

1. INTRODUCTION

1.1. Background

Aricom plc is a UK company, established with the objective of acquiring and developing deposits in Russia. Aricom currently owns 74 % of the company named Olekminskiy Rudnik (OR), which wholly owns the Kuranah titanium-magnetite deposit site. The company OR has held an exploration and mining licence since 1 June 2004, which is valid until 1 June 2026.

High titanium and iron oxides were discovered on this area for the first time in 1982. The first detailed exploration works were undertaken between 1984 and 1988 and as a result the Kuranah zone was marked out. On the whole, exploration works were undertaken by several organizations until 2001.

During the period from 1987 to 2004, about 4,300 metres of core drilling and about 42,700 m³ of trenches were excavated in total, with a range of geophysical and geochemical works. Additional exploration work was undertaken from May to October 2005 in accordance with recommendations of the State Committee on Resources (SCR), and now new documents are ready for approval.

The development of the Kuranah deposit was designed by the planning organization (design institute) VNIPIpromtechnology (VNIPI) at the beginning of 2006, together with Aricom specialists, and is now going through the permitting procedure. The environmental part of that project documentation is the chapter entitled “Environmental protection”, which contains the results of calculations of emissions, and describes the technical environmental protection measures in accordance with Russian legislation. A full OVOS (the Russian equivalent of an Environmental Impact Assessment) was not available for the project and will be prepared later on the basis of existing calculations by VNIPI and this document.

An independent consultant E.Vershinina has been commissioned by Aricom plc to prepare an Environmental Impact Assessment (EIA) report in accordance with international requirements on the basis of the project report, prepared by VNIPIpromtechnology.

This EIA report is based on the project report, designed by VNIPIpromtechnology, a number of separate reports relating to different environmental aspects and two visits to the region of project. A list of the reports and other documents used is in Attachment № 1.

This EIA has been prepared to meet the requirements of the Equator Principles, which are a series of principles adopted by international financing institutions to ensure that project sponsors take systematic account of all environmental and social concerns and principles of sustainable development in an EIA. The Equator Principles and other international requirements are discussed in Section 3 of this report.

The objectives of this EIA are to:

- Describe the existing environment of the proposed project area.
- Evaluate the potential environmental impacts of project development (construction, operation and closure) depending on the specific design criteria.
- Assess the environmental risk associated with each impact both in the short- and long-term.
- Propose environmental management and mitigation measures designed to minimize all predicted impacts.

This EIA report covers the following land areas:

- Mine license area (mine site).
- Process plant site;
- The road linking the mine site, process plant site and Olekma railway station;

1.2. Contact details of mine owner and /responsible person (mining)

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St. Staraya Basmannaya, 7, building 2, Moscow, 105064, Russia
Phone: +7 (495) 775-18-24
e-mail: info@aricom.ru
Web-site: //www.aricom.ru
- Company “Olekminskiy Rudnik”
Ignatyevskoye shosse, 19, Blagoveshensk, Amur oblast, 675028, Russia
Phone: +7 (4162) 35-06-06

1.3. Structure of this report

This EIA report is structured as follows:

Executive Summary: is the short description of the documentation with identifying of main points.

Section 1: Introduction

Section 2: Describes international requirements, mainly the requirements of the World Bank and International Finance Corporation.

Section 3: Presents an explanation of the Russian environmental regulations and standards in the field of environmental protection and gives some comparison between Russian and international standards.

Section 4: Describes the baseline condition of the project area.

Section 5: Presents project design details description for every site and infrastructure.

Section 6: Environmental impact assessment of proposed project proposals.

Section 7: Environmental management plan.

Section 8: Closure and rehabilitation plan.

1.4. Kuranah project location

The Kuranah titanium-magnetite deposit site is located in the Tundinskiy district in the north-west part of Amur oblast on the east of the Russian Federation. The Amur river provides a natural border with China to the south. The Amur oblast borders the Republic of Saha in the north, Chita oblast to the west and the Jewish Autonomous Oblast and Khabarovsk Krai to the east (Figure 1).

