntary resettlement refers to both physical displacement and economic displacement. PS5 defines physical displacement as relocation or loss of shelter. Economic displacement is defined as loss of assets or access to assets due to project-related land acquisition or restriction on land use and that leads to loss of income sources or other means of livelihood. The impacts of the Yamal LNG Project on reindeer herders do not constitute either physical or economic displacement under the PS5 definitions for the following reasons:

- The total area taken for the construction of the Project facilities is 1,419 hectares, including 623 hectares of land on short-term lease (after construction period the land will be restored and become suitable for further use by local communities) and 796 hectares on long-term lease (operations phase). The total area of the South Tambey license field is over 190 thousand hectares, so the Yamal LNG objects allocation area is less than 1% of the total South Tambey License Area. The reindeer herders can still use the rest of the Project Licence Area. Therefore, the territory occupied by the Project and potentially taken from economic use of the herders is negligible;
- No physical relocation of local residents is required by the Project design;
- Reindeer herders did not use the land of the Project footprint prior to Project construction as it was already largely a brownfield area and not suitable for grazing. Therefore, the land occupied by the Project is not considered as source of income for the herders;
- The primary measures to mitigate the impacts on nomadic herders' lifestyle include installation of reindeer/herder crossing points at strategic locations along linear facilities that will allow safe passage of both herders and reindeer. Crossing locations were agreed with all key local stakeholders, including MOP Yamalskoye, Valama, SOH Yamal, Tusyada and Ilebts in 2012 and 2013. Specific aspects of the design of crossing points (including fencing) ensure safety of reindeer and herders; they can be used all-the-year-round. Therefore, the Project design

ensures that land which is considered by the herders as their productive assets is fully accessible for economic activities;

- Reinstatement of legacy waste and contaminated areas within the Licence Area will return previously unusable areas back into potential use by indigenous peoples.

Risks associated with economic displacement vary and can manifest themselves in a range of aspects, as indicated by IFC Guidance note 5. The relevance of these risks/aspects to the Yamal LNG Project is assessed below:

- Landlessness – partially relevant due to restricted access to land; however, as identified above, restricted land parcels were not in use by the herders prior to the Project start.
- Joblessness – not applicable due to beneficial nature of Project impacts on local job market;
- Homelessness – not applicable as no permanent dwellings are present in the area;
- Marginalization – not applicable as no changes in social stratification and traditional interpersonal ties are expected;
- Food insecurity – may be partially relevant due to restricted access to land and natural resources; however, as noted earlier, the territory occupied by the Project was not used by local herders for food production;
- Increased morbidity and mortality – partially relevant; however, the probability of occurrence of such impacts is assessed as low (see Section 10.2 for more details);
- Loss of access to common property and services – not applicable as no common property has been identified. In addition, access to the services (i.e. medical assistance, transportation) will be improved and hence overall impacts are likely to be beneficial;
- Social disarticulation – not applicable as disintegration of any social groups is not expected.

In view of the reasoning provided above, and with due consideration of the suggested set of mitigation measures, the economic displacement methodological framework is considered to be not applicable in case of the Yamal LNG Project.

10.6.4 SUMMARY IMPACT TABLE

Table 10.6.2: Summary of Land Use Impacts and Mitigation/Enhancement Measures

Impact	Receptor	Phase	Design, Mitigation and Enhancement Actions	Residual Impact
Reduced Access to reindeer Pasture lands	Ilebts herders and reindeer	Construction and Operation	• Installation of reindeer/herder crossing points at strategic locations along linear facilities that will allow safe passage of both herders and reindeer. Specific aspects of the design of crossing points to ensure the safety of reindeer and herders are described in Section 10.2. In total 13 crossing locations are currently proposed. • Local reindeer herders and indigenous communities will continue to be consulted, to further ascertain their requirements for ensuring access and the right of passage within across the Project boundaries. • The foot print of the project facilities will be minimised (see also Chapter 9) • Reinstatement of legacy waste and contaminated areas within the Licence Area (see also Chapter 11) will return previously unusable areas with the Licence Area back into potential use by indigenous peoples.	**Low**
Blockage of annual migration routes	Route #1 Reindeer and herders	Construction and Operation	• Installation of reindeer/herder crossing points at strategic locations along linear facilities that will allow safe passage of both herders and reindeer. Specific aspects of the design of crossing points to ensure the safety of reindeer and herders are described in Section 10.2. Preliminarily agreed and proposed crossing locations are identified on Figure 10.6.2 above.	**Low**
Reduced	Reindeer	Construction and	• Installation of reindeer/herder crossing points at strategic	**Low**

Table 10.6.2: Summary of Land Use Impacts and Mitigation/Enhancement Measures				
Impact	**Receptor**	**Phase**	**Design, Mitigation and Enhancement Actions**	**Residual Impact**
access to fishing and gathering areas	herders	Operation	locations along linear facilities that will allow safe passage of both herders and reindeer. Specific aspects of the design of crossing points to ensure the safety of reindeer and herders are described in Section 10.2. Preliminarily agreed and proposed crossing locations are identified on Figure 10.6.2 above. • Local reindeer herders and indigenous communities will continue to be consulted, to further ascertain their requirements for ensuring access and the right of passage within across the Project boundaries. • The foot print of the project facilities will be minimised (see also Chapter 9) • Reinstatement of legacy waste and contaminated areas within the Licence Area (see also Chapter 11) will return previously unusable areas with the Licence Area back into potential use by indigenous peoples.	
Reduced Fish stocks	Indigenous peoples fishing in the Licence Area	Construction and operation	• Use of filters on water abstraction pipes • Treatment of all discharge waters to meet discharge standards for fishery waterbodies • Erosion control practices to prevent sedimentation inflows into water bodies • Use of single-span bridges over rivers to avoid the need for construction works within the water bodies • For further mitigation controls see Chapter 9	**Low**
Nitrogen impacts on lichen	Lichen and reindeer	Operation	• See Chapter 9 for details	**Low**

10.7 CULTURAL HERITAGE

The impact assessment set out below describes how the Project will eliminate, minimise, mitigate, offset or compensate for impacts on both tangible and intangible cultural heritage. Each of these impacts is assessed in terms of the nature of the impact, the existing and planned mitigation measures, the potential significance of the impact and the residual significance after mitigation measures have been implemented.

Potential Project impacts on cultural heritage are essentially the same during the construction and operation phases as Project uses the same territory; therefore, this subsection is not divided by Project stages.

Table 10.7.1: Project aspects leading to impacts on cultural heritage

Aspect/Project Component	Potential Impact
Tangible Cultural Heritage	
All Project works involving ground intervention activities and earthworks that may result in transformation of terrain and disturbance of soil and subsoil layers during pre-construction, construction, commissioning and operations phases, including: • geotechnical surveys and ground/subsoil investigations; • geological drilling and groundwater drilling; • land clearance; • surface grading and levelling; • trenching for the network of gathering pipelines; • civil works and construction; • laying of surface and underground infrastructure, utilities and communication lines; • construction of temporary, access and intra-field roads; • incidental activities such as vehicle driving or parking outside appropriately marked and designated roads and parking areas.	Potential physical damage to previously identified tangible cultural heritage sites (both sacred sites and archaeological objects) Loss/limitation of access to previously identified tangible cultural heritage sites currently used by the local indigenous population (sacred sites) Potential physical damage to yet *un*identified tangible cultural heritage sites (both sacred sites and archaeological objects)
Presence of the large non-local workforce in the license area, consisting of non-resident construction contractor personnel during the construction stage, the Yamal LNG personnel during the operation stage, as well as the security	Potential physical damage to previously identified tangible cultural heritage sites (both sacred sites and archaeological objects) Potential physical damage to yet *un*identified

Table 10.7.1: Project aspects leading to impacts on cultural heritage	
Aspect/Project Component	**Potential Impact**
personnel during the whole Project life-span	tangible cultural heritage sites (both sacred sites and archaeological objects)
Intangible Cultural Heritage	
Presence of the large a non-local workforce in the license area, consisting of non-resident construction contractor personnel during the construction stage, the Yamal LNG personnel during the operation stage, as well as security personnel during the whole Project life-span	Disturbance to traditional lifestyles due to potential contacts between the indigenous population and a non-local workforce unfamiliar with the local conventions and customary modes of behaviour

Detailed information on the baseline conditions in the Project Area of Influence related to the cultural heritage is given in the Chapter 8, subsection 8.9.

10.7.1 TANGIBLE CULTURAL HERITAGE

Description of potential impacts

Most tangible objects of traditional cultural heritage located in the Project area of influence, such as sacred sites and sanctuaries, are elements of natural landscape, with the terrain, associated with certain religious and mythological conceptions of indigenous peoples being their main typological attribute. Therefore, the direct negative Project impact on local tangible cultural heritage may be connected either with physical damage caused to these objects or with loss/limitation of the IPs' access to these sites due to the Project facilities (both areal and linear), as well as establishment of the local transport network (access roads).

According to the YNAO Historical and Cultural Heritage Protection Agency, two cultural heritage sites listed in the Regional Historical and Cultural Heritage Registry are located in the Project licence area:

- The Hill of Heads ('Neycheda Sanctuary') – located in the Sabetta Camp area and comprises a round mound on top of which reindeer antlers and skulls are traditionally placed; and
- The Seven Little Mounds ('Siulortse') – consisting of the seven small mounds (with the height of 100-120 cm) on top of which rocks as well as reindeer antlers and skulls are placed.

During the period of May - August 2013 Yamal LNG conducted additional studies with the aim of identification of sacred sites that are of cultural and spiritual importance to the local population[45]. These studies covered the Project Licence Area and a 10km wide protection zone around the Licence

[45] "Research of Traditional Nature Use and Ethno-Cultural Environment within the Area of Influence of the South Tambey Gas Condensate Field Development Project. South Tambey License Area", "Yamal LNG" JSC, Moscow-Sabetta-Petersburg 2013, prepared by FRECOM

Area. The studies identified **11 sacred and specially worshipped sites** in total (including the abovementioned ones), seven of which are categorized as sacred sites and four are cemeteries[46]. According to the map below (see Figure 10.7.1), none of the identified sacred sites is expected to be physically impacted by the Project activities either during the construction or the operation phases as they do not overlap with the Project facilities.

[46] Detailed information on the exact location of these sites is given in Chapter 8, subsection 8.9.

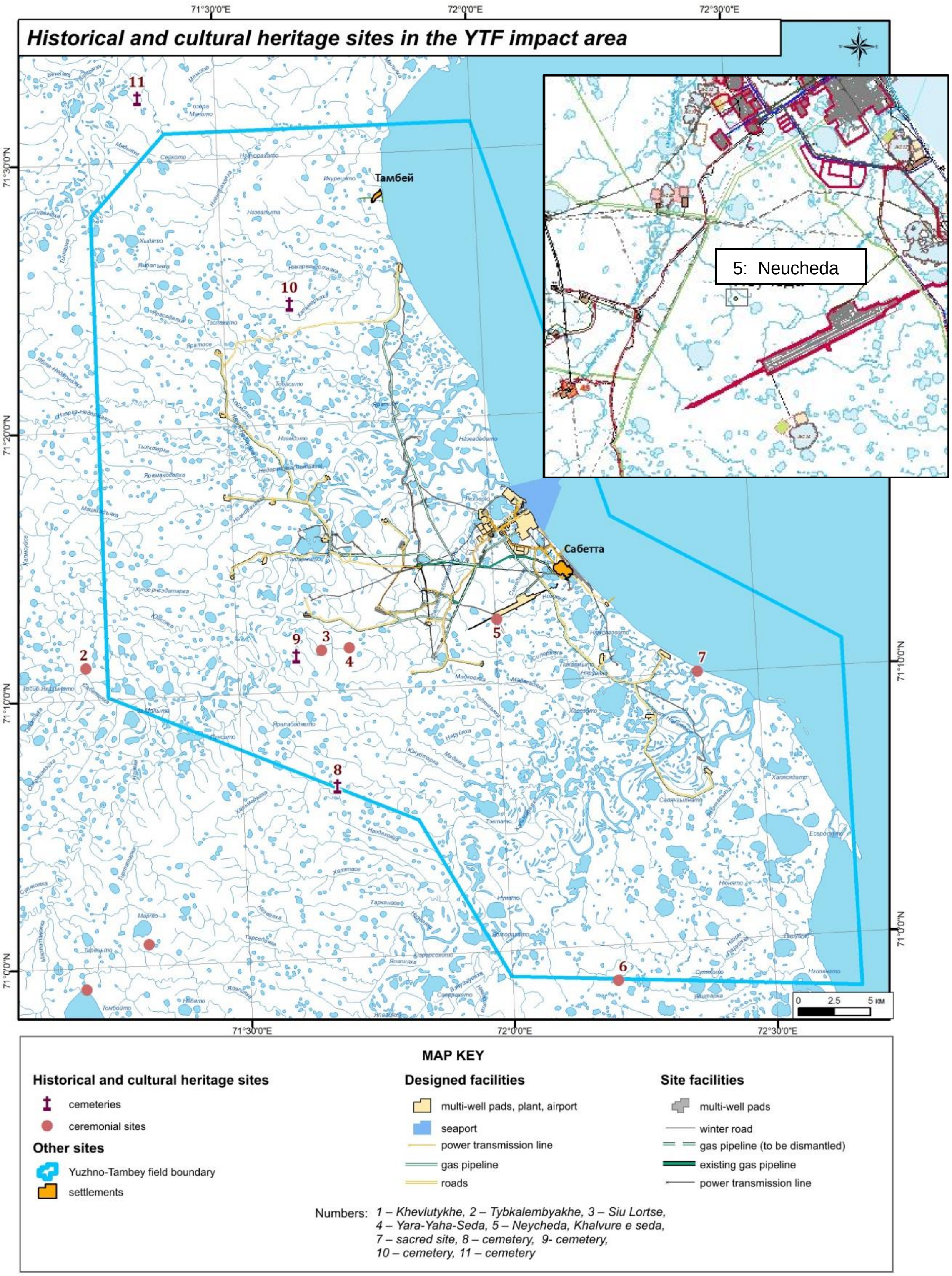

Figure 10.7.1: Location of sacred sites within the Project licence area and in the zone affected by the Project

As can be seen from the above map, two cultural sites are located in close proximity to the Project facilities, i.e. the Neucheda site (#5) 0.8-1 km distance and the Siu Lortse site (#4) 0.4 km distance from the Project assets. Despite the fact that the Project facilities does not directly overlap with those sites, such a short distance between them poses a potential risk of change to their physical layout (architecture of sacral space, religious sculpture/structures, specific religious symbols and attributes, etc.) for example due to possible actions by non-local employees working in the area who are unfamiliar with the status of these sites.

During May-August 2013 an archaeological survey of the South Tambey license area was also carried out[47]. In the process of this survey, 49 sites were investigated, **one new object of cultural heritage identified** and 65 stratigraphic cross-sections plotted. The identified object of cultural heritage was an ancient settlement - Salyangylnato 1 - located at the axis of the planned corridor for linear facilities to the well cluster #25. The planned corridor crosses the settlement site in the direction of NW-SE. Construction work in this area has the potential to damage or even completely destroy this cultural heritage object. In light of this, Yamal LNG has decided that the facilities corridor will be re-routed to bypass the Salyangylnato 1 site (see the orange contour on Figure 10.7.2).

[47] “Historical and Cultural Survey of Land Provided for the Facilities of the South Tambey licence area, the Yamal Region, Yamal-Nenets Autonomous Okrug, Moscow– Sabetta 2013”, developed by FRECOM

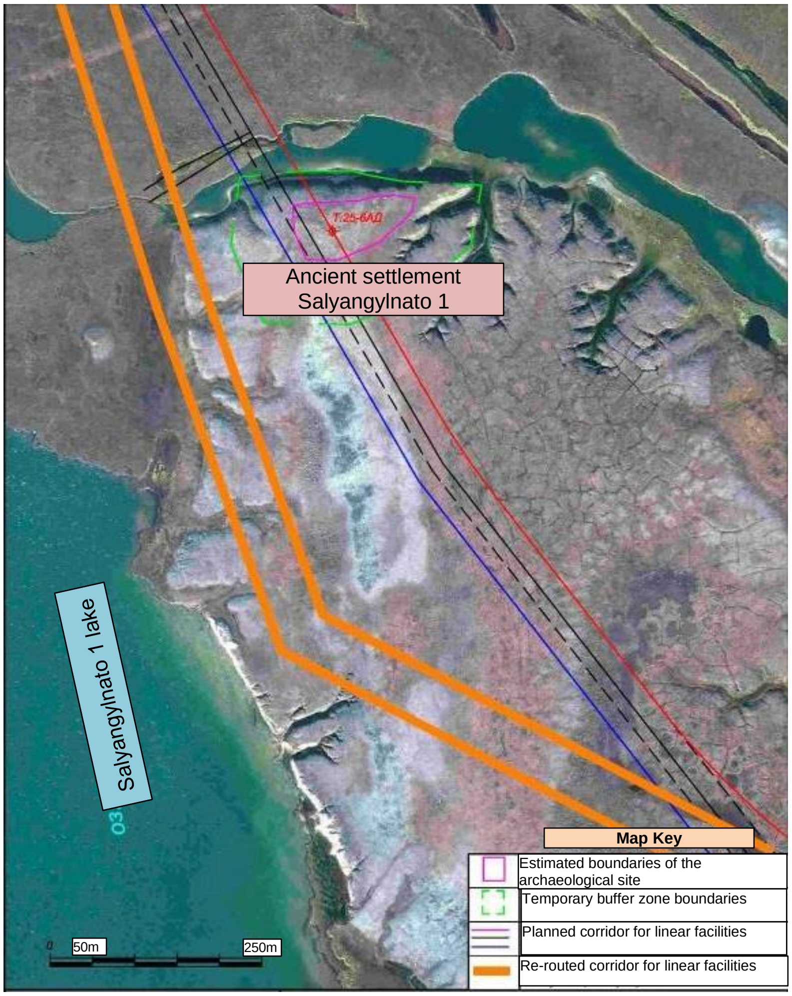

Figure 10.7.2: Location of the identified object of cultural heritage "Ancient Settlement Salyangylnato 1" in relation to the planned corridor route

Although Project facilities do not directly overlap with the abovementioned sacred sites and in case of Salyangylnato 1 the Project design solutions were reconsidered, the unmitigated risk related to potential physical damage of the identified objects is assessed as Moderate - mainly due to close proximity of some of these sites to the Project facilities and potential human factor.

Transformation of the terrain on the Project licence area may result not only in physical damage or destruction of the identified cultural sites, but also in loss or limitation of IPs' access to them. According to the map data available (see Fig. 10.7.1), due to the planned Project activities, access may be limited to two identified cultural sites – sacred site Neucheda (#5) and an unnamed sacred site #7 located directly on the Gulf of Ob coastline.

Figure 10.7.1 shows the location of the Neucheda sacred site in relation to the Project areal (Sabetta airport – see insert) and linear (access roads and pipeline network) facilities.

The IPs' access to the sacred site #7 is expected to be limited due to the Project linear infrastructure (pipelines to the well clusters #30, 47, 46, 25) encircling the cultural site from the West, and the

Vanuymueyakha River hindering the access to it from the South-East. However, during the winter months, when the river is frozen, access from the south-east will be possible.

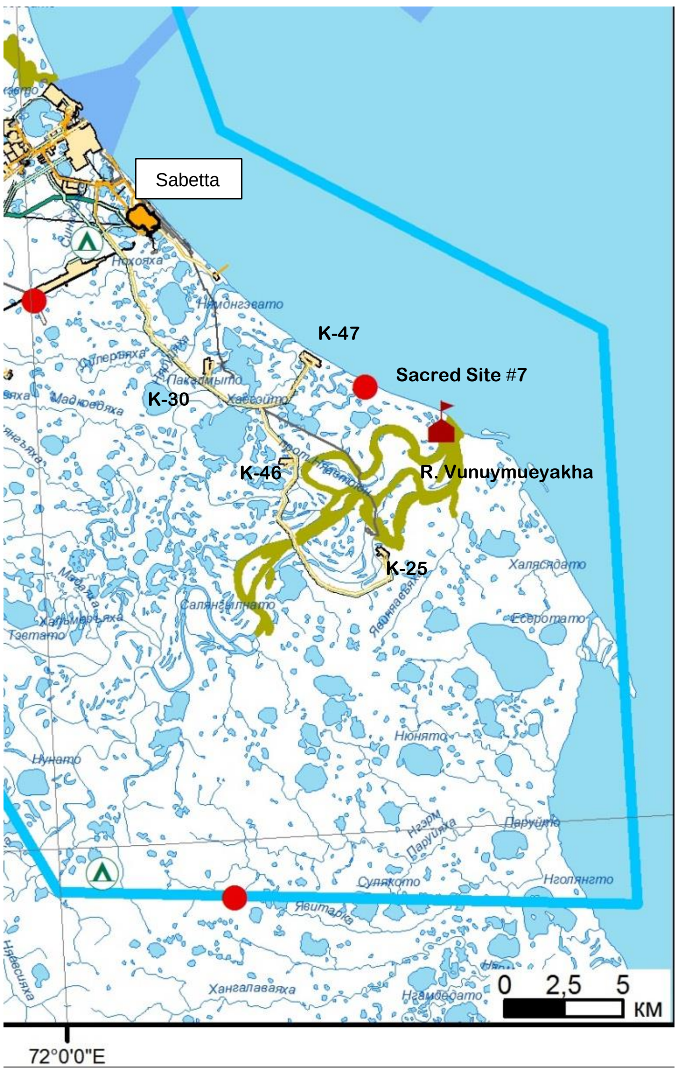

Figure 10.7.3: Location of the sacred site #7 in relation to the Project linear infrastructure

The ethno-cultural studies conducted on the Project Area of Influence in May-August 2013[48] confirm that a few cultural places located within the Licence Area are no longer visited by the local population due to the Project's industrial activities in the immediate vicinity to those sites (for instance, the studies specifically mention the Neucheda in this regard).

[48] "Research of Traditional Nature Use and Ethno-Cultural Environment within the Area of Influence of the South Tambey Gas Condensate Field Development Project. South Tambey License Area", "Yamal LNG" JSC, Moscow-Sabetta-Petersburg

In 2010 the Company obtained a positive expert review on the planned industrial activities on the area under consideration agreed by the Service for the Protection and Use of Cultural Heritage (YNAO)[49] Nevertheless, complete loss of the IPs' access to the sacred sites can be qualified as a violation of the RF legislation in force, which stipulates that any activity aimed at survey, investigation or use of such places and sites, is permissible provided it causes no damage to sacred sites and burial grounds of indigenous people and complies with the legal status of traditional use areas, i.e. does not prevent indigenous people from using these areas in accordance with their functional purpose.

If restrictions of access to the family/ kin sacred sites resulted from the Project may likely impact a limited number of the IPs migrating in the area, loss of access to the historical and cultural sites of regional importance (e.g. Neucheda sacred site) may, in the long term, jeopardize the preservation of the traditional culture and ethnic identity of Nenets population of the Seyakha/Tambey tundra as a whole.

In respect of the abovementioned aspects, the unmitigated Project impact related to limitation of access to the identified cultural sites is assessed as **Moderate.**

Finally, in 2013 the Company also undertook additional ethno cultural and archaeological studies[50]. Within the framework of these surveys, sites with both good and unlikely prospects for archeological discoveries[51] were investigated within the areas to be directly affected by the planned development in accordance with the provided Project design documentation, as well as an additional buffer area in line with regulatory requirements (namely within a range of 25 m at both sides of planned linear facilities and 50 m from the outlines of areal facilities).

The surveys also examined some objects outside of this zone, again in line with regulatory requirements. This focused on objects related to current customs and way of life of the indigenous peoples of the North, and in particular sites used for temporary and seasonal camps (*chum* camps), hunting tools (traps, etc.), ritual sites, burial grounds (*khalmers*). The surface of such objects was thoroughly examined, their location was determined with global positioning devices, and photographs were made. Therefore, the probability of identification of new cultural sites and archeological artefacts in the Licence Area during the construction works is considered low. The corresponding Project

[49] Conclusion of "The historical, cultural and archaeological expertise (cameral stage) of the area under consideration for industrial activities of Yamal LNG", agreed by the Service for Protection and Use of Cultural Heritage, YNAO 2010

[50] "Research of Traditional Nature Use and Ethno-Cultural Environment within the Area of Influence of the South Tambey Gas Condensate Field Development Project. South Tambey License Area", "Yamal LNG" JSC, Moscow-Sabetta-Petersburg and "Historical and Cultural Survey of Land Provided for the Facilities of the South Tambey licence area, the Yamal Region, Yamal-Nenets Autonomous Okrug, Moscow– Sabetta 2013", developed by FRECOM

[51] Sites with good prospects are those where the probability of finds is high; at sites with unlikely prospects the probability of finds is low, but potentially possible; sites with no prospects are those where there is no probability of discovery of any objects of cultural heritage due to specific landscape and topographic features or where any finds are impossible with the aid of conventional and commonly used methods of survey and existing technical means.

impact of physical damage/destruction of yet unidentified tangible cultural heritage sites (both sacred sites and archaeological objects) is therefore assessed as **Low**.

In summary, the unmitigated potential Project impacts on tangible cultural heritage are estimated, as follows:

- Potential physical damage to previously identified tangible cultural heritage sites (both sacred sites and archaeological objects) – **Moderate**
- Limitation of access to previously identified tangible cultural heritage sites currently used by the local indigenous population (sacred sites) – **Moderate**
- Potential physical damage to yet unidentified tangible cultural heritage sites (both sacred sites and archaeological objects) – **Low**

Mitigation measures

From the early stages of the ESIA process for the various project components, attempts have been made to 'design out' impacts to the ethno cultural sites and archaeological heritage for prevention of their physical damage and provision for continuous access of the local indigenous population to those sites. Wherever possible, changes have been made to the location of fixed project components and to the design of project linear facilities such as the roads and gas pipeline network. Other mitigation measures which will be undertaken by the Project to minimize negative impacts on tangible cultural heritage are described below.

Table 10.7.2: Tangible Cultural Heritage Impacts and Mitigation Measures

Potential Project Impact	Mitigation Measures
Potential physical damage to previously identified tangible cultural heritage sites (both sacred sites and archaeological objects) caused by location of Project facilities	Rerouting of the facilities corridor to the well cluster #25 to bypass the Salyangylnato 1 site.
Potential physical damage to previously identified tangible cultural heritage sites (both sacred sites and archaeological objects) inadvertently caused by Project workforce	• To provide measures for preservation of the identified archaeological site - ancient settlement Salyangylnato-1 as required by the RF legislation, including: ○ ○ Installation of safety signage and information billboards; ○ Prohibition of traffic, soil use, execution of any search and excavation works within the cultural site's buffer zone boundaries. • Strict enforcement of the Yamal LNG Worker Code of Conduct, including induction and regular refresher training for all personnel, control by responsible supervisors and the management of contractor companies, and application of prescribed disciplinary measures in case of breaches; • Strict compliance with the mandatory 'Accommodation Camp Policy' enforced through contractual obligations;

Table 10.7.2: Tangible Cultural Heritage Impacts and Mitigation Measures	
Potential Project Impact	**Mitigation Measures**
	• Provision for the cultural induction training for all construction personnel, including contractors.
Loss of access / limitation of access to previously identified tangible cultural heritage sites currently used by the local indigenous population (sacred sites)	• Establishment of appropriate crossing points over Project's linear infrastructure (incl. including the above-ground network of connecting gas pipelines, roads and near the power transmission towers) allowing continuous access of local indigenous population to the sacred sites currently being in use; • Continuous engagement with the IPs' representatives with the aim of identification of critical locations at Project's linear infrastructure for potential crossing points.
Potential physical damage to yet unidentified tangible cultural heritage sites (both sacred sites and archaeological objects)	• Implementation of the Yamal LNG Cultural Heritage Chance Finds Procedure

Mitigation measures related to the Project workforce (compliance with the Worker Code of Conduct, Accommodation Camp Policy, cultural induction training, etc.) are discussed in the subsection 10.7.2 below, whereas other mitigation measures to be undertaken by the Company include the following aspects that are described in turn below:

- Establishment of appropriate crossing points over Project's linear infrastructure for reindeer herders, and
- Implementation of the Cultural Heritage Chance Finds Procedure.

Reindeer herder crossings over the Project's linear infrastructure

As the Project roads and other infrastructure are being constructed, the establishment of appropriate crossing points allowing nomadic herders continuous access to the cultural sites is essential for the preservation of Nenets' traditional culture. Prior to construction, Yamal LNG undertook the preliminary identification of critical locations at Project's linear infrastructure where herder/reindeer crossing points are deemed necessary, including the above-ground network of connecting gas pipelines, roads and near the power transmission towers. The preliminary layout of the proposed crossings has been agreed with the head of the municipal reindeer breeding enterprise MOP 'Yamalskoye' that is the principal land user in the Project Area of Influence (the agreed location of crossings is indicated with green triangle signs on the Figure 10.7.4 below).

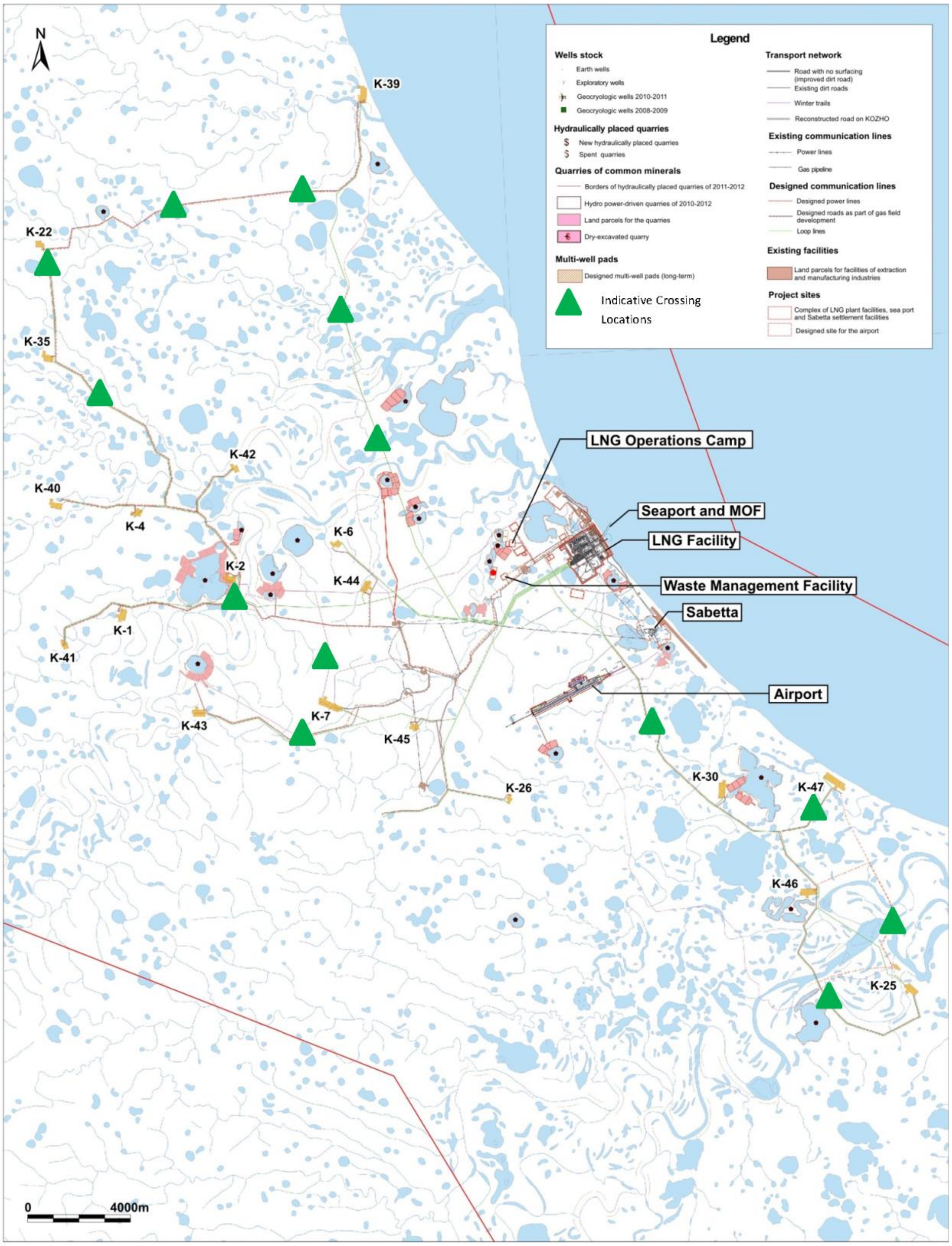

Figure 10.7.4: Location of the crossing points over the Project linear infrastructure

Development of the specific design for the crossings is currently underway, though the important aspects and features that are expected to be part of the crossings' design and related procedures are as follows[52]:

- Setting up flat-gradient berms on the roadsides to allow unhindered approach of the reindeer and herder sledges and their easy transfer onto the main surface of the road;
- Application of temporary traffic control measures at the crossings points on Project roads (flagmen) whenever heavy traffic is anticipated;
- Supervised regulation and stopping of traffic flow on the road sections at a safe separating distance from the crossing points (at least 5 m to nearest vehicles) for the entire duration of a cross-over. Reindeer and the herders must not be disturbed, harassed, hastened or in any way distracted during the cross-over process, and the undisrupted passage at their usual speed must be allowed. Excessive photographing, video recording, honking and making other loud sounds shall not be used during the cross-over in order not to frighten the reindeer and also in deference to herders' tradition. Drivers are advised to switch off vehicle engines while awaiting the passage to complete, in order to avoid extra air emissions and noise;
- Provision of a geotextile fabric cover on the road surface immediately prior to the actual cross-over to enable gliding effect as well as to prevent friction and a resultant damage to herder sledges, particularly when sledges are laden with migratory households' possessions;
- Advance coordination of the timings for herders' passage across the roads to ensure the presence of Project representative(s) supervising and assisting with the cross-over process as necessary;
- Provision of safety signage on the Project roads warning of the crossing locations and giving instructions on the applicable regulations (i.e. speed limit, herders' priority right-of-way);
- Crossing ramps will be erected over the ground-level (or buried) sections of the pipe to aid the passage. The embankments will be made of suitable material (e.g. earth fill) to ensure stability of the structure and proper drainage, as well as to allow ready passage of the reindeer and herder sledges.
- Provision of visible markings at the crossing points on the Project's linear infrastructure facilities to aid their noticeability. The crossing points will also be marked on the local maps and on the licence area plans (including the road route maps) to ensure the awareness of such features both by Project personnel, drivers and the nomadic herders traversing the area.

Yamal LNG will continue further consultations with the representatives of the local indigenous population with the aim of identification of critical locations at Project's linear infrastructure for potential additional crossing points[53].

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[52] The design of these structures should allow unhindered crossing for both humans and reindeer.

[53] This will be implemented as part of the engagement related to the preparation of an Indigenous Peoples Development Plan (IPDP).

Yamal LNG Cultural Heritage Chance Finds Procedure

For all areas where ground disturbance activities will take place, the Cultural Heritage Chance Finds Procedure[54] will be implemented. The Procedure is designed to ensure the safety, integrity and proper handling of any previously undocumented objects of cultural or historical significance, including archaeological artefacts and potential sacred sites. Observance of the Procedure is mandatory for all Yamal LNG employees and contractors.

- The objectives of the Cultural Heritage Chance Find Procedure are to provide step-by-step guidance in case any previously unknown or unrecorded sites, objects or features of cultural significance are encountered, as well as to ensure that such resources are appropriately safeguarded during Project pre-construction, construction, commissioning or operations phases.

In summary, the procedure stipulates that upon discovery of a Chance Find:

- All earth moving works be discontinued and immediate notification be issued to a supervisor overseeing works in the vicinity of a Chance Find, the Head of Field Operations (in Sabetta) and HSE Director (in Moscow);
- The find is logged and referenced by the site supervisor and YLNG responsible personnel which includes record of coordinates, location specifics, and general description of the find (observations; number of items found, names of observers etc. as appropriate). Initial photographs taken;
- Suitably qualified and competent person (e.g. archaeologist, anthropologist, ethnologist) attends the site in person to investigate the find and to provide instructions for further actions;
- If the find is confirmed as valuable, work remains ceased until full survey is undertaken and specific guidance obtained; if confirmed as non-valuable, item is safely removed and work recommences.

In order to ensure the effective implementation of the Chance Find Procedure and the protection of previously unrecorded cultural heritage resources from potential damage as a result of Project activities, the following measures will be implemented:

- Induction training shall be delivered to the Project workforce, including contractor personnel;
- A qualified expert (archaeologist, ethnologist or anthropologist) will be retained by Yamal LNG and will be authorised to provide comprehensive advice as per the Chance Find Procedure;
- Where appropriate, picture books, posters and other visual materials should be provided to facilitate familiarisation of the workforce with the typical cultural heritage resources in the Project Area;

[54] Cultural Heritage Chance Finds are defined as potential cultural heritage resources that are identified outside of or after the completion of formal site reconnaissance, survey and research activities. Cultural heritage chance finds may be made by any person or entity associated with the Yamal LNG Project

- Construction workers shall be explicitly barred from 'treasure hunting', i.e. deliberate search for potentially valuable material that can be used for trade, commercial exploitation or personal collection;
- All finds are part of national heritage and must stay in the "as found" condition and in the location of the find (in situ), i.e. shall not be removed;
- All finds must be reported in line with the Communications Protocol;
- All details of finds are deemed confidential and all details including coordinates, locations, content, etc. shall be communicated and handled with due care and discretion.
- All known sites, features or objects of cultural, historical and spiritual heritage will be avoided wherever possible, or appropriately managed through the application of prescribed protection measures.

- Additional detail on the actions expected from the Yamal LNG and the contractors' personnel in case of a chance find, as well as on documentation procedures, responsibilities for implementation and penalties for non-compliance are given in the Yamal LNG *"Cultural Heritage Chance Finds Procedure"* document.

Assessment of residual impacts

Following implementation of the mitigation measures described above, the severity of the residual impact on tangible cultural heritage objects is assessed, as follows:

- Potential physical damage to previously identified tangible cultural heritage sites (both sacred sites and archaeological objects) – **Low**
- Loss of access / limitation of access to previously identified tangible cultural heritage sites currently used by the local indigenous population (sacred sites) – **Moderate to Low**
- Potential physical damage to yet unidentified tangible cultural heritage sites (both sacred sites and archaeological objects) – **Low to Negligible.**

10.7.2 INTANGIBLE CULTURAL HERITAGE

Description of potential impact

Spiritual aspects of cultural heritage are primarily associated with the traditional way of life, rituals and habits of indigenous peoples of the North, as well as with their use of natural resources (hunting, fishing)[55] and are expressed, inter alia, through sacrifices offered to the "Masters of Nature" and guardian spirits of traditional trades while visiting the local sacred sites. The kin-ancestry cult, which is associated with the worship the family's guardian spirits and the departed spirits of ancestors is also manifested in rituals and ceremonies practised on both sacred sites and/or burial grounds (*khalmers*).

[55] Project impacts on the traditional nature use are discussed in the Subsection 10.6.

Thus, direct potential Project impacts on intangible cultural heritage comprise damage/destruction or loss/limitation of IPs' access to those areas that may physically prevent them from implementation of the traditional rituals and ceremonies. These aspects are discussed in the previous subsection.

Indirect Project influence on intangible cultural heritage, in turn, may result from the presence of non-local personnel and potential tensions/conflicts between workers and the host population, given that the local community may perceive the arrival of migrant workforce as intrusion and a threat to the traditional lifestyle, culture and the customary norms of conduct. This is likely to be exacerbated in situations where some members of the workforce are not sufficiently familiar with the local cultural imperatives, indigenous lifestyle and the specific standards of behaviour.

There is a low probability of frequent interaction between the local population and the Project workforce as all construction workers (including contractors) will be accommodated in closed camps in the licence area. Interaction is likely to be mainly limited to occasional encounters with nomadic herders. At the same time, interactions are more likely in the locality of Tambey Factoria, which is visited by the migratory indigenous population on a seasonal basis (mainly to procure foodstuffs and fuel).

A distinct source of potential stress is likely to be the interaction between the local communities and the Project's security force, though this is discussed in a separate subsection 10.2.3 above.

Overall, the potential impact on the intangible cultural heritage of the local communities resulting from occasional contacts between IPs and the Project non-local workforce is considered to be probable in the localised extent, i.e. mainly within the boundaries of the licence area. The duration of the associated adverse impact will be related to the entire project life-span, i.e. long-term. In the absence of related mitigation measures, the severity of the predicted adverse impact is therefore assessed as **Moderate**.

Mitigation measures

Yamal LNG recognises the overriding importance of fostering a 'good neighbour' relationship with the local communities and protecting their well-being and traditional culture. Ensuring a high standard of behaviour and a respectful attitude among the Project workforce is the key to minimising stress effects on local residents and to maintaining a healthy environment in the Project locality. This intention is enforced by the following documents adopted by the Company:

- *"Yamal LNG" Corporate Responsibility Policy"*: respect for universal rights and freedoms of local indigenous communities, as well as their culture and traditional way of life;
- *"Engagement and Support Programme for Indigenous Population of the Yamal District in cooperation with the Municipal Administration of Yamal District and the Yamal District Public Association of Indigenous Small-Numbered Peoples of the North "Yamal"*: regular consultations with representatives of IPs, as well as with representatives of the municipal and regional authorities with the aim of identification of all concerns related to preservation of intangible cultural heritage (meetings directly in Tambey/Seyakha tundra, settlements of Tambey, Seyakha, Yar-Sale and Salekhard city); participation and assistance in organising special events (traditional holidays) for local communities associated with the customary rituals and ceremonies.

Strict enforcement of Yamal LNG's *Workers Code of Conduct* is also one of the main measures in regard to the intangible cultural heritage preservation.

Observance of the *Code of Conduct* will be ensured through:

- induction training;
- regular refresher training, as appropriate;
- control by responsible supervisors and the management of contractor companies;
- application of prescribed disciplinary measures in case of breaches of the Workers Code of Conduct.

Key aspects of the Workers Code of Conduct will include:

- Respectful and courteous behaviour towards local communities including migratory herders in all cases of interaction;
- Familiarity with and abide by the local norms of behaviour in deference to the traditional customs of the Indigenous Peoples;
- Refrain from distracting, excessive photographing and/or video-recording of local indigenous communities without their permission, especially during the execution of their critical activities (e.g. reindeer herd passage, visiting sacred sites etc.);
- Exercise a 'no-harm' approach towards local residents, their property and local environment;
- Exercise a neutral 'non-involvement' attitude in all cases where there is a potential for conflict;
- Hunting of wildlife, fishing activities and gathering of natural produce are strictly prohibited;
- The use of dogs for any purposes is strictly prohibited;
- No harassment and hunting of reindeer is allowed, including deliberate creation of obstacles on the passage routes used by migratory reindeer herders;
- Exercise deference towards sacred sites and any other objects and features of cultural heritage, particularly those worshipped by the IPN[56].

All construction personnel and contractors will be housed in the licence area in dedicated accommodation camps and are required to comply with the mandatory '*Accommodation Camp Policy'* which is enforced through contractual obligations. The Camp Policy serves as the main reference for the workforce, particularly in relation to the movements of personnel outside their working hours or in any areas beyond the designated worksites/Project licence area.

Cultural induction training will be provided to all construction personnel and contractors workers as well as visitors to ensure that they are:

[56] Rules of worker behaviour in relation to cultural heritage sites are described also in the Yamal LNG Chance Find Procedure.

- Familiar with the local customs and norms of behaviour, including those practised by the Indigenous Peoples, and are briefed on the Company's commitments as per its CSR Policy;
- Fully informed of their obligations towards the local communities as per the Workers Code of Conduct, Chance Finds Procedure and disciplinary measures/sanctions that ensue in cases of infringement, and
- Able to align their conduct to local standards and benchmarks of behaviour.

Yamal LNG will require that the EPC Contractors and all other subcontractors involved in the construction activities implement the aforementioned provisions, and will also rigorously monitor behaviour of the contractor workforce towards the local communities.

Yamal LNG does not permit selling and buying of alcohol by the workforce from local residents. The Company's operational management on-site and the security personnel will be informed in cases of alcohol consumption and/or substance abuse within the licence area. Yamal LNG will also exercise a zero tolerance policy in relation to bribery, barter or requesting gifts in the form of alcohol or other substances from the local community. The aspects related to the Company's policy on alcohol and substance use are described in detail in section 10.2.1.1.

Finally, the implementation of the Yamal LNG Stakeholder Enquiry (Grievance) Procedure in accordance with the Company's SEP allows the collection of any feedback, concerns and/or complaints from Project-affected communities and serves as a primary indicator of any non-conformities relating to the behaviour of the Project workforce and contractors. All incidents reported and logged with the use of this Procedure are reviewed and examined by the Company's designated staff to identify the underlying causes and to determine the extent to which Project personnel or Project activities were involved in creating the situations leading to an external enquiry or a complaint. The Company's response actions prescribed by the Procedure are aimed at establishing the cause of the issue and finding an effective resolution in cooperation with the person or entity that originated the enquiry. Operation of the Procedure is therefore one of the safeguards used by the Company to ensure that it is promptly informed and appropriately acts on any incidents that may be perceived as a source of stress or mental discomfort for the local communities.

<u>Assessment of residual impact</u>

- Following implementation of the measures for appropriate regulation of workers and contractors' behaviour, prevention of alcohol and substance consumption and distribution by Project personnel, and the proactive management of community feedback through the functional response mechanism, the severity of the residual impact on intangible cultural heritage related to occasional contacts between IPs and the Project non-local workforce is assessed as **Low**.

10.7.3 SUMMARY IMPACT TABLE

Table 10.7.3: Summary of Cultural Heritage Impacts and Mitigation Measures

Impact	Receptor	Phase	Design, Mitigation and Precaution Measures	Residual Impact
Loss / limitation of access to previously identified tangible cultural heritage sites	Local communities in the Project Area of Influence	Construction/Operation	• Establishment of appropriate crossing points over Project's linear infrastructure (incl. including the above-ground network of connecting gas pipelines, roads and near the power transmission towers) allowing continuous access of local indigenous population to the sacred sites currently being in use; • Continuous engagement with the IPs' representatives with the aim of identification of critical locations at Project's linear infrastructure for potential crossing points.	Moderate to low
Potential physical damage to previously identified tangible cultural heritage sites	Local communities in the Project Area of Influence	Construction/Operation	• Measures for preservation of the identified cultural heritage site - ancient settlement Salyangylnato-1 as required by the RF legislation: ○ Installation of buffer zone perimeter fencing; ○ Installation of safety signage and information billboards; ○ Prohibition of traffic, soil use, execution of any search and excavation works within the cultural site's buffer zone boundaries. • Strict enforcement of the Yamal LNG Worker Code of Conduct, including induction and regular refresher training for all personnel, control by responsible supervisors and the management of contractor companies, and application of prescribed disciplinary measures in case of breaches; • Strict compliance with the mandatory 'Accommodation Camp Policy' enforced through contractual obligations; • Provision for the cultural induction training for all construction personnel, including contractors.	Low

Table 10.7.3: Summary of Cultural Heritage Impacts and Mitigation Measures

Impact	Receptor	Phase	Design, Mitigation and Precaution Measures	Residual Impact
Potential physical damage to yet unidentified tangible cultural heritage sites	Local communities in the Project Area of Influence	Construction	• Implementation of the Yamal LNG Cultural Heritage Chance Finds Procedure	Low to negligible
Disturbance to the traditional lifestyle and customary modes of behaviour	Local communities in the Project Area of Influence	Construction/Operation	• Strict adherence to the principles set forth in the Yamal LNG CSR Policy and the Engagement and Support Programme for Indigenous Population of the Yamal District; • Strict enforcement of the Yamal LNG Worker Code of Conduct, including induction and regular refresher training for all personnel, control by responsible supervisors and the management of contractor companies, and application of prescribed disciplinary measures in case of breaches; • Strict compliance with the mandatory '*Accommodation Camp Policy'* enforced through contractual obligations; • Provision for the cultural induction training for all construction personnel, including contractors; • EPC Contractors and all other subcontractors involved in the construction activities will rigorously monitor behaviour of their workforce towards the local communities; • Prohibition of drugs and alcohol at all its facilities within the licence area, including in the accommodation camps; • Investigating the nature and causes of complaints lodged by the local community via the Yamal LNG '*Stakeholder Enquiry (Grievance) Procedure'*; • Implementation of the Yamal LNG Cultural Heritage Chance Finds Procedure.	Low

11 DECOMMISSIONING AND ABANDONMENT

11.1 HISTORICAL CONTAMINATION AND REDUNDANT EQUIPMENT AND FACILITIES

11.1.1 PREVIOUS INDUSTRIAL ACTIVITIES

The South Tambey gas condensate field was discovered in the mid-1970s. Since that time, extensive prospecting surveys and exploratory drilling operations have been performed by other past operators to estimate recoverable reserves. In total, 55 prospecting and exploratory wells have been drilled on the Project Licence Area. Reportedly, reclamation of well sites was either partially completed or was not completed at all.

Before 2006, some wells were under pilot operations. Onsite operations included condensate separation and gas flaring in flare pits. Gas condensate was transported via pipelines to temporary storage areas, from where condensate was delivered to berth facilities and subsequently shipped by sea via the Obskaya estuary.

At that time infrastructure facilities consisted of:

- The Sabetta accommodation camp with heat supply, water supply and wastewater removal systems;
- Gas supply wells and a mobile automated gas-turbine electric power plant;
- An industrial zone on the Sabetta accommodation camp territory (a boiler-house, garages, parking lots, a filling station, repair workshops, fuel storage tanks, etc.);
- An airport (aircraft parking areas, a refuelling station); and
- Roads and pipelines for condensate transportation.

11.1.2 LEGACY WASTES

Over several decades of previous field development, not all wastes were removed from the area but instead were stored on the shore of the Gulf of Ob. As a consequence, sizable amounts of wastes were accumulated there, including metal scrap, construction debris and unused drilling mud components. Yamal LNG has made an inventory of accumulated wastes and is in the process of removing the wastes to approved recycling and/or disposal facilities in accordance with Russian regulatory requirements. Removal and disposal of the accumulated wastes is expected to be completed by 2015.

The removal of these wastes from the project Licence Area will represent a net **beneficial environmental impact**.

11.1.3 LEGACY CONTAMINATION

In addition to the presence of waste materials, the potential for legacy contamination of the environment from the historical industrial activities is also recognised. In line with RF legal requirements, Yamal LNG has carried out engineering environmental surveys within the Project Licence Area. The scope of these surveys has included land plots designated for the construction of new facilities (see Chapter 4) and the existing infrastructure (gas wells, pilot wells, and accommodation camp). The surveys included sampling of soil, groundwater, surface water and bottom sediments for testing by an accredited laboratory. Analytical data were compared with background contamination levels and hygienic regulatory values.

Details of the existing status of legacy contamination in Licence Area is presented in Chapter 7. The findings can be briefly summarized as follows:

- **Soils**

  Minor exceedances of regulatory values were found in some soil samples for cadmium, nickel, zinc, lead, and arsenic.

  Concentrations of cadmium in excess of regulatory norms were found in soil samples obtained from the area designated for the LNG Plant facilities and at multiple well platforms. In addition, concentrations of nickel in excess of regulatory norms were found in soil samples taken at certain multiple well platforms. Lead concentration in soil samples obtained at well site # 21 were twice the Maximum Permissible Concentration (MPC).

  Concentrations of petroleum hydrocarbons in excess of the regulatory value were identified in some soil samples taken in the vicinity of the seaport onshore facilities, in the airport area and at multiple well platforms. MPC values were exceeded by no more than 1.5 to 2 times.

  In autumn 2012 a survey of drilling pits for earlier exploration drilling was conducted by means of remote sensing data interpretation. Samples of soil and water were then obtained during the field survey and sent for analysis. The findings of these studies are summarised as follows:

  - In total, 55 prospecting and exploratory wells were drilled within the Project Licence Area. On the basis of the survey, 34 drill pits were identified; 22 of the pits were not subjected to remediation after drilling completion. The total area of the identified pits is 4.637 ha.
  - In total 6 minor areas were identified with contamination from oil products, with a total of area 0.23 ha.
  - A further nine land plots were identified with soil contamination by saline wastewater, with a total area 1.83 ha.
  - The total area of mechanically disturbed land plots was found to be 2792.5 ha.

- **Surface waters**

  Concentrations of most substances analysed in surface water samples were lower than the MPC value established for water bodies of fishery significance. However, minor exceedances (2 MPC to 3 MPC) were found with regard to petroleum hydrocarbons, surfactants, iron and manganese in water samples taken from a lake situated in the immediate vicinity of the Sabetta accommodation camp.

Some water samples obtained from the Gulf of Ob demonstrated minor exceedances of MPC values established for water bodies of fishery significance in relation to: chlorides (up to 2.5 MPC), magnesium (up to 1.4 MPC), and petroleum hydrocarbons (1.3 MPC to 1.6 MPC).

- **Bottom sediments**

  No regulatory norms are established in the RF for contaminant levels in bottom sediments. However samples showed that concentrations of potential contaminants complied with the local background level.

Following completion of the outstanding surveys, a reinstatement and remediation plan will be developed in order to rectify the legacy contamination to appropriate levels. Implementation of this plan will result in a net **beneficial environmental impact**.

11.2 PROJECT FACILITIES

It is anticipated that the majority of the Project facilities will be in place for the full lifecycle of the Project (the Project Licence currently extends until 2045). Given that decommissioning of these main Project facilities will not be undertaken until many years into the future, precise details for the decommissioning process cannot be defined at the present time due to inherent uncertainties concerning (for example):

- Evolution of the relevant legislative environment at the time of decommissioning;
- The status of Project developments over the currently envisaged project lifetime;
- The development of future abandonment and decommissioning technologies and practices that may be available at the time of decommissioning.

The actual abandonment and decommissioning procedures will be designed and implemented through the development of an Abandonment and Decommissioning Plan, which will reflect good international industry practice (GIIP) and Russian regulations in place at that time. In broad terms decommissioning and abandonment of the Project Licence Area will comprise the following activities:

- Operating processes will be systematically shutdown in a safe manner;
- Liquid and solid contents/wastes will be removed for treatment and disposal. For pipelines, tanks and process vessels this will entail flushing and cleaning to remove oils and grease;
- The fate of the emptied and cleaned structures, facilities and equipment will then be decided by a feasibility study to determine the best environmental, social and economic solution in line with contemporary GIIP;
- It is anticipated that all decommissioned aboveground structures will be removed and this will be facilitated by the modular structure of the primary structures and process unit, which can be readily removed for offsite dismantling and disposal;
- Abandoned wells will be capped using contemporary GIIP;
- Following removal of structures, facilities and equipment, surveys will be undertaken to identify any areas of Project-related contamination and a reinstatement plan will be developed in line with contemporary GIIP;
- Certain Project facilities, including the main seaport and the airport are not operated by Yamal LNG and may be retained after the decommissioning of the Project if future use for these facilities is identified by their operators.

Given the above uncertainties, the significance of the environmental and social impacts associated with decommissioning and abandonment cannot be determined at this stage of the Project. Nonetheless, the adoption of the GIIP will ensure that such impacts are minimised to within acceptable levels.

12 TRANSBOUNDARY IMPACTS

The Project Area of Influence is not expected to extend beyond international boundaries on the basis of:

- The scope of the Project as defined in Chapter 4.9 is located entirely within the Russian Federation (for example, the LNG/condensate transport in existing shipping lanes, including the Northern Sea Route, is excluded from the scope of the ESIA because it is not considered within the Project Area of Influence).
- The extremely low levels of sulphur in the feed gas means that regional acidification effects of SO_2 generated by the operation of the LNG Complex and associated power generation plant will not be significant and hence will not will not result in significant transboundary impacts.
- The effects of nitrogen deposition from the Project's combustion of natural gas are assessed in Chapter 9.2, but given the location of the Project, significant impacts are not anticipated to extend beyond national boundaries.