A considerable part of the Amur oblast (64 %) is covered by taiga forest, which is important for the economy and ecology of the region. From north-west to south-east Amur oblast is crossed by important transport routes – the Baikal-Amur Railroad and Trans-Siberian Railroad which are the main transport routes to the east of Russia.

The deposit site is located in close proximity to the boundaries of Amur oblast with two other Russian regions – Chita oblast and the Republic of Saha (Yakutia) (Figure 2). In spite of the presence of official administrative divisions, Chita oblast and Yakutia are similar to the deposit site project area with respect to environmental, social and economical issues. The north-west part of Amur oblast and the parts of Yakutia and Chita oblast bordering with it are sparsely populated. Distance between settlements with a population of several hundred people is usually 50 km or more.

The deposit is 40 km from Olekma railway station, which lies on the Baikal-Amur Railroad. Olekma is the nearest settlement to the deposit site. Olekma station is located 480 km from the district centre town of Tynda. The distance from Tynda to the regional centre of Blagoveshensk is 840 km. Figure 3 shows the location of the project in relation to the district and regional centres. The landscape of the Kuranah project area is mountain taiga with mountain relief of 400-1500 m above sea level and relative exceeding till 770 m (5). The area is covered by forest.

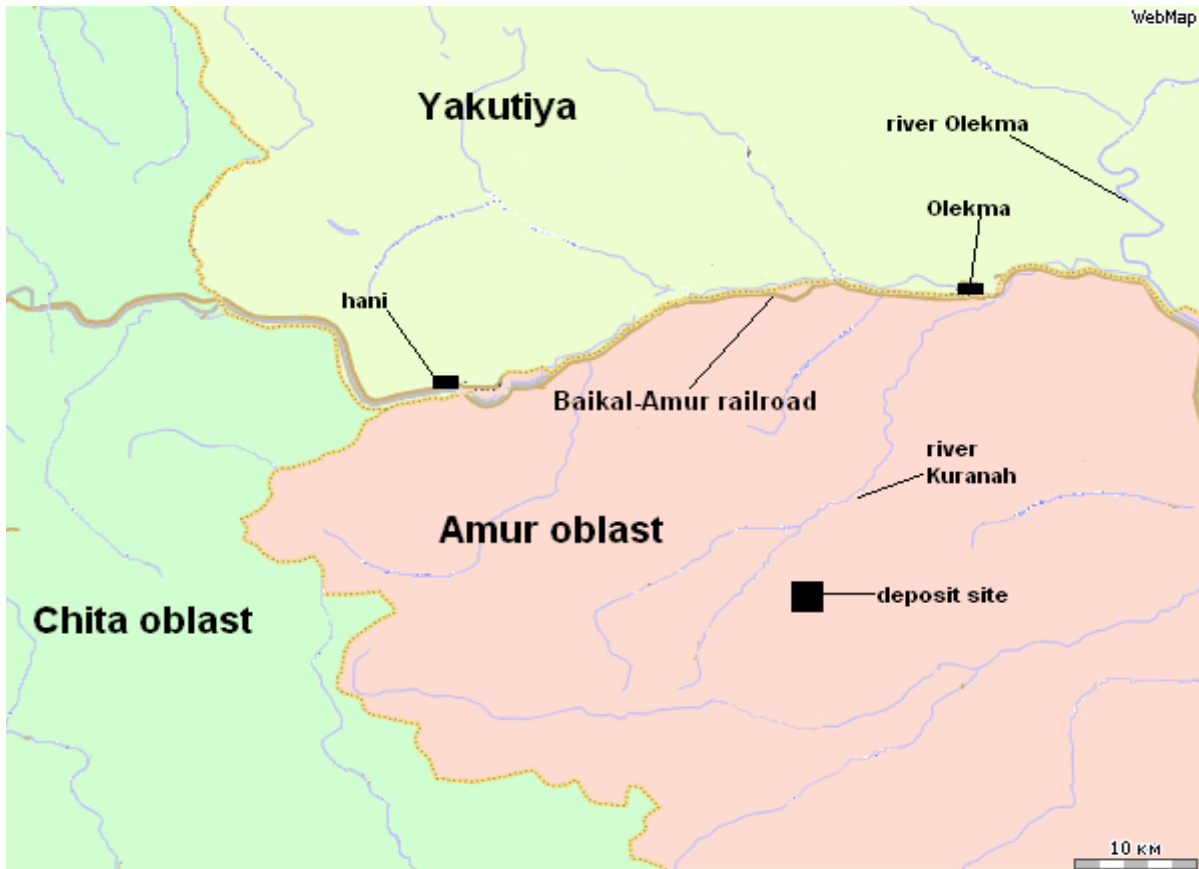
Figure 1. Location of the Amur oblast



Figure 2. Location of the project in relation to district and regional centres



Figure 3. Location of the deposit site in relation to the nearest regions



2. INTERNATIONAL REQUIREMENTS

2.1. Equator principles

The Equator Principles are a series of nine principles that were adopted by international financing institutions in June 2003, following the example of the International Finance Corporation (IFC), to enable them to review and assess requests for finance with a total capital cost of US \$50 million or more. The principles focus on ensuring that projects employ socially responsible and sound environmental management practices. They provide a framework for developing individual, internal project practices and policies.

At the present time, a new version of the Equator Principles is under consideration and the latest draft was published in March 2006.

In both previous and new versions of the Equator Principles, all projects are allocated to category A, B or C on the basis of environmental and social criteria. For A and B categories, which are the categories of most environmental and social risk, the borrower has to provide an Environmental Assessment (Social and Environmental Assessment on the new version - SEA), which has addressed the following:

- assessment of the baseline environmental and social conditions
- requirements under host country laws and regulations, applicable international treaties and agreements
- sustainable development and use of renewable natural resources
- protection of human health, cultural properties, and biodiversity, including endangered species and sensitive ecosystems
- use of dangerous substances
- major hazards
- occupational health and safety