Significant transboundary impacts are therefore not anticipated. The one exception to this relates to emission of greenhouse gases (GHG) through the lifecycle of the Project and these impacts are addressed in Chapter 9.2.

Project waste will generally be managed locally at the onsite waste facility (see Chapters 4 and 9 for further details). Select wastes will also be sent to third party licenced facilities for recycling, including scrap metals, spent catalysts etc. (see Chapter 9). These will generally be facilities in the Russian Federation (only facilities with all relevant licences will be used), although during the operational phase small quantities of some wastes may also be sent to suitablty licenced specialist international companies for recycling. In the event international companies are used for this recycling, the transport of such wastes will be undertaken in accordance will all applicable international laws and conventions, and therefore no significant impacts are anticipated.

13 CUMULATIVE IMPACTS AND IMPACT INTERACTIONS

13.1 INTRODUCTION

This Chapter provides an assessment of cumulative impacts resulting from existing or planned developments in the area (future expansions and neighbouring developments). It is structured to provide:

- a definition of cumulative impacts based on current applicable guidance;
- the relevance of cumulative impacts assessment to this Project;
- the approach adopted in this ESIA; and
- a Cumulative Impacts Assessment.

Multiple impacts to a single receptor from the different project facilities (and Associated Facilities) are not addressed in this chapter, but instead have been addressed in Chapter 9.

13.2 DEFINITION AND APPLICABLE GUIDANCE

The assessment of cumulative impacts is a long established requirement for any comprehensive ESIA. For the purposes of this Project, the IFC Performance Standards have been used as a primary reference source, which include the following definition:

> *Cumulative impacts*[1] *that result from* ***the incremental impact,*** *on areas or resources used or directly impacted by the project,* ***from other existing, planned or reasonably defined developments*** *at the time the risks and impacts identification process is conducted*. [emphasis added]

13.2.1 IFC GUIDANCE NOTES: PERFORMANCE STANDARDS ON ENVIRONMENTAL AND SOCIAL SUSTAINABILITY, 2012

Guidance on the interpretation of this requirement is provided in the Guidance Note 1 to the IFC Performance Standards[2]. Relevant text from this guidance has been summarised below again with emphasis added using bold text.

> *GN37. ….. Multiple environmental and social impacts from existing projects, combined with the potential incremental impacts resulting from proposed and/or anticipated future projects may result in significant cumulative impacts that would not be expected in the case of a stand-alone project.*

> *GN38. …In situations, where cumulative impacts are likely to occur from activities by third parties in the region and the impacts from the client's own operations are expected to be a*

[1] *Cumulative impacts are limited to those impacts generally recognized as important on the basis of scientific concerns and/or concerns from Affected Communities. Examples of cumulative impacts include: incremental contribution of gaseous emissions to an airshed; reduction of water flows in a watershed due to multiple withdrawals; increases in sediment loads to a watershed; interference with migratory routes or wildlife movement; or more traffic congestion and accidents due to increases in vehicular traffic on community roadways.*

[2] IFC Performance Standards Guidance Note 1, Assessment and Management of Environmental and Social Risks and Impacts, January 2012.

relatively small amount of the cumulative total, a regional or sectoral assessment may be more appropriate than a CIA. [Note that this would typically be in the form of a strategic regional assessment undertaken by regional authorities]

GN40. At a practical level, the critical element of such an assessment [CIA] is to determine how large an area around the project should be assessed, what an appropriate period of time is, and how to practically assess the complex interactions among different projects occurring at different times. Because a CIA transcends a single project development, the resulting potential management or mitigation measures typically require participation from a larger and more diverse number of stakeholders in order to be coordinated and implemented. Furthermore, the active participation of government authorities is typically required to assess the incremental contribution of each project to the cumulative impacts, monitor and enforce the implementation of the mitigation measures corresponding to each project, identify the additional mitigation measures required, and coordinate, ensure and document their implementation.

GN41. Paragraph 8 of Performance Standard 1 requires that…..the risks and impacts identification process ….. identifies and ***assesses cumulative impacts from further planned development of the project and other project-related developments, any existing project or condition whose impacts may be exacerbated by the project, and other developments of the same type that are realistically defined at the time of the risks and impacts identification process****. Impacts from unplanned but predictable developments caused by the project that may occur later or at a different location should also be identified and assessed. The assessment should be commensurate with the incremental contribution, source, extent, and severity of the cumulative impacts anticipated, and* ***be limited to only those impacts generally recognized as important on the basis of scientific concerns and/or concerns from Affected Communities.*** *Potential impacts that would occur without the project or independently of the project should not be considered. [Emphasis added]*

……the client should ensure that its assessment determines the degree to which the project under review is contributing to the cumulative effects.

GN42. …..In terms of anticipated future projects, priority should be given to assessing cumulative impacts stemming from the project being considered for financing, such as further planned developments associated with the project and other future developments of the same type in the project's area of influence that are realistically defined at the time of the assessment (this may include any combination of developments which are either proposed, licensed or for which permits exist).

GN43. Where appropriate, the client should use commercially reasonable efforts to engage relevant government authorities, other developers, Affected Communities, and, where appropriate, other relevant stakeholders, in the assessment, design, and implementation of coordinated mitigation measure to manage the potential cumulative impacts resulting from multiple projects in the same project's area of influence.

13.2.2 GOOD PRACTICE HANDBOOK: CUMULATIVE IMPACT ASSESSMENT AND MANAGEMENT; GUIDANCE FOR THE PRIVATE SECTOR IN EMERGING MARKETS (AUGUST 2013)

The CIA Good Practice Handbook (GPH) was issued on the IFC website in August 2013. This GPH supplements the IFC Performance Standard and Guidance Note, providing further guidance on the practical assessment of cumulative impacts, recognising some of the uncertainties and constraints faced by private sector proponents. It also introduces the concept of valued environmental and social components (VEC) in the assessment of cumulative impacts.

A six step approach outlined in the GPH is consistent with IFC PS 1 and associated guidance note and is broadly applied in the methodology and approach outlined in Section 13.4.

13.2.3 EU GUIDANCE

Guidance on the assessment of cumulative impacts is also provided by the EU-commissioned document entitled 'Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions, 1999'. The document provides guidance that has been used extensively by European EIA practitioners as a primary source of guidance and remains a useful document.

It advocates an approach that is consistent with more recent guidance IFC guidance described above, including:

- Gathering of project information
- A scoping phase (temporal and spatial scope)
- Scoping, to identify important issues for further assessment
- Collection of baseline data, potentially over a wider geographic area than for the Project alone
- Assessment of cumulative impacts (outlining a range of assessment tools and techniques) with consideration given to the carrying capacity of the receiving environment

Recognising that temporal boundaries need to be determined on a project-by-project basis, and that this is dependent upon the availability and quality of information, the guidance states that '*In setting the future time boundary it is suggested that in general, beyond 5 years there is too much uncertainty associated with most development proposals. It is therefore recommended that in the majority of cases the limit does not exceed 5 years into the future.'*

13.3 PROJECT CONTEXT

The Yamal LNG Project is located in a remote area and within a defined licence area that excludes other industrial activity from close proximity of the Project. However, while there is minimal other activity ongoing within or close to the Project Licence Area, historically there has been activity by previous oil and gas developers in the Project Licence Area that has resulted in legacy waste and contamination; this is addressed within Chapters 7, 9 and 11 of this ESIA.

Currently undeveloped oil and gas fields have been identified across the Yamal Peninsula. The majority of these fields are located in excess of 100 km from the Project. The only operational gas field, the Bovanenkovo field, is located on the Yamal Peninsula over 100 km from the Yamal LNG Project. There are three undeveloped fields located relatively close to the Project, Zapadno-Seyakhinskoye to the south, as well as Zapadno-Tambeyskoye and Severo-Tambeyskoye to the north.

The status of the historical, existing and planned industrial activities in the Yamal District is further described in Section 13.7.

13.4 APPROACH

The approach towards the assessment of cumulative impacts has evolved over recent decades and as new guidance has become available. The approach adopted for this ESIA is intended to meet with current guidance and established practice, while at the same time giving due consideration to the latest developments and draft guidance as appropriate. The approach is therefore based primarily on the 2012 IFC Performance Standards and supplemented by complementary current good practice, and in particular the IFC Good Practice Note (GPH) described in Section 13.2.2.

The GPH recognises that where impacts are likely to arise from multiple projects at a regional level, or where there is uncertainty over potential impacts due to the longer term timeframes involved, it would be more appropriate for a CIA to be undertaken by the relevant authorities. In recognition of the constraints often faced by private sector organisations when assessing cumulative impacts, the GPH introduces the concept of a simpler Rapid Cumulative Impacts Assessment (RCIA) that follows a similar process but is based on desk review of readily available information.

For this ESIA, the CIA will draw upon primary data collected specifically for the Project and secondary data from desk review of available literature. A significant amount of primary data has been collected for the ESIA, providing detailed information within the Project Area of Influence. Outside of the Project Area of Influence, at the wider regional level, greater reliance is placed on secondary data sourced from publicly available documentation; less detailed information is available outside of the Project Area of Influence (AoI). Consequently, for the purposes of this ESIA, the CIA draws from two tiers of information:

1. Detailed - primary and secondary data for the Project Area of Influence that enables a detailed assessment of cumulative impacts within the Project's Area of Influence using primary data gathered for the Project.
2. Less detailed - secondary data at the regional level gathered by desk-based review of readily available information (similar to the approach for RCIA), to determine the contribution of the Project to cumulative impacts at a regional level i.e. outside of the Project Area of Influence.

Further detail regarding the manner in which the two tiers of information has been applied is further discussed in the methodology section below.

13.5 METHODOLOGY

The methodology is broadly based on the guidance described previously and in particular follows the six step approach outlined in the GPH.

13.5.1 STEP 1. SCOPING PHASE I – VECS, SPATIAL AND TEMPORAL BOUNDARIES

The first stage of the cumulative impacts assessment is to identify potential valued environmental and social components (VEC) and define the spatial and temporal boundaries.

VECs

VECs are those receptors that are considered to be important when assessing the risks posed from cumulative impacts. VECs have been identified through the ESIA process, including through consultations undertaken with stakeholders (e.g. see Chapter 5 and the Stakeholder Engagement Plan) and through reviews and assessments undertaken by relevant specialists as part of the ESIA (e.g. see Chapters 7, 8, 9 and 10).

Consistent with the guidance, the assessment is limited to impacts generally recognized as important on the basis of scientific concerns and/or concerns from Affected Communities and will exclude any potential impacts that would occur without the Project or independently of the Project. In addition, only those environmental/social receptors on which the Project itself is assessed to have potentially significant effects, including those that have some potential to act as a 'tipping point' in conjunction with other potential influences, (see Chapters 9 and 10) are included in the CIA. In practical terms, this means that:

- If the impact of the Project on a receptor has been assessed **Negligible** then it is not considered as a VEC in the CIA (i.e. scoped out in all cases)
- Receptors on which the assessed Project impact is **Low** are considered on a case-by-case for inclusion as a VEC in the CIA based on the potential for such effects to act cumulatively with other non-Project influences (i.e. scoped out on a case-by-case basis).

Spatial boundary

The Project Area of Influence (AoI) defined in Chapter 4 was derived in accordance with the IFC Performance Standards' guidance and, as such, the Project Area of Influence was defined taking account of potential cumulative impacts[3]. Cumulative impacts are assessed within the pre-defined Project AoI as defined in Chapter 4.

The CIA also considers the larger spatial area outside of the Project AoI. The precise spatial boundary is defined based on the geographic range of specific VECs as well as the spatial distribution of other third-party activities or influences that might impact the VECs (see Sections 13.5.2 and 13.7).

Temporal boundary

The duration of impacts considered on VECs is the lifetime of the Project. However, in doing so, there are limitations in the current knowledge of other (non-Project) activities and drivers that may lead to additional influence on the VECs at different stages of the Project lifetime. The extent to which these can be credibly addressed with the CIA is further described in Section 13.5.2 below.

Summary

The overall Phase I scoping is undertaken through consideration of the VECs, spatial and temporal boundaries and also the Phase II scoping. The scoping is performed in a systematic manner. The first step in this process is the identification of the potential VECs through consultations with relevant stakeholders and review of available environmental and social baseline data at the local (Project) and regional scales (see also Chapters 5, 7 and 8). Further scoping/screening of these potential VECs is then undertaken by taking into account the following considerations:

1. The assessed Project impacts to each social and environmental VEC as identified in Chapters 9 and 10 in order to identify the potential for the Project to materially contribute to cumulative impacts (including the potential for 'Low' Project-level impacts to act as 'tipping points' in conjunction with wider cumulative influences)

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3 *This area of influence encompasses, as appropriate: Cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.*

2. Consideration of the spatial extent of the receptor in the region
3. Consideration of how the spatial extent of the receptor may overlap with both the Project's Area of Influence and the influence of other industrial activities identified through the Phase II Scoping process
4. Consideration of the relative temporal boundaries of the different stressors (e.g. whether or not such stressors are concurrent, consecutive etc.) and the duration of such impacts
5. Other non-industrial influences that may affect the receptor (within the spatial and temporal boundaries).

The above aspects are recorded and, through consideration of the above points, those receptors that are to be considered as VECs within the CIA are identified.

The results of the Phase I and II Scoping is presented in Section 13.6 and Annex A.

13.5.2 STEP 2. SCOPING PHASE II – OTHER ACTIVITIES AND ENVIRONMENTAL DRIVERS

This part of the scoping exercise identifies historical, existing and planned activities and the presence of natural influences/ stressors with the potential to affect the VECs identified in Step 1 that will require further assessment within the CIA. In line with IFC PS1, consideration is given to non-Project activities/developments that either existing, planned or reasonably defined. Consistent with established EU guidance,[4] consideration is typically given to projects that are likely to be initiated within 5 years of the time the scoping process is completed. The 5 year time period is a reasonable starting position that has been adopted for the Project CIA. The temporal boundary is therefore largely defined based on the availability and quality of information found to be available – see Sections 13.5.2 and 13.7.

Nonetheless, in recognition of the potential for more extensive development of the Yamal peninsula in the longer term, consideration is also given to potential cumulative impacts that may be associated with the *broad nature* of longer term potential developments that are neither certain to go ahead nor reasonably defined, but which, to some extent, are foreseeable. However, consideration of such uncertain/undefined potential developments can only be provided at a high-level, and detailed assessment of potential impacts is not possible.

Natural influences/stressors that are unrelated to the Project activities are also considered, for example, the potential for overgrazing of lichen pastures by reindeer herds, the potential impact of climate change in terms of the climatic extremes and impacts on permafrost, migratory and predatory animals. Given the inherent uncertainty and variability associated with climate change projections these stressors are only considered in a high-level and qualitative manner.

This Phase II Scoping is described in Section 13.7.

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[4] Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions, May 1999 states that '*In setting the future time boundary it is suggested that in general, beyond 5 years there is too much uncertainty associated with most development proposals. It is therefore recommended that in the majority of cases the limit does not exceed 5 years into the future.'*

13.5.3 STEP 3. BASELINE

Available baseline data have been gathered for the identified VECs. Baseline data for the Project AoI is based on detailed studies and survey works undertaken by the Project and as described in Chapters 7 and 8. These Project-specific studies are supplemented by readily available information at the regional scale beyond the Project AoI (see also Chapters 7 and 8). This is further summarised for the identified VECs in Section 13.8.

13.5.4 STEP 4. ASSESSMENT OF CUMULATIVE IMPACTS

The Project CIA has adopted a VEC-centric approach, i.e. VECs and their resilience have been identified/determined as described in sections 13.5.1 and 13.6 and then the impacts from various activities on these VECs assessed.

The predicted future condition of VECs is discussed taking account of all stressors and the Project's contribution to the overall cumulative impact is assessed. It is noted that as the Project is implemented in a region of very limited exiting industrial development (although as described in Section 13.7.1 significant historical geological prospecting activities have been undertaken within the Yamal LNG Licence Area itself). Therefore the assessment of cumulative impacts is largely based on consideration of potential future developments that are as yet not well defined and about which limited information is therefore available. Due to these inherent uncertainties in the nature of cumulative impacts, the CIA has by necessity been performed in a qualitative manner, but nevertheless provides useful context i.e. whether the Yamal LNG Project is a significant contributor or not.

The assessment of cumulative impacts is provided in Section 13.9.

13.5.5 STEP 5. SIGNIFICANCE OF CUMULATIVE IMPACTS

The assessment methodology in Chapter 3 describes the assessment of significance as a function of impact 'severity' and 'likelihood'. The methodology was developed primarily for the assessment of Project-specific impacts, although can be broadly applied to cumulative impacts. However, given the inherent uncertainties associated with the prediction of impacts from future projects where definitive information is limited, less reliance can be placed on the 'likelihood' component of impact significance (see below).

The cumulative impact assessment draws on the methodology described in Chapter 3 to express the severity of potential cumulative impacts. The degree of any uncertainties is described at a high level i.e. the likelihood that a project will proceed and, if so, whether impacts would be expected. The detailed likelihood criteria in Table 3.2 of Chapter 3 have, therefore, not been used.

13.5.6 STEP 6. MANAGEMENT OF CUMULATIVE IMPACTS

Many of the mitigation measures identified during the assessment of Project impacts will also be applicable to the mitigation of cumulative impacts. However, it is also recognised that the cumulative impacts assessment may generate additional mitigation measures and/or strategic/long term actions, for example, the need to share findings and cooperate with third parties such as future developers and YNAO/Yamalsky district authorities.

Consistent with the approach taken elsewhere in the ESIA and described in Chapter 3, the mitigation hierarchy, which broadly requires that consideration be given to avoidance, minimisation, mitigation and offsetting in that order of preference, have been applied.

The findings of the CIA, including the significance of impacts and necessary mitigation measures/further actions are described in Section 13.10.

13.6 SCOPING PHASE I - VECS, SPATIAL AND TEMPORAL BOUNDARIES

13.6.1 IDENTIFICATION OF POTENTIAL VECS

The identification of potential VECs has been undertaken through:

1. Review of issues raised during Public Hearings (see also Chapters 5 and 8)
2. Review of issues raised during ongoing liaison with indigenous reindeer herders (including interviews with 56 representatives of the IPN who live and conduct their activities in the vicinity of the Project area – see Chapters 5 and 8)
3. Consultations with NGOs[5].
4. Discussions with researchers from the Arctic Research Centre (see also Chapter 8)
5. Review of interviews undertaken as part of the ethno-cultural studies conducted in May-August 2013 (see also Chapter 8)
6. Review by Project specialists of:
    a. Available regional-level environmental and social baseline data (see also Chapters 7 and 8, and the ESIA Scoping Report)
    b. Project-specific environmental and social baseline field studies (see also Chapters 7 and 8, and the ESIA Scoping Report)

A summary of the potential VECs identified through this process is provided in Table 13.6.1 below. Each of the identified VECs is included in the CIA screening assessment (see Section 13.6.2).

Further ongoing consultation will be undertaken by the Project with relevant stakeholder through the SEP in order to confirm and input to the ongoing evaluation of the VECs.

[5] Consultations with WWF Russia, including face-to-face discussions and consultation on the Scoping Report

Table 13.6.1: Summary of Identified Potential VECs for Consideration in the CIA Screening Assessment

Aspect	VEC	Identification	Commentary / specifics	Ecosystem service type
Airshed	Air quality	Project specialists	Impacts on pasture land (includes nitrogen deposition), humans	Regulating - Air quality regulation
	GHG	Project specialists	Climate change	Regulating - Global climate regulation
Groundwater	Shallow underground strata	Project specialists	Contamination risks	Provisioning – freshwater Regulating - water regulation
Freshwater	Freshwater (quality and availability)	Project specialists	Potable water Impacts to other potential VECs	Provisioning – Freshwater Regulating - water regulation
	RDB freshwater & anadromous fauna	Project specialists	RDB species include Siberian sturgeon and sterlet (see Chapter 7)	N/A
	Capture fisheries (freshwater)	IP / communities (public hearings and dedicated surveys)	Seasonal subsistence fishing	Provisioning – capture fisheries
		WWF Russia	Impacts from siltation and dredging	
		Project specialists	See chapter 7 for species	
	Capture fisheries (anadromous)	Arctic Research Centre	Sedimentation impacts in rivers and coast zones	Provisioning – capture fisheries
		Project specialists	See Chapter 7 for species	
Marine (Gulf of Ob)	Capture fisheries (marine)	WWF Russia	Issues specific to dredging impacts (raised sediments), also effects on salinity of south Gulf of Ob	Provisioning – capture fisheries
		IP / communities (public hearings)	Commercial fishing (see Chapter 7 for commercial species)	
	Non-capture marine fish/benthos	WWF Russia	Issues related to dredging impacts, especially on benthos	N/A
		Project specialists	See Gulf of Ob southern portion s below. Siberian sturgeon is semi-	N/A

Table 13.6.1: Summary of Identified Potential VECs for Consideration in the CIA Screening Assessment				
Aspect	**VEC**	**Identification**	**Commentary / specifics**	**Ecosystem service type**
			anadromous	
	Marine mammals	WWF Russia	RDB cetaceans and pinnipeds Atlantic walrus specifically mentioned	N/A
		Project specialists	Mammals at regional level include polar bears, whales species and seals (see Chapter 7 for further details)	N/A
	Gulf of Ob (southern low salinity portions)	WWF Russia	Salinity change impacts on general ecology in south portion of Gulf of Ob	Regulating – water regulation
		Project specialists		
Terrestrial fauna	Reindeer, pasture lands and migration routes	IP / communities (public hearings and dedicated surveys)	Access to land / land take	Provisioning – livestock
		WWF Russia	Traditional lifestyles	
		Arctic Research Centre	Effects of overgrazing	
		Project specialists	See also humans (IP)	
	Wild food (terrestrial fauna)	IP / communities (public hearings and dedicated surveys)	Includes species for fur. Concerns over hunting by immigrant workers	Provisioning - Wild foods and hunting
		Project specialists		
	Birds	IP / communities (public hearings)	Noise impacts	N/A
		Project specialists	See chapter 7 for specific nesting bird species of interest	N/A
	Mammals (non-hunted)	Project specialists	Polar bear	N/A
Terrestrial flora	Wild food (flora/fungi)	IP / communities (dedicated surveys)	Fruit and berries for subsistence, medicinal plants	Provisioning - Biochemicals, natural medicines, and pharmaceuticals and Wild foods
		Project specialists		
	Lichen (reindeer pasture lands)	Project specialists	See reindeer/reindeer pasture lands	Provisioning – livestock (indirect)

Table 13.6.1: Summary of Identified Potential VECs for Consideration in the CIA Screening Assessment

Aspect	VEC	Identification	Commentary / specifics	Ecosystem service type
	RDB flora	Project specialists	See Chapter 7 for specific species, including Forb-graminoid, horsetail-graminoid meadow communities	N/A
	Tundra habitat	Project specialists	Also relates to flora and fauna species, reindeer herding and permafrost	Various
Humans	Nomadic IPs (traditional indigenous lifestyles)	IP / communities (public hearings and dedicated surveys)	See also reindeer, wild foods and sacred sites	Various
	Communities (non-nomadic)	Project specialists		N/A
	Employment & economy	Project specialists	Includes employment for IP – see Nomadic IP above	N/A
		IP / communities (public hearings and dedicated surveys)		N/A
	Services & Infrastructure	Project specialists		N/A
		IP / communities (public hearings and dedicated surveys)	Includes medical services, education and fuel	N/A
	Workers	Project specialists		N/A
	Sacred sites	IP / communities (public hearings and dedicated surveys)	Access and loss	Cultural - Sacred or spiritual sites and Areas used for religious purposes
		Project specialists	See Chapter 8 for types of sites and known locations	
Soils	Permafrost	WWF Russia		Regulating - Regional/local climate regulation and Natural hazard regulation
		Project specialists	Climate change and infrastructure thermal impacts (includes risks to infrastructure)	
		Arctic Research Centre	Climate change	
	Chemical contaminants in soils	Project specialists	Includes indirect effects on other VECs	Various (indirect)

13.6.2 SCREENING OF VECS FOR CONSIDERATION IN THE CIA

The output of the Phase I and II scoping assessment is summarised in Annex A to this Chapter and is the result of the scoping processed described in Section 13.5.1. Following the scoping process the following VECs have been identified for further consideration within the CIA:

Natural tundra habitats	Defined as unmodified tundra habitats prevalent on the Yamal peninsula and specifically the vegetation and bioclimatic zones identified in Section 13.8.1.
Avifauna	Specifically birds that breed in the Yamal peninsula and specifically the breeding birds and Important Bird areas identified in Section 13.8.2.
Nomadic indigenous reindeer herders	Comprises the indigenous reindeer herders on the Yamal peninsula as described in Section 13.8.3, and includes the indigenous people, their reindeer stock, there pasture and migration lands/routes and subsistence wild food sources
Fish and fisheries	Comprises those freshwater, anadromous and marine fish species, including capture fish species present on the Yamal peninsula and the Gulf of Ob, identified in Section 13.8.4.
Marine mammals	Marine mammals (cetaceans and pinnipeds) located in the Gulf of Ob and in the Area of Influence of the shipping lanes in the Gulf of Ob up to the intersect with the Northern Sea Route. Specific species are as identified in Section 13.8.5
Cultural heritage	Features, ,locations and objects of cultural and historical heritage that are significant to the indigenous people on the Yamal peninsula, including its tangible and intangible forms.
Regional-level community infrastructure and services	Includes health services (including emergency facilities) and transport infrastructure at the regional level
Employment and economy	YNAO-wide employment and economic conditions

These aspects are assessed further Section 13.8 to 13.10.

13.7 SCOPING PHASE II – OTHER ACTIVITIES AND ENVIRONMENTAL DRVERS

13.7.1 INTRODUCTION

A number of developed and undeveloped oil and gas fields have been identified within the Yamal and Gydan Peninsulas and these are shown in Figure 13.7.1. Further discussion is provided on the historical, existing/ongoing and planned/potential future human activities in turn in the following sections.

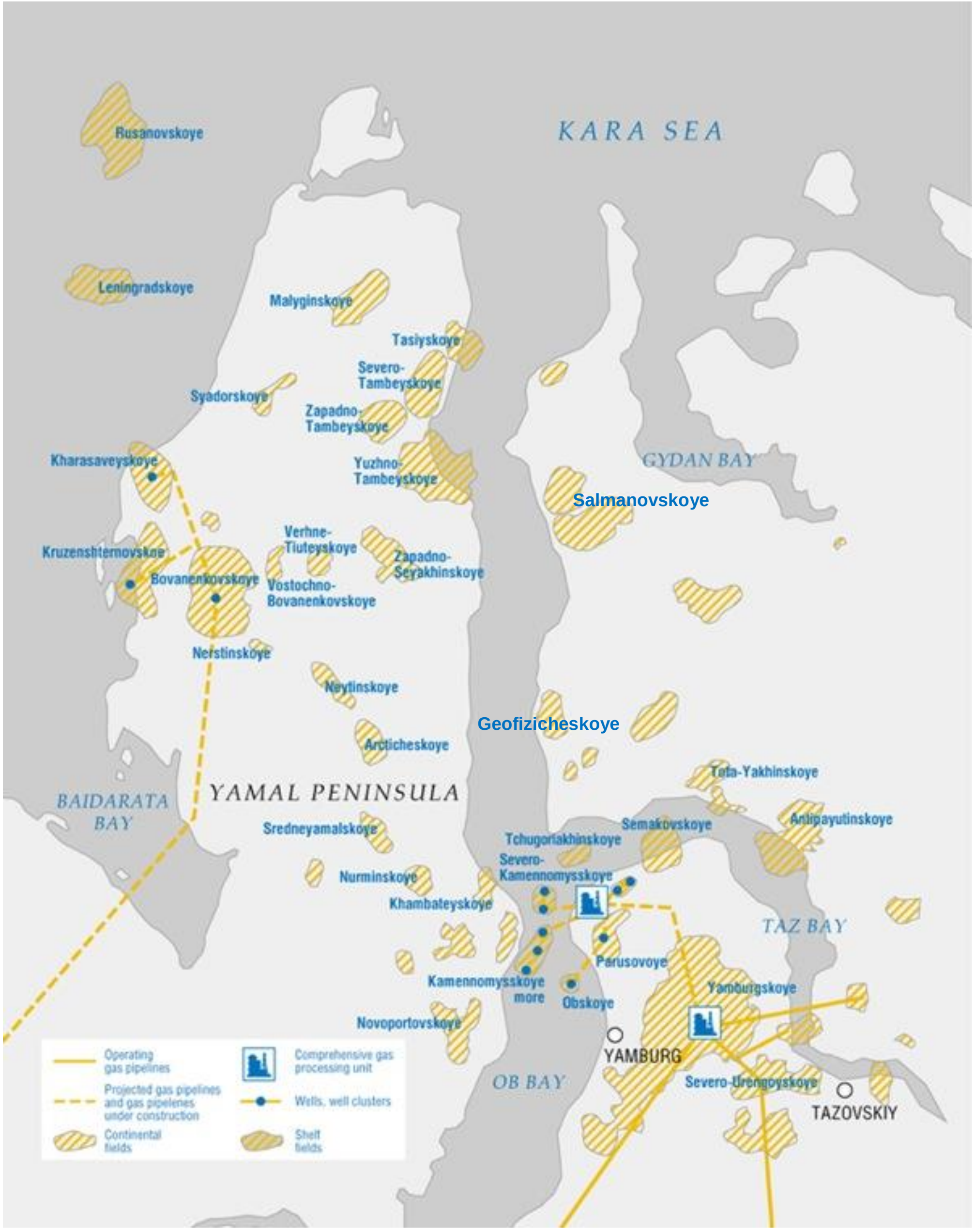

Figure 13.7.1: Gas field licence areas within the Yamal and Gydan Peninsulas

13.7.2 HISTORICAL ACTIVITIES

While the Yamal peninsula is largely undeveloped, historical oil & gas exploration activities have been undertaken in the region, including exploration activities within the Project Licence Area. Yamal LNG has a good understanding of historical activities and legacy wastes and contamination within the licence area and these are described in Chapters 7 and 11. As of January 2014, the total area of mechanically disturbed lands comprises 487 hectares. These areas are mainly generated during construction activities. Reclamation of industrial sites and roads will be carried out after decommissioning of the facilities. These historical activities are pertinent to the consideration of cumulative impacts, and Yamal LNG has committed to the restoration legacy contamination and wastes.

13.7.3 EXISTING ACTIVITIES

13.7.3.1 BOVANENKOVO FIELD

The only operational gas field on the Yamal peninsula is the Bovanenkovo field (see Figure 13.7.1), which is operated by Gazrpom and is located on the Yamal Peninsula over 100 km to the south west of the Yamal LNG Project. The first start-up complex for this field was commissioned in October 2012 and comprises a comprehensive gas treatment unit (CGTU) with the annual gas capacity of 30 billion cubic meters of gas and 60 wells. According to data from the Gazprom website, the field is planned to reach its design capacity of 115 billion cubic meters per year in 2017. In future, the design capacity of the field may be increased to 140 billion cubic meters of gas annually.

A gas trunkline system (GTS) is being constructed to deliver gas from the Bovanenko field to the Unified Gas Supply System (UGSS) to the south of the Yamal peninsula (see Figure 13.7.2).

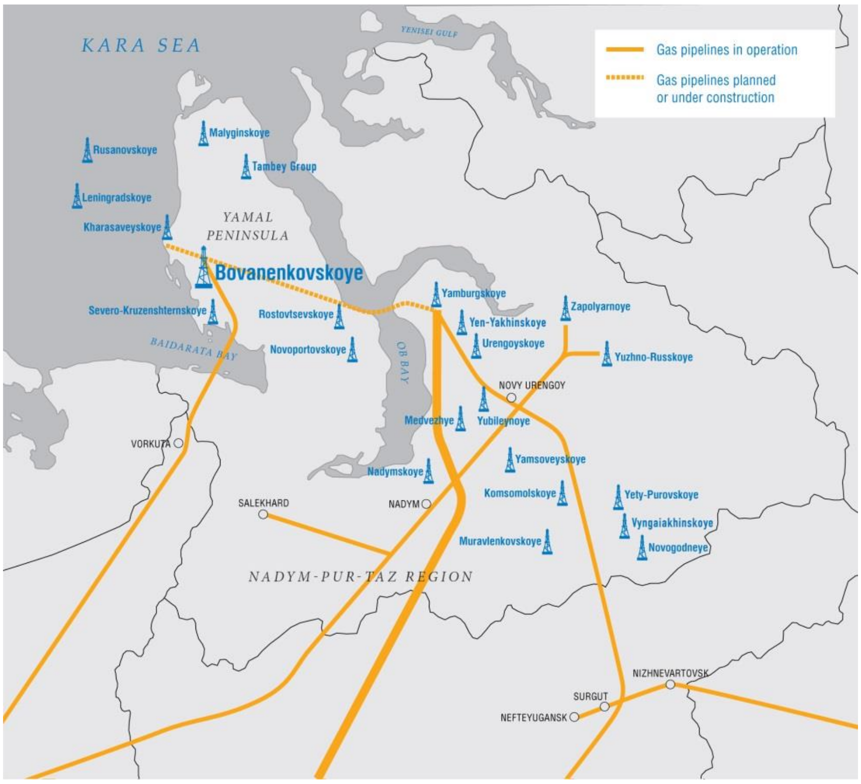

Figure 13.7.2: **Existing and Planned Pipeline System (source Gazprom website0**

The field also includes an airport and a 572km railway that links Karskaya and Bovanenko southwards to Okskaya.

The overall area of the Bovanenkovo field covers 2052 km^2 (VNIPIGazdovycha, 2005). Estimates of the spatial extent of industrial impacts of the Bovanenko field development have been made using remote sensing by Kumbula *et al*[6] and their findings are summarised as follows:

- Permanently changed area 9.3km^2
  - Buildings and yards 2.1km^2
  - Roads 2.9km^2
  - Sand quarries 4.3km^2
- Pipeline, length 16km
- Off-road tracks, length 2400km
- Off-road tracks, area 24km^2
- Total affected area 448km^2

13.7.3.2 OTHER EXISITNG FIELD DEVELOPMENTS

Novoport

Gazprom Neft has completed a drilling program as part of a larger pilot development program at Novoport field, one of the largest fields being developed in the Yamal region and located in the southern portion of the Yamal peninsula (see Figure 13.7.3), some 400km south of the Yamal LNG Licence Area.

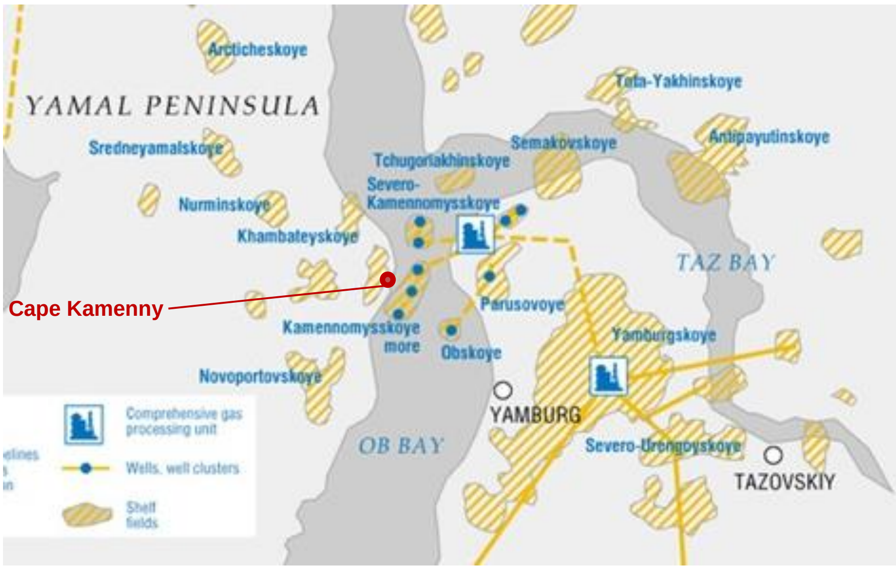

Figure 13.7.3: Location of Oil and Gas Fields in South Gulf of Ob

With reserves of 230 million tons of oil and 270 billion cubic meters of gas, the Novy Port field is one of the largest currently under development in the YNAO. Oil was first produced at Novy Port in

[6] Land use and land cover change in Arctic Russia: Ecological and social implications of industrial development, Kumpula, Pajunen, Kaarlejarvi, Forbes and Stammler, Global Environmental Change 21 (2011) 550–562.

August 2012, and a drilling program for pilot field development was completed in September 2013. Full-scale drilling began at Novy Port in 2014, ahead of full commercial production. The field is expected to reach its peak oil production capacity of 8.5 million tons per year after 2020.

A terminal is planned for completion by the end of 2015 for the export of oil from the Novoport field. The terminal's facilities will include offshore and land navigation equipment, a marine traffic control system, landside port infrastructure facilities, office and other accommodation to support the work of government agencies, and a range of other facilities. The terminal will be located near Cape Kamenny on the Yamal Peninsula (see Figure 13.7.3 above), connected to the Novy Port field by a 100km pipeline.

Given the distance of the Novoport field from the Yamal LNG project, the primary potential for cumulative effects relates to additional shipping in the Gulf of Ob between Cape Kamenny and the Northern Sea Route. This additional shipping is therefore considered within the CIA.

Severo-Kamennomysskoye

The Severo-Kamennomysskoye offshore gas field is operated by Gazprom Dobycha Yamburg and is in the initial stages of implementation. The field is located some 50km from shore and gas condensate will be delivered to Cape Parusniy by pipeline (see Figure 13.7.4 below) for onward export via mainland Russia. The reserves are estimated at 350 billion m^3 and full production is estimated to commence in 2016.

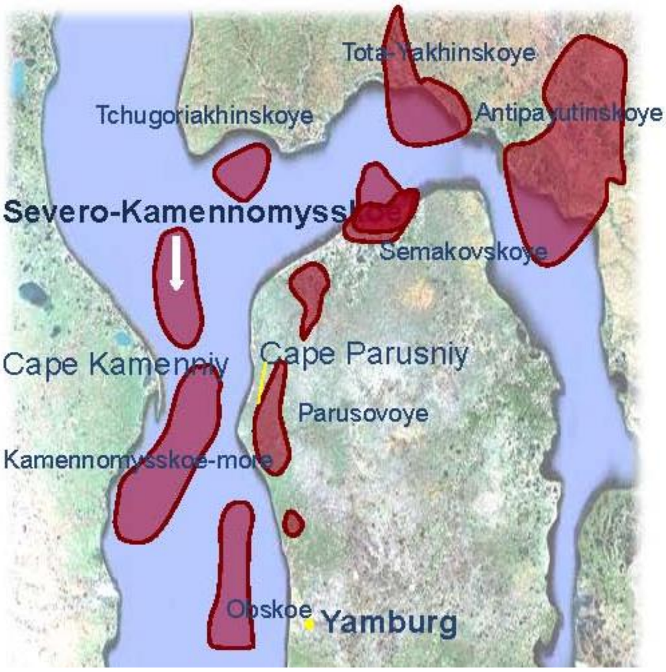

Figure 13.7.4: Location of Severo-Kamennomysskoye Field

Given the distance of the Severo-Kamennomysskoye development from the Yamal LNG Licence Area (some 300km) significant cumulative impacts with the Yamal LNG project are not anticipated.

13.7.3.3 OTHER EXISITING HUMAN ACTIVITY

The principal other relevant human activity in the area is reindeer herding. This is described in detail in Chapters 8 and 10 and issues associated with reindeer herding are further described in Section 13.7.5.

13.7.4 PLANNED AND POTENTIAL FUTURE ACTIVITIES

13.7.4.1 PLANNED AND POTENTIAL OIL AND GAS DEVELOPMENTS

Yamal Peninsula

A number of undeveloped oil and gas fields have been identified across the Yamal Peninsula (see Figure 13.7.1).

The current status of these fields and identification of planned activities has been assessed through review of available source materials, including:

- the Strategy for Development the Arctic zone of the Russian Federation and ensuring the national security for the period until 2020[7]
- the YNAO Strategy for socio-economic development until 2020 and the YNAO Territorial Planning Scheme
- the Strategy for socio-economic development of Yamalsky District until 2020
- Public hearings announcements on official government websites
- Expertisa notifications on official government websites
- Other public announcements.

Following this review, the status of the fields is shown in Table 13.7.1; no information is available on the other fields and it is assumed no significant development activities are likely to occur in those fields within the short to medium term and these are hence excluded from this assessment.

Table 13.7.1: Status of field developments in Yamal

Group of fields	Field	License holder	Development plans	Status / Public hearings, announcements; expertise
Bovanenkovskaya	Bovanenkovskoye	Gazprom	2012 - start of development	See Section 13.7.3.1
	Kharasaveyskoye	Gazprom	2014 - start of development	March 2013 – approval by SEE for individual well design for drilling of exploration well №2 within the Kara Sea offshore part of Kharasavey field
	Kruzenshternskoye	Gazprom	2021 - start of development	Oct 2013 –Programme of engineering geodesic, geological, hydrometeorological, ecological surveys has been submitted to SEE and currently is under consideration. Documents on exploration wells construction are also submitted (incomplete portfolio)
Kara Sea shelf	Rusanovskoye	Gazprom	Kara Sea offshore fields development is expected after 2025 (according to YANAO 2020 Strategy)	July 2011 – approval by SEE for Programme of marine engineering survey for exploration drilling on Kara Sea shelf (north-west Yamal shore) in the framework of OOO GAZFLOT geological survey in 2011-2013
	Leningradskoye	Gazprom		

[7] Approved by the RF President.

Table 13.7.1: Status of field developments in Yamal				
Group of fields	**Field**	**License holder**	**Development plans**	**Status / Public hearings, announcements; expertise**
Yuzhnaya	Novoportovskoye oil field	Gazprom neft	2012-2013 – start of development	March 2013 – public hearings in Mys-Kamenny and Novy Port (arctic offshore terminal) Nov 2013 - public hearings in Salekhard (oil and gas treatment and transportation facilities)
	Nurminskoye	Gazprom	2007 - strategic field	No information
	Maloyamalskoye	Gazprom	2010 – license holder JSC Tambeyneftegaz acquired by NOVATEK	No information
	Rostovtsevskoye oil field	Gazprom	2007 - strategic field According to the YANAO 2020 Strategy the development of this field is expected after 2020	By Aug 2013 the fields remains in the unallocated reserve fund.
	Neytinskoye	Gazprom	2007 - strategic field	No information
	Kamennomysskoye offshore gas field	Gazprom	2017-2020 - start of development 2013 - "Gazprom dobycha Yamburg" announced the start of the project engineering phase	See Section 13.7.3.2
Tambeyskaya	Severo-Tambeyskoye	Gazprom	2024-2027 - start of development	May 2013 – approval by SEE for construction of exploration wells
	Zapadno-Tambeyskoye	Gazprom	2007 - strategic field	May 2013 –approval by SEE for construction of exploration wells
	Yuzhno-Tambeyskoye	Yamal LNG (NOVATEK, Gazprom)	2018 – launch of LNG plant operation and field development	Refer to Chapter 4 for the status of public hearings and Russian Federation approvals for the Yamal LNG Project
	Tasiyskoye	Gazprom		May 2013 –approval by SEE for construction of exploration wells
	Malyginskoye	Gazprom		May 2013 –approval by SEE for construction of exploration wells

Of the fields in relatively close proximity to the South-Tambey licence area, the only identified planned activities are for exploration well development in the following fields (see also Figure 13.7.5):

- Severo-Tambeyskoye
- Zapadno-Tambeyskoye

- Tasiyskoye
- Malyginskoye

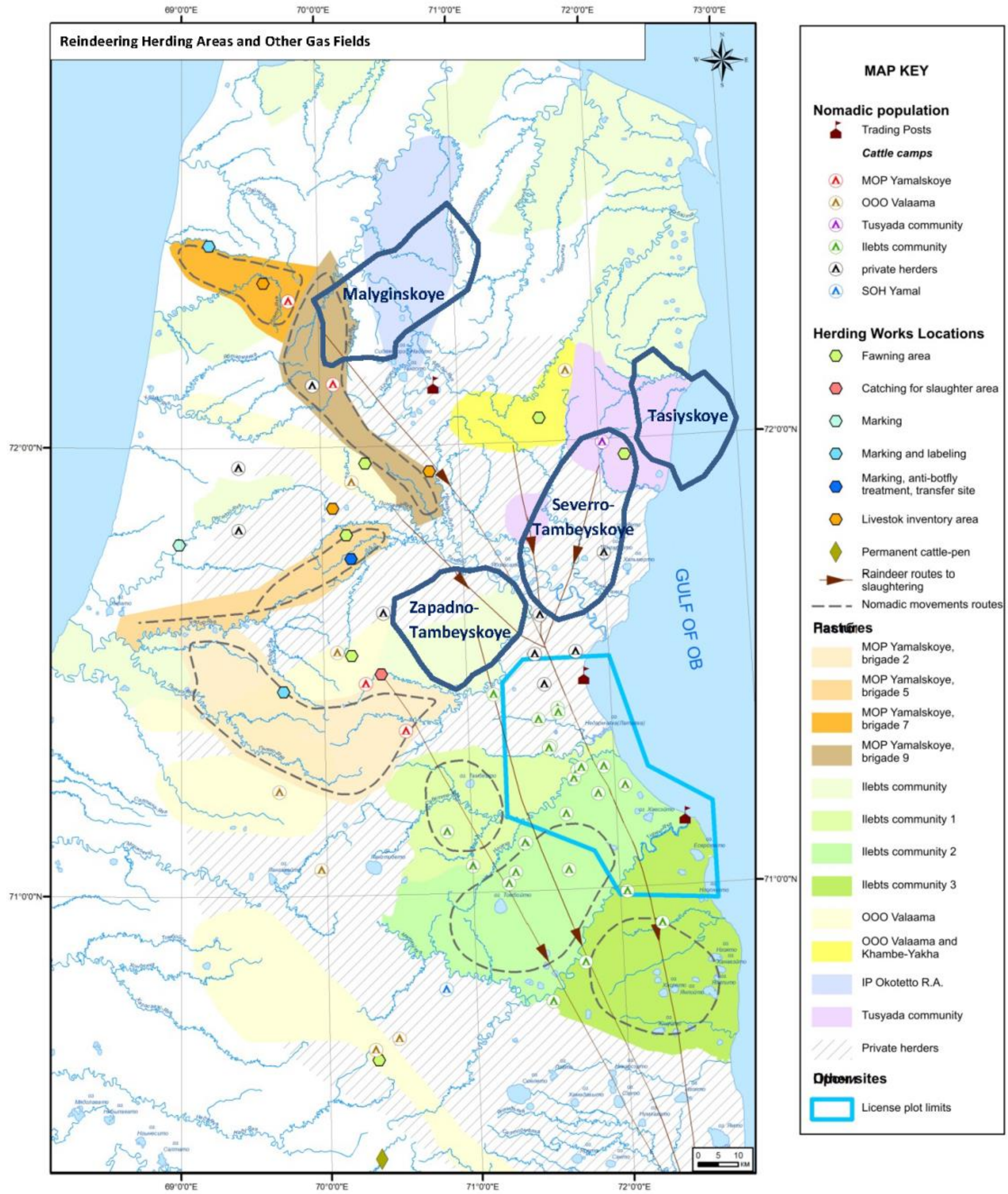

Figure 13.7.5: Fields in the nearest vicinity of the Licence Area

The likely activities associated with the development of exploration wells in these fields are considered within the context of this assessment. However, the viability of these fields remains uncertain until the completion of exploration drilling and project development within a five-year timeframe is unlikely. As such, assessment of any future project activities beyond the development of exploration wells in these fields is not considered realistic at this stage and hence these are only assessed in a high-level manner in the CIA (see Section 13.7.6 for further discussion).

Gydan Peninsula

Novatek has licences for the Geofizicheskoye and Salmanovskoye (formerly Utrenneye) fields on the Gydan Peninsula (see Figure 13.7.4) that are valid through 2031.

The Salmanovskoye field is located in the northern part of the Gydan peninsula on the shores of the Gulf of Ob in close proximity to the South-Tambeyskoye field, and was discovered in 1980. It is the largest field by recoverable reserves that has been found to date on the Gydan Peninsula. The field contains 34 hydrocarbon deposits, including 16 gas deposits, 15 gas condensate deposits, two oil and gas condensate deposits and one crude oil deposit. Proved reserves to SEC standards were estimated for the first time in 2012 and as of 31 December 2012 amounted to 235.2 bcm of natural gas and 8.6 mmt of liquid hydrocarbons.

The Geofizicheskoye oil and gas condensate field is located in the middle part of the Gydan peninsula on the shores of the Gulf of Ob. It was discovered in 1975 and contains 35 hydrocarbon deposits, including 19 gas deposits, 12 gas condensate deposits, three crude oil deposits and one crude oil and gas condensate deposit. Proved reserves to SEC standards were estimated for the first time in 2012, and as of 31 December 2012 amounted to 124.9 bcm of natural gas and 0.4 mmt of liquid hydrocarbons.

Long-term development options are not confirmed for the Salmanovskoye and Geofizicheskoye fields. However, options under consideration include the development of LNG facilities either on the Gydan peninsula or Yamal peninsula (requiring laying of pipelines across the Gulf of Ob), although precise locations for the LNG plant are not yet defined. Nonetheless, these potential development options will only be considered in a high-level manner in the CIA

13.7.4.2 OTHER POTENTIAL DEVELOPMENTS

The existing railway system on Yamal peninsula is shown in Figure 13.7.4 below. Potential extensions of the railway system have been mooted as follows (and shown on Figure 13.7.6 as ‘promising directions’):

- Bovanenkovo to Tambey
- Bovanenkovo to Kharasavey
- Payuta to Novy Port.

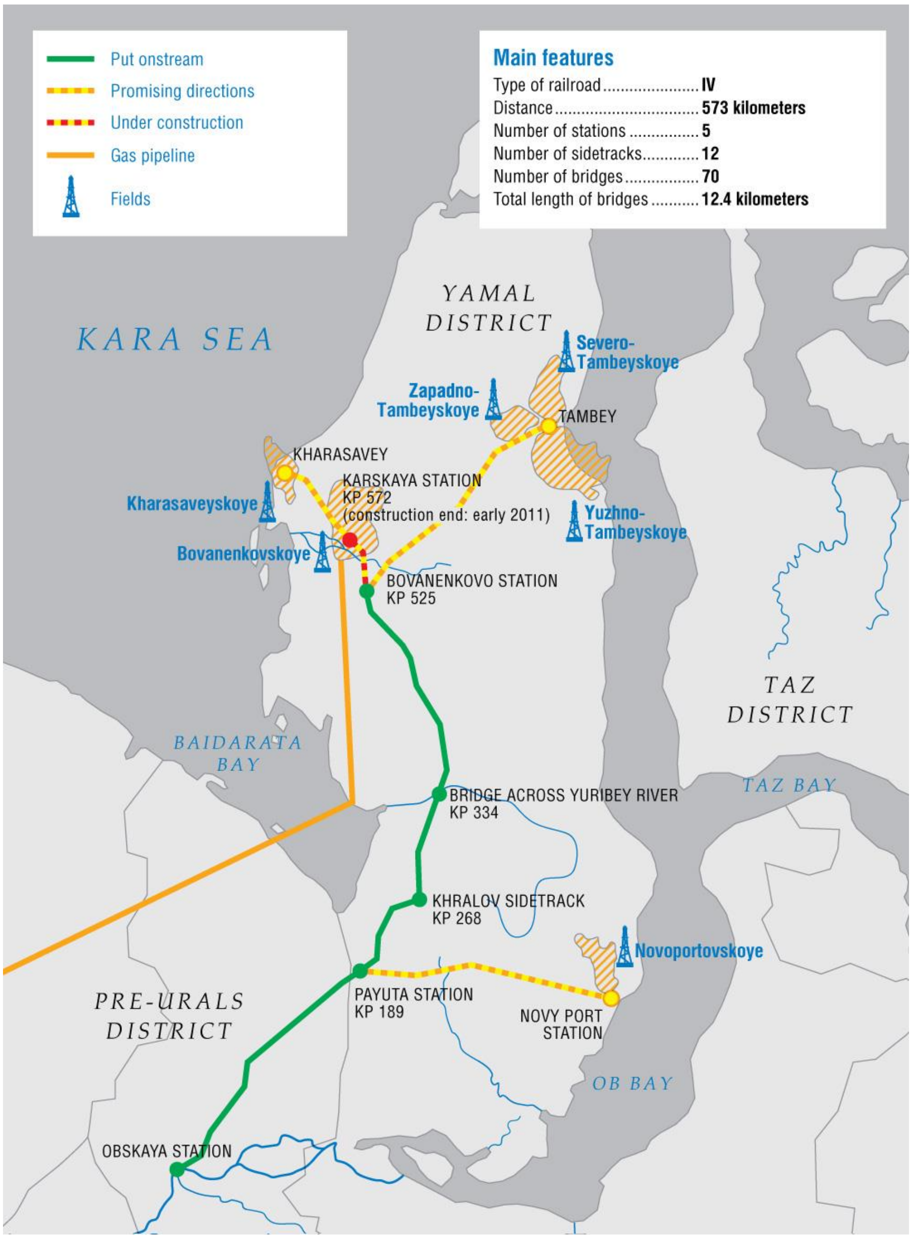

Figure 13.7.6: Existing Railways and Potential Future Extensions

Of these, an extension from Bovanenkovo to Tambey would be of most relevance in the context cumulative impacts with the Yamal LNG Project. However, at the time of writing, no firm plans or approvals for this railway extension is in place and it is therefore extremely unlikely that it would be realised within a five-year timeframe. As such, assessment of this potential railway extension is only assessed in a high-level manner in the CIA.

13.7.5 OTHER ENVIRONMENTAL PRESSURES

Reindeer herding is the principal non-oil and gas human commercial activity on the Yamal peninsula and is described in detail in Chapters 8 and 10. One of the key existing issues associated with reindeer herding is the pressure on suitable pasture lands due to potential over-grazing (see Chapter 7 and Figure 13.7.4).

Figure 13.7.7 Example of vegetation cover degradation due to overgrazing deer, north-western part of the Yamal LNG Licence Area

As described in Chapter 7, this potential impact would not only influence future reindeer herding in the region, but also the habitat of other fauna including avifauna.

Climate change also has the potential to lead to region-wide impacts in Yamal. Potential impacts include changes to the extent and depth of permafrost and changes to range of migratory species, for example polar bears in the event of changes to sea ice. However, the strength and nature of any such induced changes over the lifetime of the Project are highly uncertain. As such, the effects of climate change are discussed only in qualitative high-level terms in this CIA.

13.7.6 DISCUSSION

13.7.6.1 EXISITING DEVELOPMENTS

The only currently operating industrial development within the northern part of the Yamal peninsula is the Bovanenkovo field development. This development is over 100km from the Yamal LNG Project and the direct area of influence will not overlap that of the Yamal LNG Project. Potential cumulative impacts from the Bovanenkovo considered in the CIA are therefore limited to any potential VECs that are located in the AoI for both developments.

Given the distance of the Novoport field from the Yamal LNG project, the primary potential for cumulative effects relate to additional shipping in the Gulf of Ob between Cape Kamenny and the Northern Sea Route. This additional shipping is therefore considered within the CIA.

Given the distance of the Severo-Kamennomysskoye development from the South-Tambey Licence Area of Yamal LNG (some 300km) significant cumulative impacts with the Yamal LNG project are not anticipated. And this development is considered further within the CIA.