- fire prevention and life safety
- socioeconomic impacts
- land acquisition and land use
- involuntary resettlement
- impacts on affected communities and vulnerable groups (including indigenous peoples)
- cumulative impacts of existing projects, the proposed project, and anticipated future projects
- consultation and participation of affected parties in the design, review and implementation of the project
- consideration of feasible environmentally and socially preferable alternatives
- efficient production, delivery and use of energy
- pollution prevention and waste minimization, pollution controls (liquid effluents and air emissions) and solid and chemical waste management.

Category of the project is defined as following:

Category A – Projects with potential significant adverse social or environmental impacts those are diverse, irreversible or unprecedented;

Category B – Projects with potential limited adverse social or environmental impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures;

Category C – Projects with minimal or no social or environmental impacts.

In accordance with this categorization Kuranah mine project is defined as Category B project.

The new version of the Equator Principles contains both minor changes and additions and some significant differences. The most important change is the reference to the new IFC Performance Standards. Besides cost of the project which is required to be in compliance with Equator Principles requirements was changed from US \$50 million to US \$10 million.

All projects, as with the previous version, are required to comply with host country laws, regulations and permits. In addition, the project should follow the minimum standards applicable under the World Bank *Pollution Prevention and Abatement Guidelines, April, 1999*. The SEA should also refer to IFC Performance Standards, which also represent a new version of previous IFC Safeguard Policies, and were adopted in 2006.

Category A, and in some cases Category B, projects should have an Environmental Management Plan (Action Plan in the new version) which draws on the conclusions of the EA and describes mitigation measures and monitoring to manage impacts and risks defined in the EA.

Both versions require public consultation, which should be undertaken with affected groups during project development, including local non-government organizations (NGOs) and indigenous people.

During construction and operation the borrower should comply with the Environmental Management Plan (EMP), report regularly on compliance with it, and decommission the facilities in accordance with the agreed Decommissioning Plan.

2.2. Pollution Prevention and Abatement Guidelines of WB

A series of environmental guidelines was published by The World Bank in 1998 in the *Pollution Prevention and Abatement Handbook (PPAH)*. The IFC also uses these guidelines. The guidelines are industry specific and some of them are appropriate for the Kuranah deposit site development:

- Base metal and iron ore mining;
- General environmental guideline;
- Monitoring;

Besides the parts of the PPAH outlined above, there is another WB guideline which is also appropriate for the Kuranah project entitled “Mining and milling – open pit”.