13.7.6.2 POTENTIAL FUTURE OIL AND GAS FIELD DEVELOPMENTS ON YAMAL

The nature of proposed exploration well developments in the Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye and Malyginskoye fields is not well defined at this stage. However, in general terms it would be anticipated that such developments would results in impacts associated with:

- Physical land take associated with well pads as well as accommodation camps, utilities etc. For exploration well drilling, it is anticipated that the scale of land take would be small compared to the operational Yamal LNG and Bovanenkovo projects.
- Flaring during well testing. Impact zones (e.g. for noise and air quality) from well testing within the exploration fields are unlikely to overlap spatially with one-another or with the Yamal LNG project. Temporal overlap is also unlikely due to the short duration of well test flaring.
- Land and surface water contamination. Such impacts should be readily controlled through the adoption of good practice measures. However, in the event that such controls are inadequately implemented these impacts could be more significant. It is noted (see Figure 13.7.3) that the catchment areas of the inland rivers within the Licence Area do not extend into the areas of the exploration fields. It is therefore not expected that these developments would impact on the rivers in the Licence Area. Impacts to the rivers in the exploration fields do have the potential to impact on freshwater and anadromous species that are also present in the Projects AoI (the Licence Area and, in the case of anadromous species, offshore dredging areas). However, given the low level of impact to anadromous fish in both inland rivers and in the Gulf of Ob, together with the relatively small footprint (and therefore impacts) of the exploration fields, significant cumulative impacts are not expected.
- Access utilities. The methods by which workers and equipment would be transported to other exploration fields is unknown. However, it is possible that use would be made of the seaport and airport at Sabetta. In this event, the increased level of use at these facilities within the Project Licence Area is unlikely to be significant (due to the scale of the exploration works relative to the Yamal LNG development Project). However, onward transport from Sabetta to the exploration fields has the potential to both overlap the Project AoI and also to affect receptors (e.g. birds) present both in the Licence Area and elsewhere along the transport route to the exploration fields.
- Influx of people. Workers from outside of the Yamal District or YNAO are likely to be required as part of the well exploration works. The number of workers would be relative small compared to both the Yamal LNG Project operational and, more specifically, construction workforce in the Licence Area. Nonetheless, if not properly controlled, these workers have the potential to impact on nomadic reindeer herders in the region, including those that migrate annually through the Yamal LNG Licence Area (see Figure 13.7.3). The presence of a large non-local workforce in the area may also negatively influence local tangible and intangible cultural heritage, as well as lead to short-term impacts on the capacity of regional community infrastructure and services.
- No offshore components are known to be included as part of the well exploration works.

It cannot be known at this stage which (if any) of the xploration fields will be developed for production, and the precise nature of any such development is impossible to define at this stage. Therefore, this CIA considers the different types of development in general terms only and, by necessity, assesses such developments in a high-level and highly qualitative manner.

It is likely that any field development would entail a number of well sites connected to central gathering facilities by pipelines and other associated infrastructure (roads, transmission lines etc.), of a generally similar nature to that planned for the Yamal LNG Project well clusters. The precise scale of any such production facility networks would depend on many factors, including the nature of field resources and the structure of reservoirs etc. Nonetheless, based on the approximate sizes of the fields (see Figure 13.7.3), the scale of the physical footprint of each field may be comparable to (or perhaps smaller than) the Yamal LNG Project. In general terms, and notwithstanding site-specific sensitivities, the potential impacts of developments of this type would be similar in nature to the Yamal LNG Project. In-field processing and export facilities for such field developments are currently unknown, although a (non-comprehensive) theoretical range of potential high-level options is summarised in Table 13.7.2 below.

Table 13.7.2: Illustrative High-Level Field Development Options

General aspect/option	High-level option	Sub-option	Additional aspects
Processing Options	No/limited processing	-	Oil/gas pipeline export or crude export by sea
	3 phase separation prior to export	Intra-field (dedicated) facilities	New facilities
		Inter-field (shared) facilities	New shared facility
	LNG for export (LNG plant would need to be constructed near seaport – see below – and would require pipelines from field to LNG). Maybe onshore or offshore LNG.	Intra-field (dedicated) facilities	New facilities
		Inter-field (shared) facilities	New shared facilities
			Expansion of Yamal LNG facilities
Export by trunk pipeline	Pipeline to south of Yamal peninsula	Link to existing network (note capacity issues)	Requirement for compressor/booster stations
		New trans-Russian pipeline network	
	Pipeline via sea	Export locations include to ice-free locations to the west (e.g. Kanin Nos)	Would require further infrastructure at destination (LNG, tanker loading etc. – see above and below)
Export via marine vessels	There are a variety of port/mooring location options around peninsula. (Note need for pipeline links between field and seaport)	Dedicated field seaport	New facilities
		Shared seaport	New shared facilities
			Expansion of existing

Table 13.7.2: Illustrative High-Level Field Development Options

General aspect/option	High-level option	Sub-option	Additional aspects
			facilities
	Design options for oil and gas loading facilities	Jetty/port	-
		Offshore mooring	LNG would require cryogenic pipeline
		Offshore LNG plant and mooring	-

The above table is provided for illustrative purposes only, but it demonstrates the wide range of different development types that could theoretically take place in the longer term. In reality, the actual field developments in the region may include any combination of the broad options above (or indeed other, more novel, options). It is particularly important to recognise that the theoretical development options encompass a wide variety of possible physical locations, and therefore site-specific assessment is generally not possible within the CIA.

Given the above uncertainties, consideration of potential future oil and gas developments is restricted to the generic development types summarised in Table 13.7.3.

Table 13.7.3: Generic Types of Third Party Field Developments Considered in CIA

Type		Example facility types	Example potential impacts
Onshore developments	Linear facilities	Pipelines, transmission lines, roads	Reindeer migration route disruption, habitat fragmentation, spill risk, river crossing impacts, permafrost impacts, etc.
	Discrete (non-linear) facilities	Well pads, processing facilities	Light, noise, air emissions, aqueous emissions, land-take, permafrost, etc.
	Networked facilities	Clustered intra-field combinations of discrete and linear facilities	See above

Table 13.7.3: Generic Types of Third Party Field Developments Considered in CIA

Type		Example facility types	Example potential impacts
Offshore/coastal developments	Coastal facilities	Ports/jetties (assumed within the Gulf of Ob)	Noise (including construction piling), sedimentation (dredging), spills, etc.
	Shipping	Vessel traffic, ice-breakers, shipping channels	Noise, spills, sedimentation (dredging of channels), ice-breaking, etc.
	Offshore facilities	Offshore pipelines, offshore loading mooring/loading	Noise (including construction piling), sedimentation and noise (trenching/armouring/ dredging), spills, etc.

Aspects associated with transport (excluding intra-field roads which are considered above) for these potential field developments are discussed separately in Section 13.7.6.6.

13.7.6.3 POTENTIAL FUTURE OIL AND GAS FIELD DEVELOPMENTS ON GYDAN

Potential future development of the Salmanovskoye and Geofizicheskoye fields includes options for LNG export via the Gulf of Ob. Such developments would have the potential to impact cumulatively with the Yamal LNG project, particularly in relation to:

- Air emissions from the LNG (depending on location relative to the Yamal LNG facilities)
- Physical disturbance to the Gulf of Ob during construction (e.g. in relation to any necessary dredging of shipping areas or trenching of any pipelines)
- Increased shipping within the Gulf of Ob

Given the uncertain nature of these developments, the potential future cumulative impacts identified above are only assessed in a high-level manner in the CIA.

13.7.6.4 PROJECT EXPANSIONS

No Project expansions (e.g. additional LNG trains) are currently identified within the Licence Area, although the potential need for an additional booster compression capacity has been identified. Nonetheless, the potential for such expansions is considered qualitatively in the CIA (and CIA scoping).

13.7.6.5 RAILWAY

The development of future railway links in the region remains uncertain and there are no known firm plans of potential future routes. Therefore, potential impacts are assessed in a generic manner within the CIA through consideration of the impacts associated with a potential east-west linear development (potential impacts include habitat fragmentation, disruption of reindeer migration routes, river crossings etc.). Aspects associated with the more general development of transport links in the Yamal peninsula are discussed separately in Section 13.7.6.6.

13.7.6.6 GENERAL TRANSPORT LINKS

There is a number of existing, planned and potential future transport infrastructure developments on the Yamal peninsula. These are summarised in the Table 13.7.4 below.

Table 13.7.4: Existing, Planned and Potential Future Transport Developments

Status	Region	Transport mode	Commentary
Existing/ confirmed plan	Bovanenkovo	Airport	Project use for intra-field helicopter transport and staff transfer to/from region.
		Railway	Project use for intra-field helicopter transport and staff transfer to/from region. Potential for non-Project transport
	Yamal LNG / Sabetta	Sabetta seaport	Dedicated YLNG berths See below for potential for non-Project shipping transport
		Sabetta airport	Project use for intra-field helicopter transport and fixed-wing staff transfer to/from region. Potential for non-Project transport
Unconfirmed Potential future	Sabetta	Future development of Sabetta seaport	Potential for non-Project transport
	General regional	Potential railway extensions (e.g. east-west – see Section 13.7.6.5)	Potential for range of users for intra and inter-regional transport for people and goods.
	Future third party field developments	Potential airfields (e.g. heliports)	Could include (i) helicopter links to existing/planned airports at Bovankov or Sabetta for staff transfer to/from region and/or (ii) intra-field personnel transport.
		Potential seaport (assumed within Gulf of Ob)	Potential for field-specific and wider transport.

Potential direct impacts associated with these transport developments (noise etc.) are considered in the CIA. Of particular potential importance in this regard, is the possibility for intra- and inter-field helicopter transport of personnel for future field developments to/from the existing airports at Sabetta and Bovanenkovo.

The general development of transport infrastructure in the Yamal region may also have wider indirect implications (i.e. not related to oil and gas field development). These are summarised and discussed below:

- **Links to regional services.** Extended transport infrastructure would have the potential to provide increased access to regional services, including education and medical facilities. This would represent a potential benefit to local communities. These potential positive impacts have been considered in the CIA.
- **Links to wider markets.** The potential rail, sea and air links have the potential to provide increased ability for the import and export of goods to/from the region. This has the potential to provide economic benefits to the local communities, including nomadic indigenous people, in terms of improved access to imported goods and also opening up improved export markets for local products (including reindeer products). These potential impacts have been considered in the CIA.
- **Support industry/'camp followers'.** There is a theoretical potential that any improvements to the transport infrastructure could lead to the development of support industries and 'camp followers'. However, there is currently no indication that such developments have occurred to date and the harsh arctic climate reduces the likelihood of this occurring to a significant extent, at least in the short to medium term. This issue is therefore not considered further within the CIA.

13.8 BASELINE

13.8.1 NATURAL TUNDRA HABITATS

The habitat types within the Project Licence Area have been assessed in detailed and are described in Chapter 7. Of note, habitats within the Licence Area are assessed as meeting the IFC Performance Standards (PS) criteria for Critical Habitat as follows:

- Critical Habitat under PS6 Criterion 4 for highly threatened and/or unique ecosystems, and specifically Forb-graminoid, horsetail-graminoid meadow communities. Further details on the habitat types in the context of cumulative impacts are discussed below

The vegetation of the Arctic region has been mapped at the 1:7,500,000 scale using false colour infrared (CIR) imagery (based on 1 km x 1 km pixel resolution)[8]. Vegetation types were classified into five broad physiognomic categories, which were further subdivided into 15 vegetation mapping units. The vegetation of the wider Yamal region is shown in Figure 13.8.1. The vegetation within the northern Yamal peninsula includes a number of vegetation categories:

- P1. Prostrate dwarf shrub, herb tundra

[8] CAVM Team. 2003. Circumpolar Arctic Vegetation Map. (1:7,500,000 scale), Conservation of Arctic Flora and Fauna (CAFF) Map No. 1. U.S. Fish and Wildlife Service, Anchorage, Alaska. ISBN: 0-9767525-0-6, ISBN-13: 978-0-9767525-0-9

Dry tundra with patchy vegetation. Prostrate shrubs < 5 cm tall (such as Dryas and Salix arctica) are dominant, with graminoids and forbs. Lichens are also common.

- S1. Erect dwarf shrub tundra

  Tundra dominated by erect dwarf-shrubs, mostly < 40 cm tall.

- S2. Low-shrub tundra

  Moist tundra dominated by low shrubs >40 cm tall sometimes on permafrost-free soils. Peatlands with permafrost are common in wet areas.

- W1. Sedge/grass, moss wetland

  Wetland complexes in the colder areas of the Arctic, dominated by sedges, grasses, and mosses.

- W2. Sedge, moss, dwarf-shrub wetland

  Wetland complexes in the milder areas of the Arctic, dominated by sedges, grasses, and mosses, but including dwarf shrubs < 40 cm tall.

- G2. Graminoid, prostrate dwarf-shrub, forb tundra

  Moist to dry tundra, with open to continuous plant cover. Sedges are dominant, along with prostrate shrubs < 5 cm tall.

- G3. Non-tussock sedge, dwarf-shrub, moss tundra

  Moist tundra dominated by sedges and dwarf shrubs < 40 cm tall, with well-developed moss layer. Barren patches due to frost boils and periglacial features are common.

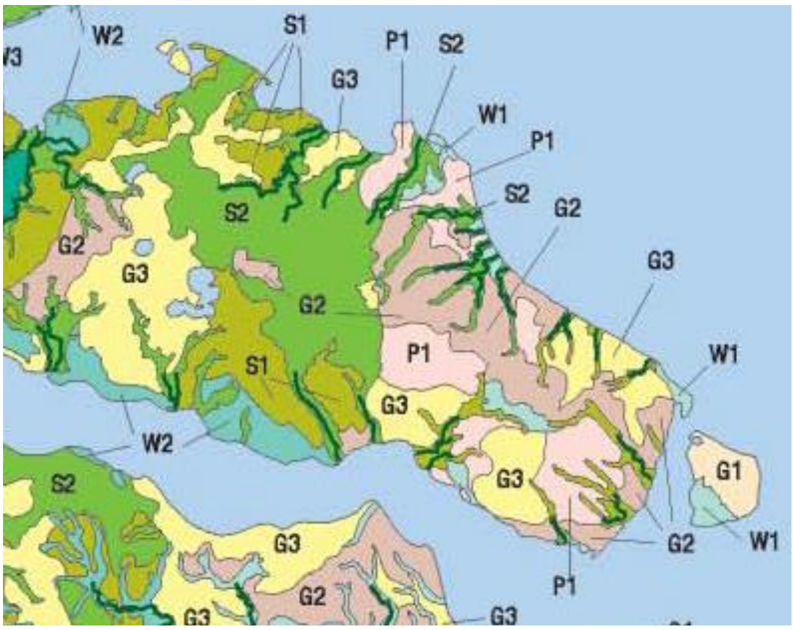

Figure 13.8.1: Vegetation categories within the YNAO

Review of the above data suggests that the known development fields in Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye, Malyginskoye and, to a lesser extent, Bovanenkovo all share similar habitats to those prevalent in and around the Project Licence Area, namely types P1, S1, S2 and G3. A potential railway extension between Bovanenkovo and Tambey would potentially also run through these habitat types. The potential development fields on the Gydan peninsula would potentially be located in habitat types S2, G2 and G3.

Permanent permafrost is present across almost the entirety of the Yamal peninsula. The depths of the seasonally thawed layers (STL) on the peninsula are shown in Figure 13.8.2 below, which also shows the seasonally frozen layer (SFL) depths in the most southern portions of the peninsula.

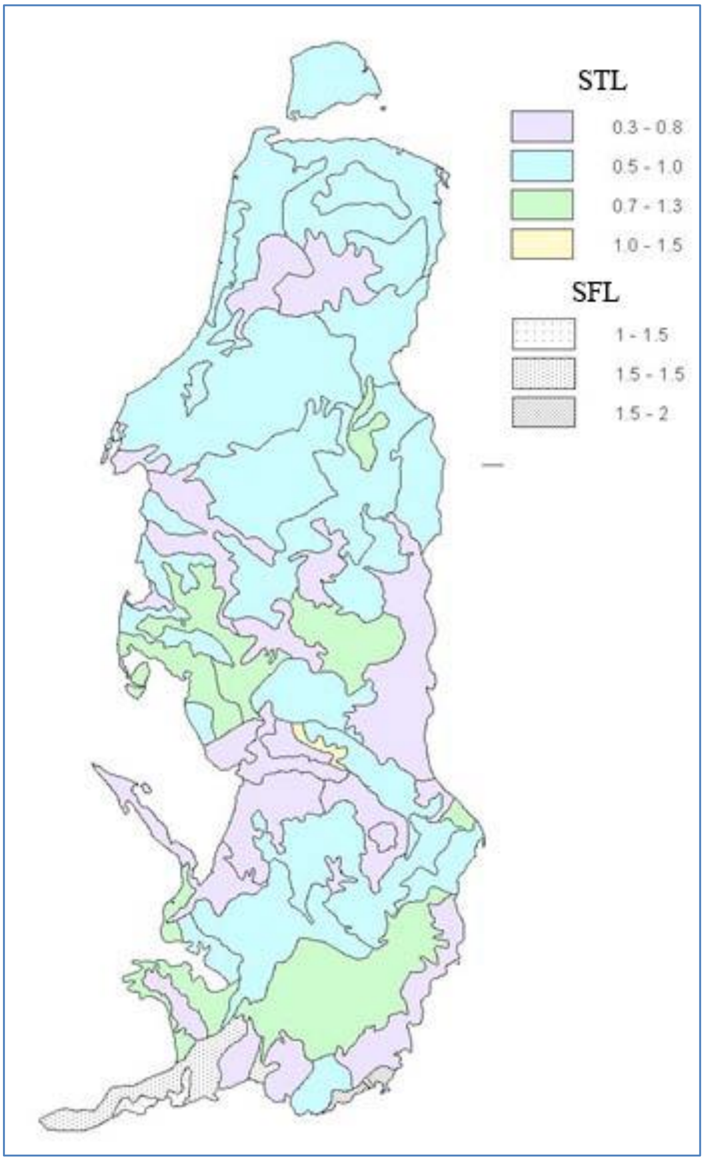

Figure 13.8.2: Permafrost zones on the Yamal Peninsula[9]

Vegetation within the Arctic is strongly influenced by climatic factors and across the region vegetation types display a strong latitudinal climatic gradient. This gradient can be divided into five

[9] Orekhov *et al*, http://www.geobotany.org/library/talks/OrekhovPT2010_yamal_tal100408.pdf

broad 'bioclimatic zones' (A-E), where A is the coldest and E the warmest [10,11]. The remote sensing work completed by the Circumpolar Arctic Vegetation Map (CAVM) Team (2003) indicates that the Yamal LNG and Bovanenkovo Projects are situated in the transition between zone C and zone D (see Figure 13.8.3).

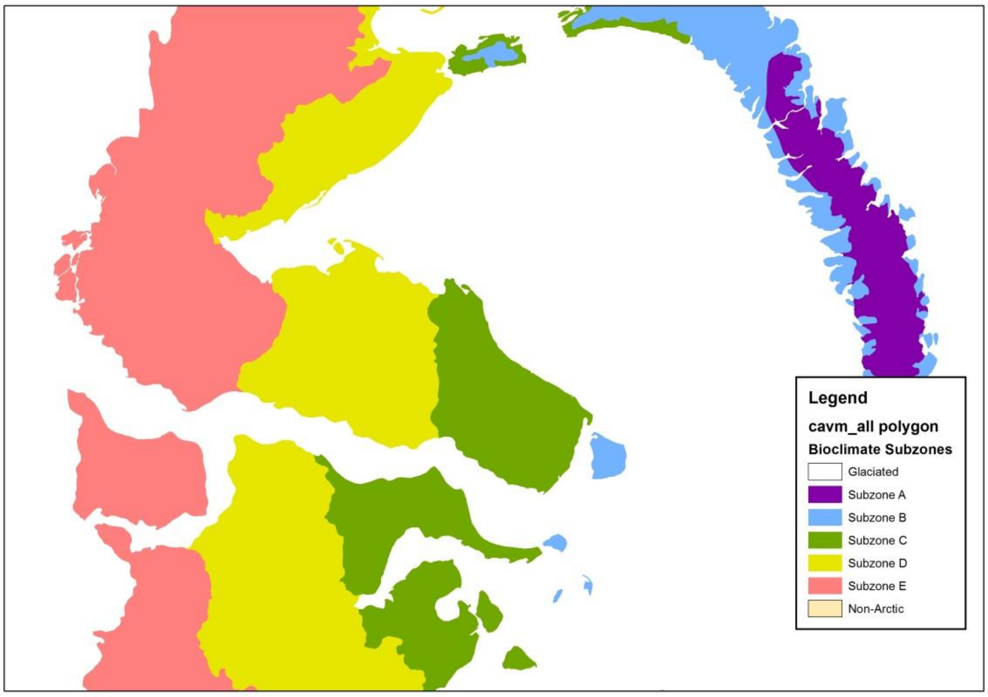

Figure 13.8.3: Yamal Peninsula Bioclimatic Subzones (CAVM Team, 2003)

This boundary is broadly equivalent to the boundary between typical hypoarctic (sub-arctic) and arctic tundras as classified by Yurtsev (1994[12]), or between High and Low Arctic tundra as classified by Bliss (1997)[13]. This boundary marks a significant change in vegetation types, influenced by both climate and soils. During the summer, zone D is influenced by periods of relatively warm air from the south. In contrast, zone C experiences predominately colder arctic air masses. The boundary between zones C and D also marks a general shift from relatively moist tundras on peaty soils in the south to drier tundras on mineral soils in the north. Dominant plant growth forms in zone D comprise erect dwarf shrubs, sedges and mosses, whereas zone C is characterised by hemi-prostrate and prostrate dwarf shrubs and sedges. Zone D also tends to

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[10] Elvebakk, A. 1999. Bioclimatic delimitation and subdivision of the Arctic. I. Nordal, V.Y. Razzhivin (eds.) The Species Concept in the High North - A Panarctic Flora Initiative. The Norwegian Academy of Science and Letters. Oslo. pp. 81-112

[11] Walker, D.A., Raynolds, M.K., Daniëls, F.J.A., Einarsson, E., Elvebakk, A., Gould, W.A., Katenin, A.E., Kholod, S.S., Markon, C.J., Melnikov, E.S., N.G., M., Talbot, S.S., Yurtsev, B.A., CAVM Team 2005. The Circumpolar Arctic Vegetation Map. Journal of Vegetation Science. 16(3):267-282

[12] Yurtsev, B.A. 1994. The floristic division of the Arctic. Journal of Vegetation Science. 5:(6):765-776

[13] Bliss, L.C. 1997. Arctic Ecosystems of North America. F.E. Wielgolaski (eds.) Polar and Alpine Tundra. Elsevier. Amsterdam. pp. 551-683.

have a greater percentage of plant cover (50-70%) compared to zone C (5-50%) and greater species diversity (125-250 species in zone D, compared to 75-150 in zone C).

The other nearest development fields on Yamal (Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye and Malyginskoye) and Gydan (Geofizicheskoye and Salmanovskoye) are situated in Zone C.

No specific pre-determined 'thresholds' are defined tundra habitat, although it is recognized that the prevailing climate conditions general result in slow levels of vegetation recovery following any disturbance. Issues specific to nesting bird habitat and reindeer pastures are discussed in Sections 13.8.2 and 13.8.3 respectively.

13.8.2 AVIFAUNA

Characterisation of avifauna within the Project Licence Area is described in Chapter 7.

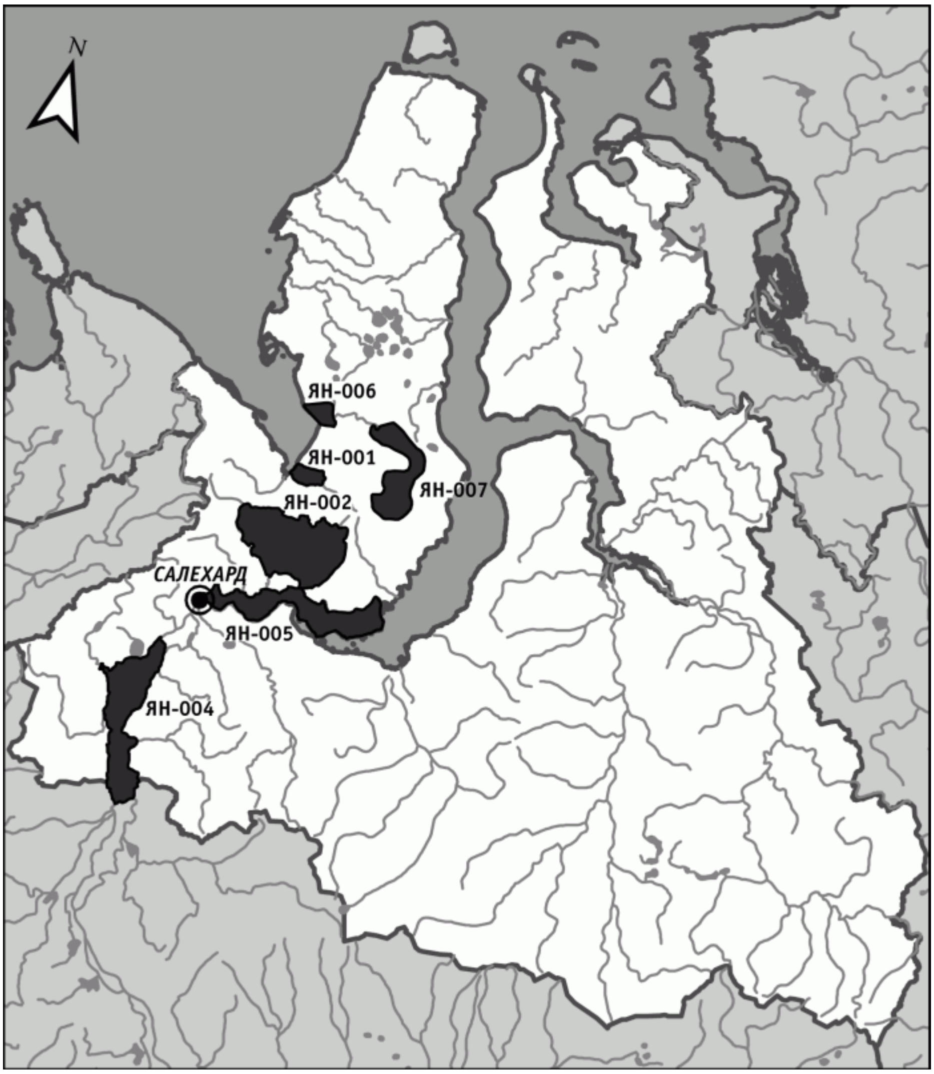
The majority of the breeding bird species present in the Project Licence Area are long-distance migrants. As described in Chapter 7, Discrete Management Units (DMUs) for breeding birds habitats, and estimation of the size of the bird populations within them, is currently difficult to determine due to data deficiency. Key among the uncertainties in this regard is the uncertainties in bird densities identified in 2013 due to the atypical conditions encountered, although breeding bird density estimates within Project Licence Area have been produced by earlier studies. In order to further investigate the nature of the DMUs and the potential breeding bird habitats within them, further surveys will be required, and these will be developed as part of a Biodiversity Action Plan (BAP). Yamal LNG has committed to reinstatement of legacy waste and contamination areas within the Licence area reinstated (see also Chapter 11), and consideration of such reinstatement will be included within the BAP in order the best return these areas to usable habitat and to act as potential partial offsets for any habitat loss. .

Of the birds having been previously recorded breeding within the Project Licence Area, a number have been assessed as threatened by either the IUCN, RDB RF and/or RDB YNOA.

- **Black-throated diver** *(Gavia arctica)* assessed as category 2 (by the RDB RF). Not included in RDB YNAO and assessed as Least Concern by IUCN RL.
- **Brent goose** (*Branta bernicla*) assessed as category 3 by the RDB RF. Not included in RDB YNAO and assessed as Least Concern by IUCN RL.
- **Steller's eider** (*Polysticta stelleri*). Not included in RDB RF or RDB YNAO. Assessed as Vulnerable (VU) by IUCN RL.
- **Long-tailed duck** (*Clangula hyemalis*). Assessed as Vulnerable (VU) by IUCN RL. Not included in RDB RF or RDB YNAO.
- **Peregrine** (*Falco peregrinus*). Included in the RDB RF (category 2) and RDB YNAO (category 3) and assessed as Least Concern by IUCN RL.
- **Snowy owl** (*Bubo scandiaca*). Listed within RDB YNAO (category 2). Not included in RDB RF and assessed as Least Concern by IUCN RL.

Data on breeding birds in the wider Yamal region are limited. However, neither the Project Licence Area nor the other industrial developments identified in the Phase 2 Scoping are located within Important Bird Areas (IBAs) (although Novoport field is relative close to IBA area Jan-007). The

IBAs within Yamal peninsula are Jan-006 and Jan-007, located over 250 km to the south (Figure 13.8.4).



Source: Yamal LNG OVOS documentation

Figure 13.8.4: Location of Important Bird Areas

Literature reviews indicate that the majority of Arctic bird species occurring on the Yamal Peninsula have a palearctic or circumpolar distribution. The avifauna in the Arctic tundra subzone in the north-eastern parts of the Yamal peninsula includes about 80 bird species, of which 52 are likely to breed (46 confirmed and six probable), five species are transient migratory and around 25 species are vagrant. The proximity of the coast, together with the large area of wetlands means that aquatic and semi-aquatic bird species are common in the Yamal. This is reflected in the relative diversity of wetland bird species, including 30 species of waders (*Charadriiformes*), of which 21 breed and 18 species of geese and ducks (Anseriformes), of which 11 breed (Rutilevsky, 1977)[14]. The absence of trees and low density of shrubs in the tundra habitats limits the populations of species typical of sub-arctic tundra. This is reflected by the relatively low diversity of passerine

[14] Rutilevsky G.L. (1977) Wildlife - Yamal Gydanskaya area. Gidrometeoizdat. Pp. 226-260.

species (*Passeriformes)* (20 in total, of which 11 breed). Most bird species are migratory summer visitors, with only around ten species wintering in the area.

Review of surrounding habitat types (see Section 13.8.1) may also give an indication of the likely suitability of habitat for the breeding birds in the wider area. As the known development fields in Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye, Malyginskoye and, to a lesser extent, Bovanenkovo and Gydan fields all share similar habitats to those prevalent in and around the Project Licence Area, it is therefore conservatively assumed that the areas within these fields potentially provide habitat for the breeding birds identified in the Project Licence Area.

Increased numbers of reindeer on the Yamal peninsula (see Chapter 7 and 8) have resulted in overgrazing of pasture lands, some of which is suitable nesting bird habitat. Detailed information on the extent of pastures that have been affected by overgrazing is not available at the regional scale, although the area of lichen tundra in the Yamal has reportedly reduced dramatically over the last few decades. Over-grazing of upland areas within the Licence Area has been identified, which has reduced suitable nesting habitat and is likely to have negatively influenced the density and breeding success of birds in the region (see Chapter 7 for further details).

13.8.3 NOMADIC INDIGENOUS REINDEER HERDERS (AND THEIR REINDEER)

Baseline characterisation of nomadic reindeer herders within northern Yamal is described at both the regional levels and specific to the Project Licence Area in Chapter 8. Land use of the indigenous peoples in northern Yamal is summarised in Figure 13.7.5 in terms of:

- Pasture areas used by various reindeer herder groups/communes
- Annual migration routes
- Location of both the Yamal LNG Licence Area and the location of the main other oil and gas fields for which exploration licences have been granted.

Annually (once per year in autumn) the herds of the Tusyada Commune, Khabeyakha Commune, SPSK Ilebts, Brigade #9 of MOP Yamalskoye and Brigade #4 of OOO Valama are driven to the slaughtering facility through the license area. In addition, herds of Brigade #2 of MOP Yamalskoye are driven in the direct vicinity of the license area to the slaughtering facility in Seyakha. There are three routes for driving reindeer herds to the slaughtering facility (see Figure 13.7.5) as follows:

- Route #1

  The main route for driving reindeer herds to the slaughtering facility is located in the eastern part of the peninsula. It is used by Brigade #9 of MOP Yamalskoye, Brigades #4 and #5 of OOO Valama, and the Tusyada and Khabeyakha Communes. A reindeer herd for slaughtering is prepared by each of the above groups independently and driven to a gathering station located in the upper reaches of a nameless watercourse tributary to the Nganorakhayakha River, where the herds are combined to form a joint herd, which is then driven along the final section of the route. The route enters the Project licence area 3 km to the south of the gathering station. The route then runs southwards, crossing the Nganorakhayakha River in its middle reaches (15 km from the river mouth) and the lower reaches of the Khalmeryakha River, and then exits the licence area 2 km to the west from the upper reaches of the Yavitarka River.

- Route #2

  This route runs through the western part of the licence area and is used by Brigade #5 of MOP Yamalskoye and by reindeer herders from one of the divisions of SPSK Ilebts. The herds enter the licence area in the middle reaches of the Yabta-Nedarmayakha River and the middle reaches of the Khunzerngedatarka River, and exit the licence area in the vicinity of Punsito Lake.

- Route #3

  This route runs to the west of the licence area without crossing its boundary and is used by Brigade #2 of MOP Yamalskoye. The route runs from the middle reaches of the Varyakha River through the middle reaches of the Yalyatarp-Khalmeryakha River - the mouth of the Tyrabeiyakha River (a right-hand tributary of the Sabetayakha River) - the Tomboyto Lake - the Serto Lake to the settlement of Seyakha.

Information on reindeer herding in the vicinity of the Bovanenkovo field is available in Kumbula *et al*[15] and identifies that the field is on the migration path of two major Yarsalinski reindeer brigades. These brigades reach the gas field from the south in early to mid-July on their way to the Kara Sea coast, where reindeer are brought for access to insect relief and high-quality forage. The brigades return through Bovanenkovo in mid to late August when they start migration towards their winter pastures on the south side of the Ob River. In addition, Kumula reports that at least a dozen private reindeer herding camps use the larger Bovanenkovo area as reindeer grazing grounds. In comparison to the brigades, they reportedly have smaller herds and shorter migration routes, and their presence in the vicinity of the gas field is longer, lasting from early summer until October–November. Very little is known about the exact migration patterns of these private herders. According the Bovanenkovo field developers' website[16], there are special crossings of utility lines to enable free migration of reindeer.

Reindeer herders use the pasture lands for reindeer herding and also undertake seasonal fishing, hunting and gathering as described in Chapter 8.

Numbers of reindeer and reindeer herders in the Yamalsky District has risen significantly in recent years (see Chapter 8). Evidence of overgrazing and reduction in suitable pastures lands indicates that reindeer husbandry may be close to or above carrying capacity, at least on the traditionally used pastures area/routes, although ongoing research is required at the district/regional authority level to confirm. In addition, reindeer numbers can be affected by unusual weather events, and this has occurred in the winter of 2014, where significant reindeer die-off has been reported due to animals struggling to forage for lichen under snow crust formed after unusually heavy snow.

13.8.4 FISH AND FISHERIES

One fish species, the Siberian Sturgeon (*Acipenser baerii*) is identified as a VEC partly on the basis of its conservation status. The Siberian Sturgeon is semi-anadromous and is present in

[15] Remote Sensing and Local Knowledge of Hydrocarbon Exploitation: The Case of Bovanenkovo, Yamal Peninsula, West Siberia, Russia, T. Kumpula, B.C. Forbes and F. Stammler, Arctic, Vol. 63, NO. 2 (June 2010) P. 165–178

[16] http://www.gazprom.com/about/production/projects/deposits/bm/

large rivers on the Yamal peninsula as well as coastal waters of the Gulf of Ob. However, it has not been identified as being present in rivers within the Project Licence Area. The Siberian sturgeon is listed as Endangered (EN) on the IUCN RL, Category 2 in the RDB RF and Category 1 in the RDN YNAO. This species can be found in all types of freshwater benthic habitats in large rivers and lakes. It spawns in strong-current habitats in the main stream of large and deep rivers on stone or gravel bottom. From the 1930s to 1990s annual sturgeon catches have declined in the Ob river basin (which is estimated to contain 80 percent of the global population) by 99.5 percent. Water pollution from mining has caused abnormalities in reproductive systems of female Siberian sturgeon in Ob populations. Natural reproduction of the Ob River population has significantly decreased mainly due to damming (Ruben and Bin Zhu, 2010)[17]. It is a highly valued capture fish species.

Other fish species are identified as VECs on the basis of their commercial/capture fishery value. Example species of primary importance and relevant to the CIA are briefly summarized in the table below, with further details provided in Chapter 7.

Table 13.8.1: Capture fish species

Fish Species	Range Within Yamal	Species Ecology	Commercial Value	Local Population Status[1]
Siberian vendace - *Coregonus sardinella*	Enters large rivers of Yamal	Semi-anadromous, more rarely - lake fish	Very important commercial fish	Middle-size population species
Arctic cisco - *Coregonus autum nalis*	All Yamal rivers	Semi-anadromous fish	Very high commercial value	Large population
Round-nosed whitefish – *Coregonus nasus*	Large Yamal rivers, not found further north than the Tambey river basin	Lake-river fish	High commercial value	Population: low
Muksun – *Coregonus muksun*	Large Yamal rivers, not found further north than the Tambey river basin	Semi-anadromous cisco	Most valued commercial fish	Low numbered species.
Burbot – *Lota lota*	Large rivers of Yamal	Freshwater lake-river fish	Valued commercial fish	Middle size population
Navaga – *E. navaga*	Enters large rivers of Yamal	Sea species. Bottom, littoral, cold water fish	Valued commercial fish	Middle size population

[17] Ruban, G. & Bin Zhu 2010. *Acipenser baerii*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 28 November 2013.

Fishing enterprises include both municipal and state-owned entities as well as private associations (communes, cooperatives and small private undertakings). Indigenous people constitute the largest workforce in the fishing industry. Currently, fishing practices draw on traditional methods using nets and the migration of indigenous fishermen between the fishing areas accompanied by their families. Officially, the fishing areas in the region are assigned to the enterprises while the indigenous population typically fish without a special permit or allocation of individual fishing grounds. Informal fishing also occurs, although limited information on this is available.

Fishing on water bodies in the region is run mainly by the local population (reindeer farmers, trading post workers, and oil industry workers). Fishing is seasonally based as follows:

- Springtime fishing – June and July;
- Summertime – July to September;
- Autumn – September and October;
- Ice fishing – October to December; and
- Wintertime fishing – November to May.

Detailed fishing statistics specific to the Yamal Peninsula and the Gulf of Ob are not available.

13.8.5 MARINE MAMMALS

Cetaceans

The following three species of whales are thought to have the potential to occur in the Gulf of Ob, although year-round use is excluded by fast sea ice and no cetaceans were recorded during the 2013 marine mammal survey (see Chapter 7 for further details).

- Beluga whale (*Delphinapterus leucas*). Almost nothing is known about population abundance of beluga in the Russian sector of the Arctic, in a continuum including the Kara, Laptev and East Siberian Seas (Reid *et* al, 2013.). They are the most abundant cetacean in the Kara Sea, which provides an important summer feeding area for the species. Kara Sea beluga whale populations over winter in the Barents Sea (Culik, 2010)[18]. The beluga whale is classified on the IUCN RL as Near Threatened (NT), but is not included in the RDB RF and is included in the RDB YNAO as insufficiently studied and uncertain in status (category 4).
- Fin whale (*Balaenoptera physalus*). According to (Reilly *et al.* (2013)[19], the main range of fin whale does not extend into the Kara sea although anecdotal reports of fin whale occur from the northern end of Yamal peninsula. The fin whale is classified by the IUCN RL as Endangered (EN) and category 2 in the RDB RF.

[18] Culik, (2010) Odontocetes. The toothed whales: "Delphinapterus leucas". UNEP/CMS Secretariat, Bonn, Germany. http://www.cms.int/reports/small_cetaceans/index.htm

[19] Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. & Zerbini, A.N. 2013. Balaenoptera physalus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 28 November 2013.

- Bowhead whale (*Balaena mysticetus*). T he bowhead whale population in Svalbard-Barents Sea area has not been estimated due to low numbers, although up to 17 bowhead whales were sighted on summer surveys between 2006 and 2008 in NE Greenland and the Fram Strait, indicating that whales do persist in this area (Rugh *et al.* 2003, Boertmann *et al*. 2009, Wiig *et al*. 2010 in Reid *et al,* 2013). There is a small population in the Sea of Okhotsk that likely number less than 400 animals but no recent surveys have been conducted (Ivaschenko & Clapham 2009, in Reid *et al*, 2013)[20]. The bowhead whale is assessed of being of Least Concern by the IUCN RL, but is assessed as category 1 on the RDB RF.

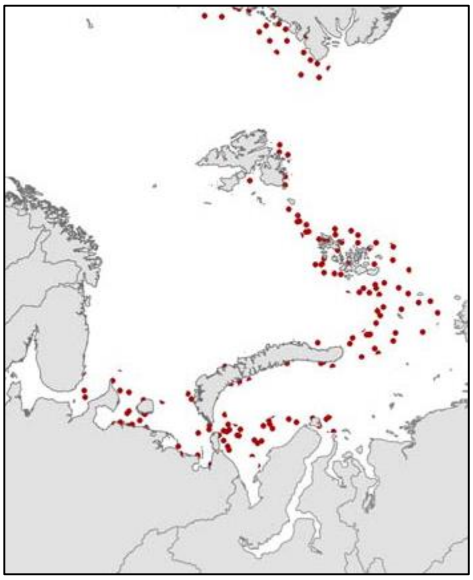
Based on the survey evidence and available information it is considered unlikely that cetaceans occur regularly within the Gulf of Ob as far south as the Project Licence Area. However, the presence of cetaceans in the more northern reaches of the Gulf of Ob and up to the Northern Sea Route cannot be ruled out.

Pinnipeds

Bearded seal (*Erignathus barbatus*) and ringed seal (*Phoca hispida*) are the two most common species of seal found along the coastline of the Gulf of Ob and Kara Sea. Harp seal (*Phoca groenlandica*) is also present. However, the main area for these species in the region is on the northern border of the Yamal Peninsula (Heptner, *et al.,* 1976[21]; Rutilevsky, 1977[22]). Ringed seal were regularly recorded at sea and on the coast of the Gulf of Ob during 2013. They also enter the mouths of a number of rivers on the coast, particularly at high tide (Frecom, 2013).

Atlantic walrus (*Odobenidae*) occurs in eight sub-populations around the Arctic region (see Chapter 7). The nearest sub-population to the Yamal peninsula is the Kara Sea-Southern Barents Sea-Novaya Zemlya sub-population. No accurate population data are available for this sub-population, although estimations have ranged from less than 500 (NAMMCO, undated)[23] to approximately 2000 (Boltinov*, et al.* 2010[24]). An indication of the range of the sub-population is provided in Figure 13.8.5). Sea ice plays an important role in the lifecycle of the walrus, which it uses as a haul out between November and June. Walrus also give birth on sea ice during this period. During the summer, walrus move to haul outs at costal locations (Boltinov*, et al.* 2010).

[20] Donald G. Reid, Dominique Berteaux and Kristin L. Laidre (2013) Mammals in Arctic Biodiversity Assessment 2013 http://www.arcticbiodiversity.is./index.php/the-report/chapters/mammals downloaded 29/11/13
[21] Heptner V.G., Czapski, K.K., Arsenyev, V.A., Sokolov, V.E. (1976) Mammals of the Soviet Union. T. 2/3. Pinnipeds and toothed whales. Moscow High School. 718
[22] Rutilevsky G.L. (1977) Wildlife - Yamal Gydanskaya area. Gidrometeoizdat. Pp. 226-260.
[23] North Atlantic Marine Mammal Commission. (undated) Status of Marine Mammals of the North Atlantic: The Atlantic Walrus. Polar Environmental Centre N-9296 Tromsø, Norway
[24] Boltinov, A.N, Belikov, S.E., Gorbunov, Yu. A., Menis, D.T. and Semenova, V.S.(2010) The Atlantic walrus of the southeastern Barents Sea and adjacent regions: Review of the present-day status. WWF, Moscow



Source WWF/MMC 2009[25].

Figure 13.8.5: Atlantic Walrus Range in Kara Sea

Incidental records suggest that the Atlantic walrus is only an occasional visitor to the vicinity of the Gulf of Ob and does not breed in the area. In December 2005, a single adult male stayed in the Gulf of Ob near Seyakha. In 2013, walruses were observed in early summer to the north of the seaport. Walrus is classified by the IUCN RL as Data Deficient (DD) and is listed in the RDB RF as decreasing population (category 2) and the RDB YNAO as an Endangered species (category 1).

Hunting of Atlantic walrus in Russia is prohibited, with the exception of a limited subsistence harvest for native people (NAMMCO, undated).

13.8.6 CULTURAL HERITAGE ELEMENTS

A list of the known cultural and historical objects found in Yamalsky District is available from the official website of the YNAO Department of Culture[26], with a total of 181 registered sites and objects in the District, including monuments, notable sites and other features. A summary of this is presented in Table 13.8.1 below.

[25] WWF and MMC (2009) Materials for the working meeting: Saving walrus southeastern Barents Sea in intensification of economic development of the region. Moscow. *available at http://walrus.2mn.org/documents/atl_walr_worksh_2009_paper.pdf*

[26] Information on cultural heritage sites located in Yamal-Nenets Autonomous Okrug, as of 1 February 2013. Source: http://www.cultura-yamala.ru/obektinaslediya/spiskiobjects/

Table 13.8.1: Sites and objects of cultural heritage in Yamalsky District, as at 01.02.2013

Monuments			Places of interest/ Notable sites		Other registered objects/features			
Federal importance	Regional importance	Local importance	Regional importance	Local importance	Total	Archaeology	History/ architecture	Ethnic culture
-	1	-	5	-	175	160	-	15

Source: YNAO Department of Culture, 2013

It should be noted that the Yamalsky District remains relatively under-investigated in terms of tangible cultural heritage of indigenous people, particularly with regard to the sites of significance for individual communes, the kin or families. The numbers given in Table 13.8.1 mainly derive from desk-based anthropological and archaeological studies undertaken in the Soviet era. Thus, a significant number of these previously identified cultural sites might no longer be in use by local population.

Within the Licence Area and its immediate surroundings, additional desk studies and fields surveys were undertaken in order to gain a detailed characterisation of all cultural heritage within the Project's direct Area of Influence. The cultural heritage sites within the vicinity of the Project Licence Area are described in detail in Chapter 8 and are summarised below in Figure 13.8.6.

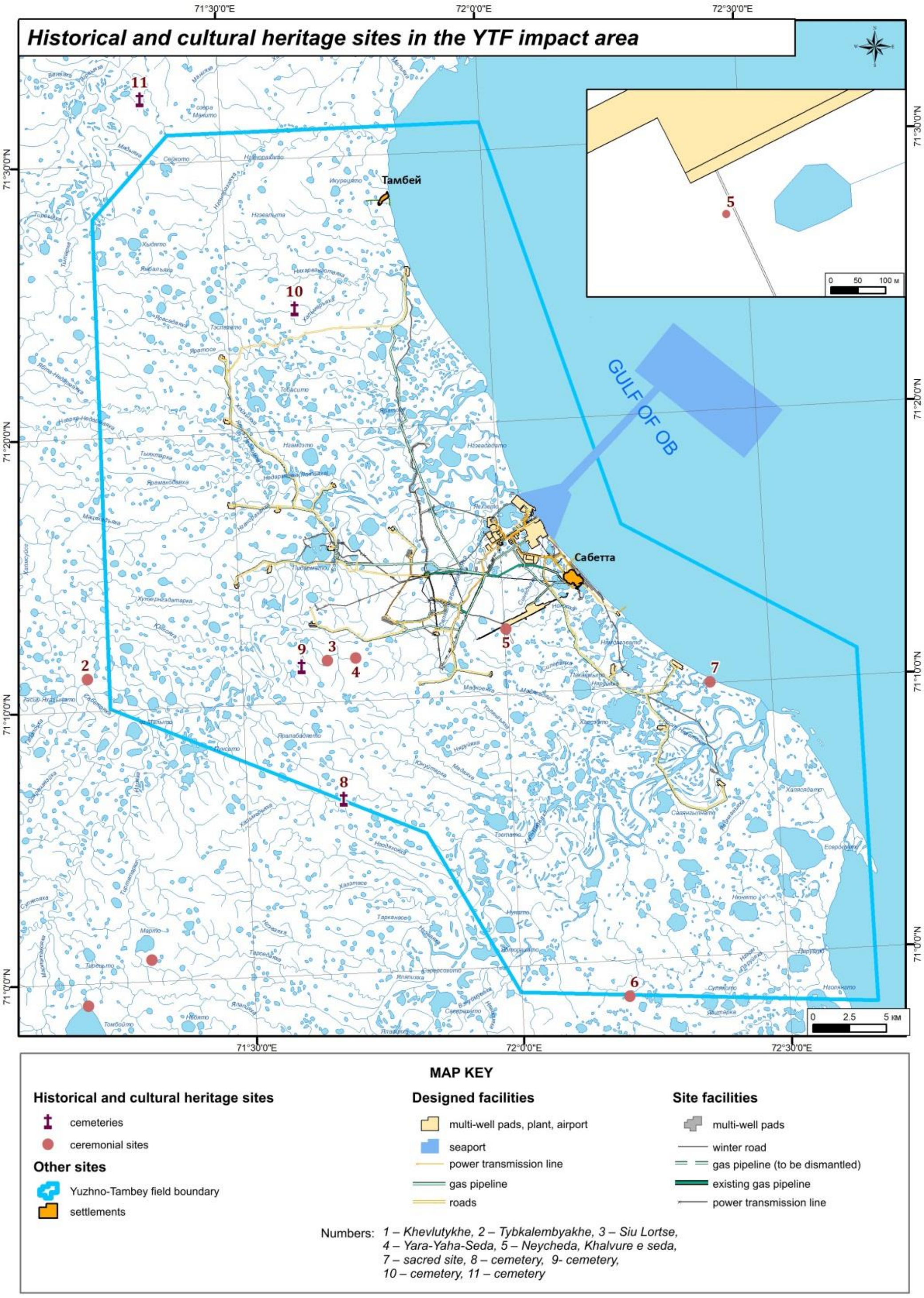


Figure 13.8.6: **Location of sacred sites within the Project Licence Area and surroundings**

13.8.7 REGIONAL-LEVEL SERVICES (E.G. HEALTH FACILITIES, TRANSPORT)

Existing regional level services in the Yamalsky district are full described in Chapter 8.

13.8.8 EMPLOYMENT AND ECONOMY

The employment and economic baseline of the Yamalsky district is fully described in Chapter 8.

13.9 ASSESSMENT AND SIGNIFICANCE OF CUMULATIVE IMPACTS

13.9.1 NATURAL TUNDRA HABITATS

The primary impact on natural tundra habitat from the Yamal LNG project and other potential industrial developments is the long term physical loss of habitat due to physical land take by project facilities and infrastructure. This section deals with the general issue of tundra habitat, while specific aspects associated with nesting bird habitat and reindeer pastures habitats are addressed separately in Sections 13.9.2 and 13.9.3 respectively.

The total areas of land take are summarised below:

- Yamal LNG: approximately 40km^2
- Bovanenkovo: approximately 9.3km^2 of permanent modified land (see Section 13.7.3.1)
- Other development fields on Yamal and Gydan: Land take during exploration is unlikely to be significant during exploration (in comparison to the Yamal LNG and Bovanenkovo). During any future production development phases, the extent of land take will be very much dependent on the precise nature of the development. Nonetheless, it is theoretically possible that a number of fields currently under exploration may require land takes broadly equivalent to Yamal LNG or Bovanenkovo. In a worst case, this should involve several hundred square kilometres in total across the northern portion of the Yamal peninsula and the Gydan peninsula.
- A potential additional railway from Bovavenkovo to Tambey may extent a distance of up to 200km. This would be a largely linear development and the overall area of the land take would depend on the width of any corridor, but nonetheless may be of the order of several tens of square kilometres.

On the basis of the proportional scale of land take (approximately 40km^2) within the total Project Allotment Area (approximately 970km^2), the Yamal LNG Project residual impact on natural habitats in the Licence Area is assessed in Chapter 9 as **Moderate** to **Low**. This takes into account the presence of an area of critical habitat in relation to Forb-graminoid, horse-tail-graminoid meadow communities. The precise location and extent of this critical habitat is under further investigation (see Chapter 7), but is nonetheless small relative to the Yamal LNG foot print and also relative to the Yamal LNG Allotment Area.

The significance of the cumulative impact of the overall potential land take (including the other developments considered within the CIA) would depend not just on their overall spatial extent, but also on the location-specific sensitivities. Without any reasonable knowledge of the extent or precise location of these potential future developments, understanding of the potential sensitivities, and hence magnitude of the cumulative impacts, is not possible in any detail. However, we note that regional mapping at a scale of 1:75,500,000 (see Section 13.8.1) indicates that:

- All the identified potential future developments are likely to encompass broadly similar habitat types to those encountered in the Yamal LNG Licence Area (habitat class types P1, S1, S2 and G1 - see Section 13.8.1).
- The potential field developments on Gydan and a potential railway extension between Bovanenkovo and Tambey, may also cross habitat type G2, which comprises grammoid forb tundra.

This suggests the possibility of similar habitats, including Forb-graminoid, horse-tail-graminoid meadow communities, near the locations of these other developments. However, detailed, site-specific surveys of the precise footprints of the other developments would be required (by the individual developers) to better confirm the potential presence of sensitive species and the nature of potential cumulative impacts on the tundra habitat.

In the overall context of available habitats types present in the region, the scale of withdrawn land is relatively small. However, given the sensitivity or the habitats, their likely slow inherent recovery capacity, and the overall duration of such impacts, the cumulative impact is tentatively assessed as **Moderate**. Yamal LNG's contribution to this impact may be significant.

13.9.2 AVIFAUNA

Impacts of primary significance on breeding birds from the considered industrial developments are likely to relate to:

- Loss of habitat through permanent land take
- Noise impacts and in particular noise impacts associated with helicopter flights

In addition, it is likely that stresses placed on habitat through over-grazing of reindeer pastures may also be contributing to current trends of declining numbers of breeding birds (see Chapter 7).

The extent of land take by the existing and potential future projects within the Yamal peninsula is as described in Section 13.9.1 above. The worst case aggregated total land take is still low relative the overall peninsula. However, under the precautionary assumption that the declining numbers of breeding birds in the Licence Area (and the likelihood that over-grazing may play a partial role in this) is replicated more widely across the Yamal peninsula, then this land take may be still be significant in terms of breeding bird habitat. Actual impacts will depend on the precise location and extent of the future projects relative to suitable breeding bird habitat. However, assuming the same bird species that use the Yamal LNG Project Licence Area are also present in at least some of the other affected development areas, the cumulative impact from land take is conservatively assessed as **High**, on the basis that long term species abundance may be affected. Yamal LNG's contribution to this impact is moderate, although nonetheless significant.

Yamal LNG's noise impacts on breeding birds are assessed as **Moderate** specifically in relation to noise disturbance from helicopter within the Licence Area. The development of exploration wells, and potentially production fields in the remote Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye and Malyginskoye fields is likely to result additional cumulative noise impacts, especially if these developments utilise helicopters from Sabetta to provide transport to and from the sites. Railway developments also have the potential to lead to disturbance of nesting birds in particular, although the likely frequency and speed of trains is such that significant long term impacts are unlikely.

Helicopter noise poses the risk of cumulative impacts in terms of both:

- additional flight numbers over the Yamal LNG Licence Area and resultant additional noise impact to breeding bird habitats also impacted by Yamal LNG activities
- Noise impacts to additional breeding bird habitats north of the Yamal LNG Licence Area as the helicopter continue on route to the sites of other development fields.

Uncontrolled, these cumulative impacts could disrupt breeding inside the Licence Area and beyond. Given the known decline in breeding numbers in this area, the unmitigated cumulative impact is cautiously assessed as **High**.

13.9.3 NOMADIC INDIGENOUS REINDEER HERDERS (AND THEIR REINDEER)

13.9.3.1 INTRODUCTION

Potential cumulative impacts to nomadic indigenous reindeer herders include impacts associated with:

- The health and safety of the herders
- Access to and condition of reindeer pastures and migration routes
- Economic and employment effects
- Impacts on hunting, gathering and fishing

Each of these each aspects is discussed in turn below.