2.3. IFC’s policies and guidelines

Although the IFC uses the PPAH as guidelines as well, it has its own guidelines, including:

- occupational health and safety;
- rail transit systems;
- road and highways;
- waste management facilities;
- wastewater reuse;

2.4. IFC Performance Standards

In April 2006 the IFC has adopted 8 Performance Standards concerning the key issues of the IFC’s policy on Social and Environmental Sustainability, to be considered during the assessment of requests for finance. The relevance of the Standards to the Kuranah project is discussed in Table 2.1.

Table 2.1. Relevance of the IFC's Performance Standards to the Kuranah project

Performance Standard	Main positions	Relevance to the project
Standard 1: Social and Environmental Assessment and Management System	<p>Client will establish and maintain a social and environmental management system appropriate to the nature and scale of the project, which includes the following elements:</p> <ul style="list-style-type: none"> - Social and Environmental Assessment; - Social and Environmental Management Program - Organizational Capacity - Training - Community Engagement - Monitoring - Reporting 	<p>This document contains social and environmental assessment and a conceptual management plan on the basis of the assessment. Detailed management programs on all aspects will be developed further on the basis of the management plan.</p>
Standard 2: Labor and Working Conditions	<p>Objectives of the Standard are:</p> <ul style="list-style-type: none"> - To establish, maintain and improve the worker-management relationship - To promote the fair treatment of workers and compliance with national labor and employment laws - To prevent unacceptable forms of labor, such as harmful child labor and forced labor - To promote safe and healthy working conditions, and to protect and promote the health of workers 	<p>The company will organize its activity in accordance with the Standard's requirements. Documentation presented contains statements on health and safety, employment and emergency response.</p>
Standard 3: Pollution Prevention and Abatement	<p>The client will meet the requirements in the following areas:</p> <ul style="list-style-type: none"> - General Emissions of Pollutants - Resource Conservation and Energy Efficiency - Hazardous Materials - Wastes - Emergency Preparedness and Response - Technical Guidance - Ambient Considerations - Greenhouse Gas Emissions - Pesticide Use and Management 	<p>Release of pollutants has been avoided or minimized in the project design. The most environmental appropriate source of energy was chosen for the operation and water recycling will be undertaken. There will be no use of chemicals in the process, and waste management procedures will be developed on the basis of the conceptual environmental management plan presented in this document.</p>
Standard 4: Community Health and Safety	<p>Objectives of the Standards are:</p> <ul style="list-style-type: none"> - To avoid or minimize risks and impacts to the health and safety of the local community during the project life-cycle from both routine 	<p>The distance of the nearest settlement from the operational units, and the absence of dangerous substances, result in a decreased risk of impact on the</p>

	<p>and non-routine circumstances</p> <ul style="list-style-type: none"> - To ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security 	<p>local community.</p>
<p>Standard 5: Land Acquisition and Involuntary Resettlement</p>	<p>Standards objectives are:</p> <ul style="list-style-type: none"> - To avoid or minimize involuntary resettlement wherever possible by exploring alternative project designs - To mitigate negative social and economic impacts from land acquisition or restrictions on affected parties' use of land by: (i) providing compensation for loss of assets at replacement cost; and ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation and the informed participation of those affected - To provide opportunities to displaced persons to improve or at least restore their livelihoods and standards of living - To improve living conditions among displaced persons through provision of adequate housing with security of tenure at resettlement sites 	<p>There will not be any involuntary resettlement during the project development. Land has little current economic value. Questions of economical land acquisition are discussed in this document and appropriate measures are planned.</p>
<p>Standard 6: Conservation of Biodiversity and Sustainable Natural Resource Management</p>	<p>The client will meet the requirements in the following areas:</p> <ul style="list-style-type: none"> - Protection and Conservation of Biodiversity, including <ul style="list-style-type: none"> - Modified Habitat - Natural Habitat - Critical Habitat - Legally-protected areas - Invasive Alien Species - Management and Use of Renewable Natural Resources 	<p>The project area is not unique and is a part of large similar territory, excluding a reserve area, which is located close to the project area, but will not be disturbed by project.</p>
<p>Standard 7: Indigenous Peoples</p>	<p>The client will meet the requirements in following areas:</p> <ul style="list-style-type: none"> - Avoidance of Adverse Impacts - Information Disclosure, Consultation and Informed Participation - Development Opportunities - Impacts on Traditional or Customary 	<p>The project area is used by indigenous people, and the company is conducting a consultation process to assess the possibilities for achieving mutually beneficial cooperation.</p>