13.9.3.2 HERDER HEALTH AND SAFETY

All of the existing and potential future developments considered within the CIA have the potential to impact on the health and safety of the local population. The considered developments are all located at large distances from significant settlements, and so the primary potential receptors are the nomadic reindeer herders that utilise the northern portions of the Yamal peninsula. Specific health and safety impact types are discussed in turn below.

- **Communicable diseases**

  The influx of significant workforces from outside of the region poses the risk of the introduction and spread of communicable to the local communities. This may include diseases to which the local population may have low immunity or elevated susceptibility (see Chapters 8 and 10 for further discussion). Operational workforces will be associated with the existing and potential future oil and gas production fields, although typically operational workforces will be relatively limited size. Similarly, workforces will be associated with the planned exploration activities in the Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye and Malyginskoye fields. However, larger workforces would be associated with any future construction phases in these fields, and also in relation to the potential railway construction. These different developments have the potential to affect many of the different herder groups/communes through:

- direct contact by individual groups/communes with both Yamal LNG workers and workers from other projects (e.g. reindeer herders who use pasture lands in the Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye and Malyginskoye fields also migrate through the Yamal LNG Licence Area during the annual autumn migration – see Figure 13.7.5)
- indirect contact when the different herder groups/communes congregate (e.g. at factoria).

The size of the construction workforces for any particular development project is unknown at this stage, but may be comparable to Yamal LNG (peaking at approximately 14,000). The timings of the construction of future potential developments are unclear in terms of both duration and when any construction may occur. However, it may be reasonable to assume that any such developments would be likely to extend over many years, but with the potential for some level of concurrent construction. As such the period over which such risks occur is potentially several years / decades.

The primary risk control mechanisms at the local project levels are the use of closed camps and the implementation of worker health screening. These control measures are implemented by the Yamal LNG and, given the remote location and severe climate on the peninsula, is it reasonable to assume that similar controls would be rigorously applied by other development projects. With application of the anticipated mitigation controls, the cumulative risks associated with the spread of communicable disease is **Low** and Yamal LNG's contribution to the risk is low.

- **Stress and mental health effects**

The influx of significant workforces from outside of the region also poses the risk of the increased stress/mental health effects among the reindeer herders. Such risks may be particularly associated with interactions between reindeer herders and immigrant workers who are unfamiliar with or insensitive to local culture and customs. In this context, interactions with project security personnel may pose a particular risk. Security will be required over the lifetime of any oil and gas field development, and hence such risks are likely to be present in the long term. Impacts may cumulate where individual reindeer herders or herder communes have the potential to directly interaction with both Yamal LNG workers and workers from other potential developments (e.g. reindeer herders who use pasture lands in the Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye and Malyginskoye fields also migrate through the Yamal LNG Licence Area during the annual autumn migration – see Figure 13.7.5).

Ensuring a high standard of behaviour and a respectful attitude among the workforce (and security personnel in particular) at the local project level is the primary mechanism to minimising stress effects on the local population. Yamal LNG has adopted robust codes of conduct for its workforce to control these measures and, at the project level, Yamal LNG's impact on stress and mental health is assessed as Low. However, should similar measures not be implemented by other development projects then the cumulative impacts may be **moderate**, although Yamal LNG's contribution to this would remain low.

- **Alcohol and drugs**

  The influx of significant workforces also poses the risk of the introduction of sources of drugs and alcohol to the local communities. This could be related to the presence of accommodation camps associated with any of the considered potential project developments, including developments that provide improved transport links into the district (e.g. the airports at Bovanenkovo and Sabetta, the seaports at Sabetta, Novoport and potentially associated with other LNG developments, and potential railway expansions).

  The control of alcohol and drugs needs to be addressed at the individual project/facility level. To this end, Yamal LNG has prohibited of drugs and alcohol among its site workforce and implemented closed-camps, which facilitates strict adherence to this policy. These controls are common practice in the oil and gas industry and it is assumed that such policies would be replicated at other project developments. The cumulative risks associated increased risk of access to drugs and alcohol are therefore assessed to be **Low**.

- **Public safety risks**

  All industrial and construction activities within the Yamal peninsula have the potential to pose safety risks to the reindeer herders. Potential risks are particularly associated with areas where reindeer herders may pass close to industrial facilities or else cross linear infrastructures, such as roads and railways (see also Section 13.9.3.3 below for consideration of linear infrastructure impacts on reindeer migration). During initial industrialisation of any region, risks may be higher due to lower familiarisation and aware of risks by the local population. In response this, and as one of the first developments in the northern part of the Yamal pensinsula, Yamal LNG will implement a range of mitigation controls as described in Chapter 10, that reduce the project-level risks to **Low**.

  The safety risks posed by other oil and gas developments would depend on the specific nature of such developments, although it would be reasonable to assume that similar project-level mitigation controls to those being implemented by Yamal LNG will be applicable to other future developments. Nonetheless, residual safety risks will remain and the overall cumulative risks may be considered **Moderate**, taking into account the probably duration of the developments, the potential scale of the district-wide developments, and the severity of any safety incidents (although noting the low likelihood).

In addition to the above potential negative cumulative health and safety impacts on reindeer herders, the presence of medical facilities at most (or possibly even all) of the future project developments, together with general improves to transport infrastructure, is likely to provide a cumulative **benefit** to local population in the event of medical emergencies. This is further discussed in Section 13.9.7. Net **benefits** may be gained from increased access opportunities to vital goods in the region, and in particular fuel.

13.9.3.3 PASTURE LANDS AND MIGRATION ROUTES

Pasture land usage and reindeer herder migration routes are described in Chapter 8 and also shown on Figure 13.7.5. Reindeer herders who use pasture lands in the Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye and Malyginskoye fields also migrate through the Yamal LNG Licence Area during the annual autumn migration (autumn migration routes #1 and #2 as described in Section 13.8.3). The three main autumn migration routes #1, #2 and #3 (see Section 13.8.3) would also intersect a potential railway extension between Bovanenkovo and Tambey should it be developed. All these potential developments have the potential to affect reindeer herding through physical land take of suitable pasture land, disruption of migration routes and limiting access to pasture lands. These impacts are associated with the development of physical land-based infrastructure and are therefore likely to be most prevalent during the operation of such project developments and in terms of duration are likely to felt for the lifetime of the project developments. Each of these impacts types is discussed in turn below.

- **Physical land take**

  The overall potential land take by the project developments considered in the CIA is discussed above in Section 13.9.1. The proportion of this land take that represents suitable reindeer pasture land is not possible to determine at this stage without more precise knowledge of the locations of the other developments (and, specifically, the Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye and Malyginskoye fields and also any potential railway link from Bovanenkovo to Tambey). Nonetheless, it can be seen from Figure 13.7.5 that the following known general pasture areas may be affected by these project developments:

  - Tusyada community pasture - Severo-Tambeyskoye and Tasiyskoye fields
  - MOP Yamalskoye brigade 9 pasture – Malyginskoye field
  - Ilebts community pasture - Zapadno-Tambeyskoye field and Bovanenkovo-Tambey railway
  - Ilbets community 1 pasture - Bovanenkovo-Tambey railway
  - MOP Yamalskoye brigade 2 pasture - Bovanenkovo-Tambey railway

  This indicates that these project developments all have the potential to result in physical loss of pasture land. However, the likely footprints of these developments would be small relative to the overall sizes of the above pasture lands and the pasture lands more widely available on the Yamal peninsula. At the individual project level, mitigation is required to avoid suitable lichen pasture areas (through micro alignment of facilities) and to use best techniques to minimise physical footprints. Nonetheless, some residual loss of suitable pasture would remain. Given the evidence of overgrazing on the Yamal peninsula, loss of even small areas of pasture land may be significant.

- **Disruption of annual migration routes**

  Reindeer herders who use pasture lands in the Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye and Malyginskoye fields also migrate through the Yamal LNG Licence Area during the annual autumn migration (autumn migration routes #1 and #2 as described in Section 13.8.3). The three main autumn migration routes #1, #2 and #3 (see Section 13.8.3) would also intersect a potential railway extension between Bovanenkovo and Tambey should it be developed. These migration routes may also theorectically intersect export pipelines associated with the development of the Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye and Malyginskoye fields (depending on the development options selected, if any).

The primary potential to interfere with migration routes is associated with the development of linear infrastructure. For oil and gas developments this may include intra-field linear infrastructure (roads, pipelines etc.) and also potential inter-field pipelines (depending on the nature of product export). The potential railway between Bovanenkovo and Tambey would also represent a potential linear structure that may affect migration routes where they intersect. It is therefore possible that cumulative impacts would result where individual migration routes are affected by multiple project developments.

Yamal LNG has developed a suite of mitigation measures to limit the effects of infrastructure on reindeer migration routes. Key among these measures is the installation of strategically placed reindeer crossing locations. These are standard methods that have previously been used on other projects in the region, including the Bovanenkovo project. It is therefore reasonable to assume that similar measures would also be adopted by other developments. Nonetheless, the success of this measure is dependent on the appropriate selection and design of crossing points, and also monitoring/consultation during operations to ensure the ongoing success of these measures.

- **Limiting access to pasture lands**

  In addition to the potential risk linear infrastructure to the annual autumn migration routes, such infrastructure may also affect the movement of reindeer herders within their primary pasture lands. In particular, there is the possibility that, without appropriate design, linear infrastructure could render areas with overall pasture lands inaccessible. These effects may act cumulatively with Yamal LNG impacts on those communes/groups that have primary pasture areas within other development fields, but also undertake annual autumn migrations through the Yamal LNG Licence Area.

  Mitigation controls are similar to those described above to avoid disruption of migration routes, although careful alignment of intra-field linear infrastructure in relation to nature features (coastline, major rivers etc.) to avoid ‘closing off’ areas of pasture land is also important.

  Related impacts associated with reduced access to fishing/hunting/gathering areas and cultural heritage sites are discussed in Sections 13.9.3.5 and 13.9.6 respectively.

The above impacts may cumulatively affect individual reindeer herder groups/communes where direct access to pastures by individual groups/communes may be reduced across their overall ranges by multiple project developments. In addition, indirect impacts may result if pressures on the availability of traditional pastures for some herder groups/communes become so acute that those communes move from their traditional pastures/migration routes and begin to encroach of those of other adjacent communes.

On the wider regional scale, the different reindeer herder groups that use the pasture lands in the vicinity of the Bovanenkovo field will be subject to similar impacts associated with the development and operation of that field. While these impacts will affect different individual herder groups, a cumulative effect may occur to the overall indigenous reindeer population in the Yamalsky district if impacts become sufficient to erode the overall reindeer production, herder/reindeer numbers or traditional lifestyles.

Another significant region-wide stress on reindeer herding is evidence of over-grazing in many areas of the Yamalsky district, which has the potential to significantly impact the future viability of reindeer herding in the longer term.

Appropriate mitigation controls can be effective in limiting the overall loss of pasture lands to relatively low levels. However, there would be some level of residual loss of pasture land availability. Given the known historically high numbers of reindeer combined with evidence of over-grazing in at least areas on the northern portions of the peninsula, even relatively small scale loss of available pasture land has the potential to lead to significant direct and/or indirect impacts on reindeer herding. Potential cumulative impacts are difficult to estimate, and how such impacts may evolve over time is also unpredictable. Nonetheless, based on the current status of reindeer herding and the temporal duration of such impacts, the overall cumulative effects are assessed as **Moderate** or, if individual projects fail to implement suitable mitigation controls, **High**. Yamal LNG's contribution to these impacts is assessed as low, due to the implementation of the mitigation measures at the project-level as described in Chapter 10.

13.9.3.4 ECONOMIC AND EMPLOYMENT EFFECTS

The industrial developments considered in the CIA have the potential to affect the economic and employment situation of the indigenous reindeer herding population. These potential effects include:

- **Increased opportunities for sales and routes to market for reindeer herder products**

  The project developments considered within the CIA have to potential to positively affect sales of reindeer herder products, such as reindeer meat, skins/furs, antlers, artisan craft items, etc. These opportunities may arise as a result of the presence of relatively large workforce populations that may become consumers of such products, and also through improved transport services out of the Yamalsky district, thus offering the potential for improved export to wider markets.

  Informal interactions between project workforces and local reindeer herders are standardly controlled through the use of closed camps, which are beneficial in management the interactions issues discussed in Sections 13.9.3.2 and 13.9.6, but at the same time limit opportunities for informal purchase of herders' products. However, the development of formal mechanisms to encourage the purchase of such goods can be implemented.

  The development of regional transport, such as the airports at Sabetta and Bavenkovo, and the potential extension of railway links on the Yamal peninsula, can offer improved export opportunities for reindeer herders' products. To be effective, this would require effort at the regional and project levels, to provide the reindeer herders with suitable access to these transport links.

- **Employment opportunities**

  The industrial developments in the Yamalsky district may provide alternative employment opportunities to indigenous reindeer herders. As described in Chapter 10, there are a number of challenges associated with employment of nomadic indigenous people on industrial projects of the type considered in the CIA. These include:

  - The lack of qualified labour resources among the herder population;
  - difficulties in both attracting and retaining nomadic indigenous people to industrial employment due to the significant differences in lifestyle involved in such employment.

  Nonetheless, the oil and gas industry may still represent an important source of employment to the nomadic indigenous people of the Yamalsky district, and this may be especially important in the long term when reindeer herding may be insufficient to sustain an increasing indigenous population. In this regard, Yamal LNG has adopted a number of initiatives to encourage the employment of nomadic indigenous people, including (see Chapter 10 and the IPDP for further details):

  - Preferential recruitment of employees from the local population, including indigenous population (under otherwise equal conditions)
  - Provision of vocational/skills training and professional development opportunities for the local workforce
  - Development of a mechanism to encourage contractors to recruit locally for semi-, low- and unqualified positions.

  If replicated by other project developers, then such measures may have a cumulatively **beneficial** effect on alternative employment opportunities for nomadic indigenous people (for those that want it). There may also be opportunities for coordination between the individual project developers and district/regional authorities to maximise these opportunities, for example through joint training programmes and initiatives.

Overall, the existing and potential future industrial developments are likely to have a net **benefit** on employment and economy within the reindeer herding communities. However, in order to maximise these benefits, proactive efforts are required at both the individual project levels and through joint initiatives at the wider Yamalsky district level.

13.9.3.5 HUNTING, GATHERING AND FISHING

Cumulative impacts on hunting, gathering and fishing by indigenous reindeer herders may result from loss of access to relevant locations in a similar manner to the potential loss of access to reindeer pasture lands described in Section 13.9.3.3 above. While hunting, gathering and fishing are generally subsidiary activities to the main activity of reindeer husbandry, they still present important additional seasonal economic and subsistence activities for reindeer herders. As such, cumulative impacts in terms of access may be **moderate**.

Fishing may also be affected by impacts to fish stocks and this is further discussed in Section 13.9.4.

13.9.3.6 SUMMARY

The existing and potential developments considered within the CIA may lead to both negative and positive impacts on indigenous reindeer herders. The interaction of these different impact types is complex and likely to vary over time in a way that is difficult to predict. The significance of some effects may vary as the overall district-level context changes, and some effects may even switch from positive to negative (or vice-versa) according to the wider circumstances. Examples of these complex inter-relationships include:

- The increased opportunities for the sale/export of reindeer herders' products can result in upward pressure on reindeer herding levels in the Yamalsky district. This may generally be seen as positive for reindeer herders. However, given the high volumes of reindeer herding currently present the peninsula, any upward pressures may lead to negative impacts in the longer term if this leads to increased overgrazing and reindeer levels reaching/exceeding carrying capacity.
- Increased employment opportunities in the industrial (primarily oil and gas) sector is beneficial for individual indigenous people interested in alternative employment and more generally may provide needed alternative forms of employment at times when the traditional reindeer herding sector is unable to provide employment for all those who wish to be involved in it. However, recruitment of significant numbers of indigenous people, especially the young, into industrialised employment may have longer term implications for the viability of the traditional lifestyle of the nomadic reindeer herders in Yamalsky district.

The overall cumulative effects are therefore difficult to predict, particularly as they evolve over time. It is possible that in the worst case overall impacts have the potential to be **high**, particularly if suitable mitigation controls are not applied at either the individual project or Yamalsky district levels. However, such significant impacts are far from certain.

As the nature of cumulative impacts on reindeer herders may change over time, so the necessary mitigation measures may also need to evolve. It is therefore important that continued monitoring is undertaken to understand both the evolving nature of these cumulative effects on reindeer herders and also to identify the changing nature of mitigation measures that need to be implemented.

13.9.4 FISH AND FISHERIES

13.9.4.1 FISH STOCKS

Following the CIA scoping and screening (see Section13.6 and Annex A), impacts on fish stocks considered in the CIA relate to marine and anadromous fish in the Gulf of Ob. Within the Gulf of Ob, potential impacts on fish are primarily related to the raising of suspended sediments and sedimentation/smothering effects on fish and their prey. Other project development activities that have the potential to cumulatively impact on fish in the marine environment are development options for the Geofizicheskoye and Salmanovskoye fields, including the potential increased sediment suspension and sedimentation associated with possible:

- Pipelines across the Gulf of Ob
- Port facilities (including associated construction and maintenance dredging)

Impacts on freshwater fish have been screened out of the CIA (see Annex A) on the basis that the Yamal LNG project:

- is not predicted to have a significant impact on such species (noting for instance that the Endangered Siberian Sturgeon is not thought to be present in rivers within the Yamal LNG Licence Area)
- is not likely, in combination with other developments (none of which are likely to affect the same catchment systems), to have significant cumulative impacts.

However, it is possible that impacts from other projects on freshwater environments may affect (semi-)anadromous fish species during their freshwater phase. Other onshore development projects may affect freshwater environments through, for example, changes in river hydrology (e.g. physical changes to river dynamics, water abstraction etc.), sedimentation and release on contaminants, primarily as a result of construction activities within or near surface waters.

As semi-anadromous species may be impacted in the Gulf of Ob by Yamal LNG's activities, the potential for cumulative impacts on these species is theoretically possible. However, it should be noted that the primary impacts from the Yamal LNG project on fish in the Gulf of Ob are associated with the construction phase and hence are likely to occur several seasons prior to other potential development project impacts. Nonetheless, some aggregation of effects may occur if other onshore project developments impact on freshwater rivers at times that coincide with the period of maintenance dredging.

Due to the scale of proposed dredging activities associated with the Yamal LNG project, the associated damage to fish feeding resources (zooplankton and zoobenthos) and the presence of both commercially valuable and Endangered fish species (see Section 13.8.4), the potential project-specific impact on fish fauna in the marine environment is assessed as **moderate** with the implementation of appropriate mitigation (see Chapter 9).

Trenching and dredging activities associated with any potential subsea pipeline for new seaport construction in the Gulf of Ob are unlikely to be as extensive as those required for the initial Yamal LNG marine works (and most specifically dredging of the main navigation channel). Nonetheless, there is the potential for some spatial overlap of the impact zones from the dredging and temporally, consecutive season dredging may impact recovery of fish stocks following earlier dredging works (including maintenance dredging required for the Sabetta seaport). In addition, other onshore project developments may impact on semi-anadromous fish species during their freshwater phase. Cumulative impacts on marine and semi-anadromous fish are assessed as **moderate**. The Yamal LNG project's contribution to this is primarily related to the maintenance dredging in the Gulf of Ob, which is an associated activity, and depends on the timing of relevant third party activities relative to the maintenance dredging.

13.9.4.2 CAPTURE FISHERIES

Capture fisheries may be affected by:

- Damage to fish stock as described in Section 13.9.4.1
- Loss of access to freshwater fishing areas as described in Section 13.9.3.5
- The imposition of fishing exclusion zones around both temporary offshore construction vessels/vessels (e.g. dredgers, pipe-lay vessels etc.) and permanent offshore/coastal

structures/features (e.g. seaport basins, navigation channels). These impacts results from both Associated Facilities to the Yamal LNG Project (the seaport and associated navigation and approach channels) and the potential development of other oil and gas fields in the northern portions of the Gulf of Ob (e.g. possible development options for the Geofizicheskoye and Salmanovskoye fields).

Assessment of cumulative impacts on fisheries is limited by the lack of detailed data on fishery locations and catch volumes in the Yamalsky district. Furthermore, obtaining accurate information in future is also likely to be difficult, especially in relation to unlicensed fishing. In the absence of more detailed information, the potential cumulative impacts are tentatively assessed as **moderate**. This assessment is based on the assessed moderate impact to fish stocks, the overall limited temporal and spatial scale of restriction zones, and the likely scale of fishing given the limited population with access to the northern portion of the Gulf of Ob.

13.9.5 MARINE MAMMALS

Potential cumulative impacts to marine mammals are summarised below.

<table>
<tr><th>Impact type</th><th>Source</th><th>Relevant development projects</th></tr>
<tr><td rowspan="3">Noise</td><td>Construction piling and dredging</td><td rowspan="2">Yamal LNG (including Associated Facilities)
Development options for the Geofizicheskoye and Salmanovskoye fields</td></tr>
<tr><td>Maintenance dredging</td></tr>
<tr><td>Shipping and most specifically ice breakers</td><td rowspan="2">Yamal LNG (including Associated Facilities)
Development options for the Geofizicheskoye and Salmanovskoye fields
Novoport</td></tr>
<tr><td>Ice habitat</td><td>Disturbance to ice habitat during ice breaker transport</td></tr>
</table>

The cumulative impacts from the different potential third party development options identified above are similar to those identified for the Yamal LNG Project as assessed and described in Chapter 9.

Impacts associated with noise from dredging (construction and maintenance) and piling (construction) are short-term in nature. In addition, it is unlikely that dredging and piling activities by third party project developments will coincide with those associated with the Yamal LNG project. As such, the cumulative impacts are assessed to be broadly the same as the individual Yamal LNG impacts, i.e. **moderate** in relation to piling and **low** in relation to dredging.

Increased shipping, and in particular ice breaking, in the Gulf of Ob up to the Northern Sea Route may result from the operation of the Yamal LNG project, the development of the Novoport project, and the possible development of the Geofizicheskoye and Salmanovskoye fields (depending of the actual development options). The nature of impacts on marine mammals in terms of noise and ice habitat loss will therefore be similar to those assessed for the Yamal LNG project in Chapter 9, but occurring with greater frequency and shipping increases. As noted in Chapter 9, the primary impacts are associated with impacts on beluga whales during the limited periods when ice sheets are forming or retreating in the Gulf of Ob region, with disturbance impacts anticipated over several tens of kilometres. Based on the spatial extent of the zone of impact and the long term use of ice breaking, but also considering the limited periods each year over which impacts may occur and likely low numbers of beluga's expected within the Gulf of Ob itself, cumulative impacts are assessed as **moderate**.

13.9.6 CULTURAL HERITAGE

Potential cumulative impacts to cultural heritage include:

- Impacts associated with the damage to tangible cultural heritage sites (either known or previously unknown)
- Loss of access to tangible cultural heritage sites due to the development of linear of linear facilities
- Disturbance to traditional cultural lifestyles due to potential contacts between non-local workforce (including security staff) unfamiliar with the traditional conventions and customary modes of behaviour and the local population (see also section 13.9.2)

All the identified offshore development projects have the potential to lead to damage to tangible cultural heritage sites if not adequately managed. These risks are enhanced in the Yamalsky district due to current general under-investigation of cultural heritage sites in the district and the potential density of such sites in areas used by reindeer herders (such areas include Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye, Malyginskoye and Bovanenkovo fields, and potential railway extensions). This emphasises the need for each project developer to:

- Undertake detailed cultural heritage surveys (including through consultation with indigenous reindeer herders) of the development areas as part of the planning process
- Develop and implement chance finds procedures to minimise the risk of damage to previously unidentified cultural heritage sites.

Without the implementation of such measures at the individual project level, cumulative impacts/risks of permanent damage to tangible cultural heritage sites may potentially be **High**. Yamal LNG has undertaken detailed surveys of the South-Tambey Licence Area and surrounding area, issued a Company order # 100 dated 26.08.2013 "Chance find procedure" for all types of earth works and therefore the residual risk of damage to tangible cultural heritage sites by the Project development is therefore assessed as **Low** to **Negligible**. As such Yamal LNG's contribution to the overall cumulative impact is small. The approach adopted by Yamal LNG to the protection of tangible cultural heritage sites also presents the opportunity to set a good practice precedent in the region.

The development of extensive linear facilities (see also Section 13.9.3), has the potential to lead to long term loss or limitation of access to tangible cultural heritage sites of importance to indigenous reindeer herders. At the individual project level, the residual impacts of the Yamal LNG on access to tangible cultural heritage sites is assessed as **Moderate** to **Low** for different sites (see Chapter 10). Cumulatively with other developments in the region, this may contribute to **Moderate** to **High** impacts on indigenous reindeer herders' access to culturally important sites.

Potential contacts between the local population and non-local workforces (including security staff) unfamiliar with the traditional conventions and customary modes of behaviour may also negatively impact on traditional intangible culture. At the Yamal LNG Project level, the residual impact has been assessed as **Low** due to mitigation measures to be implemented (see Chapter 10 for details).

Cumulatively with similar impacts from other industrial projects, this impact could potentially be **Low** to **Moderate**. This emphasises the need for each project to develop appropriate mitigation measures (which may include cultural induction training for workers, enforcement of Worker Codes of Conduct, etc.). This issue is further discussed in terms of potential stress/mental health impacts in Section 13.9.3.2.

13.9.7 REGIONAL-LEVEL SERVICES (E.G. HEALTH FACILITIES, TRANSPORT)

The influx of large workforces to multiple projects in the region has the potential to place stress on existing infrastructure and services in the region, mainly on medical and transport systems. Uncontrolled, such impacts could cumulatively be **Major** as the imported workforce is likely to be very significant compared to size of the local population of the Yamalsky district of approximately 17,000 (see Chapter 8); for example, this compares with a peak construction workforce for the Yamal LNG Project of 14,000.

However, at the Project level, Yamal LNG has effectively reduced these impacts to **Low** / **Negligible** levels through implementation of a range of control measures that include:

- Use of dedicated closed accommodation camps for all workers during both construction and operation
- No provision for families of workers to relocate to the accommodation camps
- Use of dedicated air transport for access to the site for all personnel, as well as construction of dedicated auxiliary intra field access roads (to avoid impacts on regional transport systems, including public winter ice tracks)
- Development of dedicated on site medical facilities.

As such the Yamal LNG contribution to the cumulative impacts to regional level community services is small. Indeed, the presence of medical facilities at the Licence Area and the potential to provide support to third parties (including reindeer herders) in the event of emergency medical situations and/or, where feasible, transportation assistance leads to potential net **benefits** from the Project.

For specific effects on reindeer herders see also Section 13.9.3.2.

13.9.8 EMPLOYMENT AND ECONOMY

This sub-section discussed potential impacts on YNAO-wide employment and ecomony. Specific impacts on employment and economy among the reindeer herders on the Yamal peninsula are discussed in Section 13.9.3.4.

The development of multiple industrial projects within the Yamalsky district has the potential to provide cumulative **benefits** to the local economy through:

- Direct and indirect employment opportunities and related beneficial effects on the economy
- Procurement of local goods and services and associated spin-off effects of business stimulation and development

The specific benefits provided by Yamal LNG to local employment and the local economy are described in Chapter 10. As one of two major developments in the northern Yamal peninsula with the next five year timeframe (Bovanenkovo being the other), Yamal LNG's contribution to the overall cumulative benefit is significant. In addition, the specific measures adopted by the Project in relation to recruitment and training of the local population (see Chapter 10) also have the potential to improve the longer term employability of the local population for any future major project developments in the Yamalsky district and beyond.

13.10 MANAGEMENT OF CUMULATIVE IMPACTS

13.10.1 GENERAL CONSIDERATIONS

Mitigation of cumulative impacts is required at the both the local development scale under the responsibility of the individual developers and regional scale management of the VECs. The primary mechanism for regional-scale management of VECs should be through strategic regional development assessment and planning, which is typically the function of the relevant government authorities. In particular it is not possible for an individual project developer to enforce mitigation and management methods on other parties over which it has no direct control, authority or responsibility. In this context, it is therefore not appropriate or realistic for Yamal LNG, as an individual project developer, to directly manage cumulative impacts on a regional development basis.

However, in line with IFC Performance Standards Guidance Note 1, Yamal LNG will use commercially reasonable efforts to engage relevant government authorities, other developers, Affected Communities, and, where appropriate, other relevant stakeholders, in the design and implementation of coordinated mitigation measure to manage the potential cumulative impacts identified in Section 13.9. Proposed methods for such engagement are described below.

Appropriate mitigation measures at the local, individual project scale for the other developments considered within the CIA would be, in general terms, similar to those to be implemented by Yamal LNG as described in Chapters 9 and 10. Yamal LNG will have no direct control or authority over the implementation of such measures by other developers. However, it is possible to influence the adoption of good practice mitigation measures through sharing of information (good practice, monitoring data etc.) via structured engagement with other developers/authorities. These are further discussed below.

13.10.2 MITIGATION AT THE INDIVIDUAL PROJECT LEVEL

Many of the impact types identified with the third party project developments considered in the CIA are similar in nature to those identified and assessed for the Yamal LNG Project. Therefore, the mitigation measures being developed by Yamal LNG (and as described in Chapters 9 and 10) would, to a large extent, be applicable to other project developments. Many of the key mitigation controls being implemented by Yamal LNG are either required under mandatory Russian standards or else in line with industry standard practices, and therefore may be reasonably assumed to be adopted by other project developers.

In addition, Yamal LNG has also elected to adopt a number of wider good practice mitigation measures. It is likely that Yamal LNG's adoption of these mitigation measures will provide a mechanism for the spread of good practices to other developers. To help achieve this, Yamal LNG will proactively share information on the implementation of good practice measure, including lessons learned and monitoring data, with relevant local authorities and other developers.

13.10.3 YAMAL LNG ROLE IN MANAGING CUMULATIVE IMPACTS

In addition to the control of impacts at the individual project level, Yamal LNG will, to the extent that is practicable and reasonable, take a proactive role contributing the management of cumulative impacts at the wider district/regional level. Specific approaches to be adopted by Yamal LNG in this regard are provided in Sections 13.10.3.1 to 13.10.3.4 below.

13.10.3.1 NATURAL HABITATS AND AVIFAUNA

Control of cumulative impacts on natural habitats generally, including breeding birds, requires region-wide initiatives. Specific measures to be implemented by Yamal LNG in order to proactively contribute the region-wide protection of natural habitats and nesting birds in particular are summarised below:

- Yamal LNG is developing a Biodiversity Action Plan (BAP) with specific actions for the assessment and management of natural habitats and avifauna within the Project Licence Area (see Chapter 9 for further details). Yamal LNG will use best endeavours with both local authorities and other relevant developers/operators in the Yamalsky District to:
    - Share information on the BAP (including results of any survey and monitoring data)
    - Identify potential joint initiatives under the BAP as it evolves.
- Promote the spread of good practice to local authorities and other relevant developers/operators in the Yamalsky District by:
    - Sharing information on good environmental practices being adopted by the Project (as described in Chapter 9), including lessons learned
    - Sharing of environmental monitoring data
- Use of best endeavours to liaise with other operators, including the airport operator, in relation to the control of intra- and inter-field helicopter operations from the Sabetta airport, specifically in order to protect breeding birds (including design and control of flight paths and altitude to reduce potential noise impacts).

13.10.3.2 INDIGENOUS REINDEER HERDERS

Management of the cumulative impacts on reindeer herders described in Section 13.9.3 requires the adoption of suitable mitigation controls at the source of impacts at the individual project levels and also wider initiatives to protect and maintain the tradition lifestyles of the indigenous reindeer herders. Yamal LNG will proactively play a part in the control of these cumulative impacts, and two of the primary general mechanisms to assist in this are:

- Continued liaison and consultation with the indigenous population and other stakeholders through the Stakeholder Engagement Plan (SEP – see also Chapter 5)
- Development of an Indigenous Peoples Development Plan (IPDP – see also Chapters 5 and 10), and the use of best endeavours to engage local authorities, other

developers/operators in the Yamalsky district and other stakeholders in appropriate initiatives under this plan.

Approaches to the management of specific cumulative impacts on indigenous reindeer herders are also summarised below:

- **Health and safety**
  - Regional health services and authorities (The YNAO Department of Public Health) monitor health metrics among indigenous people and YLNG will liaise with these authorities in order to maintain an ongoing understanding of any changes in health conditions. This will enable Yamal LNG to confirm whether there are any unexpected changes in the health of the region/distruct wide health of the indigenous reindeer herders and, if so, whether Yamal LNG needs to consider the implementation of any further project controls or support at the district level in coordination with other operators.
  - Ongoing consultation and liaison with indigenous groups through the IPDP, will also provide a mechanism for Yamal LNG to monitor any potential health trends among the reindeer herders or wider IP community.
  - Improved medical/emergency transport availability is likely to result from the generally improved transport links in the district (see Section 13.9.7). In this regard, Yamal LNG will, where feasible, provide transport assistance in medical emergencies among the local population and, further, would use best endeavours to liaise with any other future operators using the Sabetta airport to coordinate the wider provision of such assistance.
  - Provision of awareness campaigns for safety around industrial installations, roads and railways will be provided to reindeer herders via the IPDP (even if project/site specific, this will be useful in mitigating risks more widely)
  - Use best endeavours to collaborate with other developers to coordinate provision of fuel to indigenous reindeer herders.
- **Pasture lands and migration routes**
  - Sharing of good practice and lessons learned (on effectiveness of mitigation measures) with other operators and local authorities.
  - Ongoing consultation with IP through the IPDP and SEP to understand evolving status of reindeer herding at the district level. This will enable Yamal LNG to confirm whether there are any unexpected changes affecting reindeer herding and, if so, whether Yamal LNG needs to consider the implementation of any further project controls or support at the district level in coordination with other operators.
  - Yamal LNG will use best endeavours to engage local authorities and other operators/developers in the IPDP process as a mechanism to share information and good practice, understand district-wide status of reindeer herding, and to identify opportunities for shared initiatives to support reindeer herders at the district level.
- **Economy and employment**
  - The development of regional transport, such as the airports at Sabetta and Bavenkovo, and the potential extension of railway links on the Yamal peninsula, can offer improved export opportunities for reindeer herders' products. To be effective, this would require effort at the regional and project levels, to provide the reindeer herders with suitable access to these transport links. Yamal LNG will use best endeavours to liaise with

other developers/operators (including the operators of Sabetta airport) to help coordinate the provision of this access.
- Yamal LNG is committed to:
  - Providing vocational/skills training and professional development opportunities for the local workforce (especially youth) to build and strengthen their capabilities and reinforce their competitive position
  - Liaising with YNAO and the Yamalsky District educational institutions for cooperation in professional training provision and engagement with recent graduates.

13.10.3.3 FISH AND FISHERIES

Specific measures to be implemented by Yamal LNG (and other organisations) to help better understand and manage fish stocks and fisheries include:

- Yamal LNG will implement a comprehensive monitoring programme in the Gulf of Ob covering water quality parameters. Monitoring of hydrochemical parameters is carried out by Yamal LNG within the Program of local environmental monitoring for 2014-2016 agreed with Department of Nature Resources regulation of YNAO. Monitoring of fish stocks is carried out by organisations that are involved in dredging operations in the framework of the Program of observation for state of bio-resources and their habitats during construction and operation of marine facilities (seaport and approaching channel). The data from this programme will provide valuable information on the evolving condition of fish stock within the Gulf of Ob. Monitoring data from the programme will be shared with relevant authorities as an important input the management of fish stocks in the Gulf of Ob.
- In agreement with local fish protection authorities Yamal LNG will support the construction of new fish-breeding facilities for valuable fish species, such as Sturgeon (see Chapter 9 for further details. These measures are aimed at improving valuable fish stock on a region scales.
- Yamal LNG will endeavour to improve the understanding of the scale and location of informal fisheries via consultant under the SEP and IPDP.

13.10.3.4 MARINE MAMMALS

Specific measures to be implemented by Yamal LNG to help understand and manage impacts to marine mammals include:

- The development and implementation of a “Strategy for Protection of Atlantic Walrus Subspecies”. This strategy has been agreed in consultation with external stakeholders (including WWF Russia).
- The use of suitable trained marine mammal observers (MMOs) on LNG carriers and Condensate tankers during the initial operational period in order to improve knowledge of marine mammal distributions and to confirm potential impacts of shipping. This monitoring programme may be developed as part of the BAP.
- Sharing of good practice and lessons learned (on effectiveness of mitigation measures, such as the use of MMOs during noisy marine activity) with other operators and local authorities.

ANNEX A PHASE I AND II SCOPING ASSESSMENT SUMMARY

VEC		Nature of potential impact	Any specific sensitivity / susceptibility	Residual impact from YLNG	Spatial extent of VEC	Temporal extent of impact	Potential impact of non-industrial influences/trends	Potential influence from other developments	Discussion	Include in CIA
Generic	**Specific**									
Airshed	Humans (IP/local community)	Human health	Potentially some heightened susceptibility to AQ effects in IP population	Negligible	Across migration routes	Primarily during operation		Of primary consideration for AQ effects are: 1. Impacts from the Project are assessed as low and impacts at nearest receptors are less 25% of standards and therefore significant impacts on cumulative impacts not anticipated (see IFC EHS Guidelines for air emissions) 2. AQ impacts from our Projects outside the licence area will not overlap (only potential exception could be an LNG plant associated with the Gydan peninsula fields). Additional sources of air pollution include: - Railways (undefined, but some minor impact in licence area if routed to Tambey. However, this will be intermittent an is not considered significant in context of project emissions) - Additional booster compression - Third party process facilities/sources - Additional use of Sabetta seaport or airport (undefined)	Impacts infrequent and temporary. This is true for the YLNG project and, given the nomadic nature of the IP population, likely to be true for other future developments. Project impacts sufficiently low to render significant contribution to effects extremely unlikely, even given known prevalence for respiratory problems. Residual YLNG impact is negligible. Therefore scoped out.	N
	Humans (workers)	Human health	Some potential for heightened susceptibility on cold conditions	Low	Localised human receptors consider separately				Local receptors (worker accommodation) treated separately for different projects. Cumulative impacts only from localised additional sources (see column to left). Note assessed GLC are within 25% of standards and therefore significant impacts on cumulative impacts not anticipated (see IFC EHS Guidelines for air emissions). Therefore scoped out.	N
	Reindeer pasture	NOx Air Quality on lichen	Lichen susceptible to impact, currently over-grazed and with slow recovery times	Negligible	Across peninsula		Note pressure of over grazing on lichen and increasing levels of reindeer		Scoped out as residual YLNG impact is negligible	N
	Reindeer pasture	Nitrogen deposition - impacts to lichen		Negligible					Scoped out as residual YLNG impact is negligible	N
	Climate change	GHG		N/A					Already assessed in wider context in Chapter 9	N
Soils	Permafrost	Mechanical and thermal impacts	Permanent damage may be caused	Low	Permafrost across peninsula	Potentially long term impacts	Climate change	All other onshore projects have the potential to impact permafrost at the local scale	Impacts are localised, although numerous linear impacts could lead to more significant cumulative effects. However, in this event YLNG's impacts would be of low contribution.	N
	General soils	Chemical impacts		Low	Across peninsula	Potentially long term impacts		All other onshore oil and gas developments and railway	Impacts are localised and require control at individual project level. Note positive benefit of reinstatement of legacy contamination areas	N
Groundwater	Shallow underground strata	Chemical impacts		Low	Across peninsula	Potentially long term impacts		All other onshore oil and gas developments and railway	Impacts are localised and require control at individual project level.	N
Freshwaters	Water quality and availability	Sedimentation, chemical contamination. Knock on effects for drinking water and freshwater biota		Low	Multiple rivers/lakes across peninsula	Impacts potentially throughout operation, more likely to be more		All other onshore oil and gas developments (including linear infrastructure) and any railway extension would have the potential to impact river systems through aqueous discharges, erosion runoff	Impacts are localised (not the same rivers or catchments) and require control at individual project level in terms of water quality. However potentially on same reindeer migration routes. Impacts need to be managed at the project level but if meet MPCs etc. then impacts should be controlled. Impacts on	N

VEC		Nature of potential impact	Any specific sensitivity / susceptibility	Residual impact from YLNG	Spatial extent of VEC	Temporal extent of impact	Potential impact of non-industrial influences/trends	Potential influence from other developments	Discussion	Include in CIA
Generic	Specific									
		(see below). Water abstraction leading to reduced water availability and levels				severe during construction		and river crossings. Nearest other licences still outside of catchments to main rivers within Licence Area.	water availability/levels will not be an issue for abstraction from the Gulf of Ob and no additional intake from lakes used by the Project are identified/Foreseeable (Scoped out as residual YLNG impact is negligible) For cumulative effects on freshwater biota see below.	
	RDB Freshwater & anadromous fauna	Water contamination, water abstraction, direct loss of water bodies (infill and/or sand excavation), sedimentation effects (river crossings) and changes to hydrological dynamics (river crossings)	Siberian sturgeon (endangered). Population in region has declined. Sterlet (vulnerable). Ob population is believed to have suffered a 50% decline	Low	Sturgeon numbers are low, but thought to be large rivers and lakes across peninsula and in coastal water of Gulf of Ob Sterlet inhabits is found in large rivers Neither Siberian Sturgeon nor Sterlet have been recorded within the Project Licence Area and neither species are considered likely to occur regularly	Physical habitat loss impacts throughout operation. Sand excavation and erosion control at crossings more likely to be more severe during construction	Significant declined in surgeon numbers in particular	All other oil and gas developments have potential to impact river systems. Nearest other licences still outside of catchments to main rivers within Licence Area. Railway could have potential to influence some rivers in the northern parts of Licence Area. See marine (Gulf of Ob) below for impacts on anadromous species in marine waters.	Neither Siberian Sturgeon nor Sterlet have been recorded within the Project Licence Area and neither species are considered likely to occur regularly. Therefore impacts in rivers are negligible and scoped out of the CIA. However, there is the potential for impacts in the Gulf of Ob on sturgeon in the marine phase.	Y
	Capture fisheries (freshwater)		Round-nosed whitefish Burdot	Low	Round-nosed whitefish (large rivers south of Tambey) Burdot (large rivers)				Impacts not to the same river catchments. Low level of impact top species not considered significant and therefore screened out of CIA. However, potential for cumulative impact to access to rivers	Y
	Capture fisheries (anadromous)		Sturgeon (see above) Siberian vendace Arctic cisco Muksun	Low	Sturgeon (see above) Siberian vendace (large rivers) Arctic cisco (most rivers) Muksun (rivers south of Tambey)				Impacts not to the same river catchments. However, there is the potential for impacts in the Gulf of Ob on sturgeon in the marine phase.	Y
Marine environment	Gulf of Ob (southern low salinity portions)	Changes in salinity. Knock-on effects for marine biota (see below)	Naturally low salinity south of the sand bar (see Chapter 9)	Low	Gulf of Ob	Potentially long term		No other identified developments that are likely to affect the sand bar (Gydan fields are south of the sand bar and other shipping from other projects would use the navigation channel).	Sand bar is key issue. No additional impacts to the sand bar identified from other projects/developments	N

VEC		Nature of potential impact	Any specific sensitivity / susceptibility	Residual impact from YLNG	Spatial extent of VEC	Temporal extent of impact	Potential impact of non-industrial influences/trends	Potential influence from other developments	Discussion	Include in CIA
Generic	Specific									
	Capture fisheries (marine)	Exclusion zone (construction vessels and port area) Suspended sediment (dredging) Noise (piling, dredging, ice-breaking) Water abstraction Water contamination (including spills)	Navaga Also semi-anadromous including Siberian Sturgeon, Siberian vendace and Arctic cisco (see also above)	Negligible (abstraction) Low (contamination from onshore sources and vessels). Moderate (dredging) Low (underwater noise) Low (exclusion zones)	Gulf of Ob	Construction exclusion short term. Port exclusion long term. TSS and noise short term. Vessel noise long term but intermittent	See above regarding sturgeon decline	Additional construction noise and sedimentation if LNG export option developed for Gydan fields. Additional shipping noise from shipping associated with other projects (Gydan and Novoport) Invasive species likely to be location specific to other ports and accumulation unlikely.	Noise impact of fish not generally likely to overlap or be significant in a cumulative context. Not considered further in CIA. Exclusion zones may aggregate and considered further in CIA. Dredging impacts may cumulate and are considered further in CIA. Invasive species likely to be location specific to other ports and accumulation unlikely. Not considered further in CIA. Water abstraction impacts screened out as negligible.	Y
	Non-capture marine fish/benthos	Exclusion zone (construction vessels and port area) Suspended sediment and sedimentation/smothering (dredging) Noise (piling, dredging, ice-breaking) Water abstraction Water contamination (including spills)Water contamination (including spills, water abstraction, noise Invasive species (ballast water)	Potential for protected species within regional waters	Negligible (abstraction) Low (contamination from onshore sources and vessels). Moderate (dredging) Low (underwater noise) Low (Invasive species)	Gulf of Ob	Construction exclusion short term. Port exclusion long term. TSS and noise short term. Vessel noise long term but intermittent Sedimentation /smothering medium term	See above regarding sturgeon decline	Additional construction noise and sedimentation if LNG export option developed for Gydan fields. Additional shipping noise from shipping associated with other projects (Gydan and Novoport) Invasive species likely to be location specific to other ports and accumulation unlikely.	Noise impact of fish not generally likely to overlap or be significant in a cumulative context. Not considered further in CIA Dredging impacts may cumulate but no significant benthos identified as VECs. Not considered further in CIA. Invasive species likely to be location specific to other ports and accumulation unlikely. Not considered further in CIA. Water abstraction impacts screened out as negligible.	N
	Marine mammals	Noise Ice-breaking (for polar bear see below)	Noise disturbance for cetaceans and seals Ice habitat disturbance likely to be of low significance	Low (underwater noise during construction) Moderate (Ice-breaking noise)	Gulf of Ob	Long term but intermittent		Increased number of vessels in Gulf of Ob through to the Northern Sea Route	Noise disturbance from ice breakers of primary concern and is function of vessel numbers. Include in the CIA. Impacts of ice breaking on habitat of low impact and not considered further in the ESIA.	Y
Terrestrial fauna	Avifauna	Noise, Light, direct habitat loss	Threatened bird species present. Need for further assessment of DMUs identified	Moderate (breeding birds)	Across peninsula (species specific)	Through project lifecycle	Overgrazing, climate change	Nearest field developments (esp if use Sabetta airport) - could impact same habitat areas. Other airport at Bovanenko could impact same VEC in different areas	Noise impacts likely key effect. Aggregated habitat loss also potential issue, which links to overgrazing issues. To be included in the CIA.	Y

VEC – Generic	VEC – Specific	Nature of potential impact	Any specific sensitivity / susceptibility	Residual impact from YLNG	Spatial extent of VEC	Temporal extent of impact	Potential impact of non-industrial influences/trends	Potential influence from other developments	Discussion	Include in CIA
	Mammals	Noise, human interaction/disturbance, physical habitat loss, habitat fragmentation	Includes polar bear	Low	Some migrating mammals (e.g. polar bears) are likely to be more prevalent in the northern reaches of the peninsula than the Licence Area	Throughout the lifecycle of the project, but impacts of interactions and disturbance greater during construction phases	Climate change – potential to effect migration patterns/ranges		More northerly developments may have increased interaction with polar bears. YLNG contribution small (including on shipping route up to Northern Sea Route).	N
	Natural tundra habitat (including RDB flora)	Physical habitat loss	Forb-graminoid, horsetail-graminoid meadow communities are considered to meet Criterion 4 as critical habitat	Moderate to Low	Around 7 different habitat types are identified by CAFF within northern Yamal (see main text)	Duration of project	Overgrazing	The known development fields in Severo-Tambeyskoye, Zapadno-Tambeyskoye, Tasiyskoye, Malyginskoye and, to a lesser extent, Bovanenkovskoye all share similar habitats to those prevalent in and around the project licence area, namely types P1, S1, S2 and G3	Given identification of some critical habitats and extent of such habitat, include in CIA	Y
	Reindeer, pasture lands (including lichen) and migration route	See below								
	Wild foods	See below								
Humans	Humans (IP/local community)	Communicable diseases	Potential enhanced susceptibility to certain diseases	Low	Migration ranges	Impacts potentially throughout operation, more likely to be more severe during construction		Zapadno, Severo and Tasiyskpoye	Cumulative impacts to autumn migration routes. Other projects unlikely to affect Ilebts circular migration usage	Y
		Stress	Remote nature of lifestyle may lead to increased susceptibility to stress from changes to natural environment and tradition lifestyle	Low	Migration ranges	Impacts potentially throughout operation, more likely to be more severe during construction		Zapadno, Severo and Tasiyskpoye	Cumulative impacts to autumn migration routes. Other projects unlikely to affect Ilebts circular migration usage	Y
		Road safety	Lack of experience with road traffic risks	Moderate	Migration ranges	Impacts potentially throughout operation, more likely to be more severe during construction		Zapadno, Severo and Tasiyskpoye	Cumulative impacts to autumn migration routes. Other projects unlikely to affect Ilebts circular migration usage	Y

VEC		Nature of potential impact	Any specific sensitivity / susceptibility	Residual impact from YLNG	Spatial extent of VEC	Temporal extent of impact	Potential impact of non-industrial influences/trends	Potential influence from other developments	Discussion	Include in CIA
Generic	Specific									
		Project emergencies/ hazards		Low	Migration ranges	Impacts potentially throughout operation, more likely to be more severe during construction		Zapadno, Severo and Tasiyskpoye	Localised impacts unlikely to significantly aggregate	N
		Interactions with security guards	Dogs can pose risk to reindeer	Low	Migration ranges	Impacts potentially throughout operation, more likely to be more severe during construction		Zapadno, Severo and Tasiyskpoye	Cumulative impacts to autumn migration routes. Other projects unlikely to affect Ilebts circular migration usage	Y
		Population influx (tensions)	Remote nature of lifestyle may lead to increased susceptibility to stress from changes to tradition lifestyle	Moderate	Migration ranges	Impacts potentially throughout operation, more likely to be more severe during construction		Zapadno, Severo and Tasiyskpoye	Cumulative impacts to autumn migration routes. Other projects unlikely to affect Ilebts circular migration usage	Y
Humans	Humans (IP/local community)	Population influx (pressure on services)	Existing medical services in remote regions are already stretched	Low	Migration ranges, regional centres	Impacts potentially throughout operation, more likely to be more severe during construction		Potentially all developments	Could impact services at regional scale. Primary control is through provision of dedicated facilities at each project. If services are accessible to IP then also a potential benefit to nomadic IP. Regional economic development could help offset. Also note IPDP and other regional development initiatives. While major incidents/emergency at individual developments may lead to short term impacts on the capacity of regional medical services, these are not considered to act cumulatively as (i) coincidental incidents are extremely unlikely and (ii) the identified development projects are sufficiently distant from one-another to lead to domino effects from emergency scenarios	Y
		Disruption of cultural lifestyle	Remote nature of lifestyle may lead to increased susceptibility to stress from changes to natural environment and tradition lifestyle	Low	Migration ranges	Impacts potentially throughout operation, more likely to be more severe during construction		Zapadno, Severo and Tasiyskpoye. Other regional developments	Cumulative impacts to autumn migration routes. Other projects unlikely to affect Ilebts circular migration usage. Also regional level impacts to IP culture	Y

VEC		Nature of potential impact	Any specific sensitivity / susceptibility	Residual impact from YLNG	Spatial extent of VEC	Temporal extent of impact	Potential impact of non-industrial influences/trends	Potential influence from other developments	Discussion	Include in CIA
Generic	Specific									
		Access to fishing (see also captures fisheries above) and gathering areas	Fishing plays an import season part of subsistence and commercial IP existence	Low	Migration ranges	Impacts potentially throughout operation, more likely to be more severe during construction		Zapadno, Severo and Tasiyskpoye. Also construction works in Gulf of Ob associated with Gydan project in relation to fishing in Gulf og Ob (see capture fisheries above).	Impacts not to the same river catchments. However potentially on same autumn migration route. See also Impacts on Freshwater fish	Y
		Informal settlements		Negligible	Migration ranges	Impacts potentially throughout operation, more likely to be more severe during construction			Scoped out as residual YLNG impact is negligible	N
Humans	Humans (workers)	Various (see Chapter 10.4)		Moderate to Low	Licence area				Project specific and not relevant to CIA.	N
Economy & Employment	Humans (IP/local community)	Direct and indirect employment and economic development		Beneficial	IPs in region	Construction (primary), Operations (limited)		All developments in region	Potential benefits	Y
	Humans (workers)	Demobilisation		Low					Project specific and not relevant to CIA.	N
Cultural heritage	IP Cultural heritage	Loss of access		Moderate to low	Potentially across peninsula	Projects lifecycle		All onshore developments in region	Includes aggregated impacts to autumn migration IP, plus regional level impacts to Ips	Y
		Damage		Low	Potentially across peninsula	Construction		All onshore developments in region	Damage needs to be controlled at local project level, but some potential to aggregate to cumulative impacts	Y
Reindeer	Reindeer pasture	Access to pasture grounds		Low	Potentially across peninsula	Through project lifecycle	Evidence of overgrazing	Zapadno, Severo and Tasiyskpoye. Other onshore regional developments (including railway)	Impacts associated with loss of access and physical land take. Nearest 3 developments can impact autumn migration routes in an aggregated manner with YLNG. A potential future railway could have similar effects. Re-routing could lead to indirect impacts on other migration/pasture areas. Other onshore developments could lead to both region-wide impacts on wider population and also aggregated indirect impacts if displacement occurs	Y
Reindeer	Reindeer migration	Access to migration routes		Low	Potentially across peninsula	Through project lifecycle	Evidence of overgrazing	Zapadno, Severo and Tasiyskpoye. Other regional onshore developments (including railway)	Nearest 3 developments can impact autumn migration routes in an aggregated manner with YLNG. A potential future railway could have similar effects. Re-routing could lead to indirect impacts on other migration/pasture areas. Other developments could lead to both region-wide impacts on wider population and also aggregated indirect impacts if displacement occurs	Y

14 ENVIRONMENTAL AND SOCIAL MANAGEMENT

Yamal LNG will establish management programmes that describe mitigation and performance improvement measures and actions that address the potential environmental and social risks and impacts identified through the ESIA process. These programmes will include procedures, practices and plans to ensure that all environmental and social aspects of the Project are managed in a comprehensive and systematic way. The programmes will apply across the Project, including both Yamal LNG and the contractors over which it has control.

In particular, Yamal LNG will produce the following document packages:

1. Environmental and Social Management Plan (ESMP)

An ESMP comprising a suite of individual environmental and social management plans (MPs) is being developed that defines the Project's environmental and social requirements and how these requirements are to be managed throughout the Project development. In particular, the MPs will describe:

- The organisational approach to environmental and social management, including definition of roles and responsibilities.
- The environmental and social standards to be applied.
- The specific management, mitigation and monitoring measures to be implemented to control all potentially significant environmental and social impacts under the control of Yamal LNG. These will include the mitigation and monitoring measures identified under each topic area in Chapter 9 and which have been used to determine the residual environmental and social impacts in this ESIA.

Recognizing the dynamic nature of the Project, the MPs will be responsive to changes in circumstances, unforeseen events, and the results of monitoring and review. At this stage the ESMP and associated Construction Management Plans (CMPs) have been developed that address the construction phase of the Project. The structure for the construction phase ESMP is described in an ESMP (Construction) Framework Document, together with the individual CMPs. The operational phase ESMP will be developed at a later date prior to commencement of operations.

2. Environmental and Social Action Plan (ESAP)

The ESAP will describe and prioritise any additional actions needed to enable the development and implementation of further relevant mitigation measures, corrective actions and/or monitoring measures necessary to manage the environmental and social impacts and risks identified in the ESIA. Additional actions captured in the ESAP will typically be those that require additional time for their full development after the finalisation of the ESIA.

Both the ESMP and ESAP will sit within the Project's overarching management systems, including Yamal LNG's Health, Safety & Environmental Management System (HSE MS) that is being developed to the international ISO14001 and OHSAS 18001 standards.