	Lands under Use - Relocation of Indigenous Peoples from Traditional or Customary Lands	
Standard 8: Cultural Heritage	Objectives of the Standard are: - To protect cultural heritage from the adverse impacts of project activities and support its preservation - To promote the equitable sharing of benefits from the use of cultural heritage in business activities	There are no objects of cultural heritage value on the project area.

3. RUSSIAN REGULATORY REQUIREMENTS

3.1. Introduction

This section describes the legal framework in Russia for mining projects. Compliance with relevant legislation and standards of the country of origin is one of the requirements of the Equator Principles, and a fundamental part of assessing the significance of impacts and ensuring effective environmental management of the project.

The Russian permitting procedure consists of two distinct phases – project initiation, which includes project development and construction, and operation. The first stage is provided for by the OVOS (the analogue of Environment Impact Assessment report) which is the main document for obtaining environmental permission for the operation. Before operations have begun, several permits are required to be obtained from different authorities and the OVOS must be approved by state environmental experts. According to the laws, any proposed activity must be discussed with the interested public.

During the operation, the organization has to have regular permits for environmental pollution, namely for air emissions, water discharges and waste disposal.

The Russian system of environmental protection is based on a system of environmental standards, and covers aspects such as water quality, air quality, wastes, conservation areas and so on. The basis for evaluation is a range of maximum acceptable concentrations (MACs) covering atmosphere (both for workplace environment and for ambient air quality and including average daily and maximum concentrations), water quality (for drinking water, recreational usage and fisheries protection), soils, and sediments.

3.2. Environmental legislation and standards

3.2.1. Main laws and regulations

The main laws and regulations in the field of environmental protection and safety are presented in Table 3.1.

Table 3.1. Laws and regulations in the field of environmental protection and safety of Russia Federation

Name of the regulation and date of issue	Main aspects
Federal Law on Environmental Protection, 2002	<ul style="list-style-type: none"> • gives main definitions connected with environmental protection (EP); • determines principles of EP, including “polluter pays” principle, obligation to provide EIA and state environmental expertise, biodiversity conservation, public participation in the decision of the question of EP and others; • determines basis of the state management of EP, power of different levels of state authority; • rights of the public and NGOs in the field of EP; • defines economical regulation of EP, including payment for the use of the natural resources; • defines the basis for environmental standards; • defines general requirements during design, location, construction, operation, conservation and liquidation of the buildings, facilities and other objects of different industries; • refers to zones of extreme environmental sensitivity and protected natural objects; • gives general requirements for environmental monitoring and environmental control;
Water Code, 1995, as amended	<ul style="list-style-type: none"> • Defines water types of water bodies, which includes surface water bodies (watercourses, water reservoirs, lakes, ponds, swamps, ice and snowfields), internal seas and ground water; • Defines rights of property and other rights on water bodies – in particular says that water bodies can be in state, municipal or private (only for detached surface water) ownership; • Determines method of obtaining a right on water use, especially the need to have a licence for water use and the method of obtaining it; • Establishes basis of state management in the field of use and protection of water bodies, and defines areas of state management including: <ul style="list-style-type: none"> - territorial water balances; - federal program on water use, protection and rehabilitation; - state monitoring; - registration of surface and ground water; - state water expertise; - control for use and protection; - licensing; • defines that water bodies can be used for purposes of public health, industry and energy supply, agriculture, forestry, recreation, transport, construction, fire safety, fishery, hunting and other. • Divides water use into general (without special equipment and facilities) and special. Special water use (which is needed for mining) can be carried

	<p>out on the basis of a licence and limits on water use;</p> <ul style="list-style-type: none"> • Determines the general requirements for water protection, including protection from impacting water bodies during construction and operation; • Defines details of ground water protection • And others.
Land Code, 2001, as amended	<p>In the field of environmental protection, the law defines:</p> <ul style="list-style-type: none"> • Categories of the lands, including: <ul style="list-style-type: none"> - agricultural land; - land of settlements; - land of industry, transport, energy, defence and other special functions; - lands of conservation areas; - lands of forest fund; - lands of water fund; - lands of reserve. • Responsibility of the land users to provide measures for: <ul style="list-style-type: none"> - Protecting soil and its fertility; - protection of land from erosion, contamination and other negative impacts; - rehabilitation of disturbed areas and other. • Right to the land and method of obtaining a right to the land; • Method of choosing sites for construction; • Special requirements for different categories of land
Forest Code, 1997, as amended	<ul style="list-style-type: none"> • Defines that lands of the forest fund of Russia includes lands covered by forest, not covered by forest and destined for forestry needs. Forest reserves do not include defence lands and forests of settlements; • Defines public forest servitude; • Determines that forest reserves include three categories (groups) of forests according to economical, ecological and social importance of the forest. The first group of forests is the most valuable and includes, for example, the forest strip along rivers, railways, and highways; forests of conservation areas and National parks; buffer (protective) zones for water supply sources and others. The second group is forest which requires limitations on its use. The third group is forest mainly of economic value. • Defines general principles of forestry; • Determines that to use the forest not for the purpose of forestry (including mining), the category of the forest land site must be changed and this site is excluded from the forest reserve; • Defines rights and responsibilities of forest users and others.
The Regulation on Environmental Impact Assessment of Planned Economic and Other Types of Activities in the Russian Federation, 2000	<ul style="list-style-type: none"> • Defines the main principles of the environmental assessment in Russia (with abbreviation OVOS), including prediction of negative impacts, consideration of options, public participation and others; • Defines the stages of the OVOS; • Defines requirements for public participation; • Gives requirements for OVOS materials as a part of overall project documentation
Federal law on	<ul style="list-style-type: none"> • Gives main definition;

<p>atmospheric air protection, 1999, as amended</p>	<ul style="list-style-type: none"> • Defines principles and approaches to the state management of air protection and the power of different levels of state authorities; • Gives approaches to air protection such as development of standards, state registration of harmful substances, permits for air emissions and others; • Defines general requirements for air protection during project design, location, construction and operation; • Defines approaches to air protection, including state and public control, monitoring, economic measures; • Defines the rights and responsibilities of the citizens and organizations in the field of air protection.
<p>Federal Law on production and consumption of wastes, 1998, as amended</p>	<ul style="list-style-type: none"> • Defines the power of the different levels of the state authority in the field of waste management; • Defines general requirements for waste handling, including: <ul style="list-style-type: none"> - having technical documentation about the use and treatment of produced wastes; - providing special sites for waste storage during design; - providing an inventory of the wastes and sites of its disposal; - defining the site for waste disposal on the basis of special investigations (geological, hydrogeological and others); - conducting environmental monitoring and control; - conducting land rehabilitation after the end of operation of waste disposal sites; - prohibition of waste disposal on the land of settlements, health resorts, water protection zones and others; • Defines separate requirements for handling dangerous waste, non-ferrous and ferrous waste; • Determines requirements for training staff responsible for waste management; • Defines general requirements for waste transportation, including transboundary transport; state registration and reporting in the field of waste management and economical regulation issues.
<p>Federal Law on fauna, 1995, as amended</p>	<ul style="list-style-type: none"> • Defines state ownership of fauna; • Defines the power of the authority in the field of fauna use and protection; • Establishes the main principles of state management, including providing sustainable development, barring cruel treatment of animals, payment for fauna use, priority of international legislation; • Determines state monitoring and registration of fauna; • Defines requirements for <ul style="list-style-type: none"> - habitat conservation; - establishment of limits and prohibition of use; - conservation of rare and endangered species; - regulation of population; - prediction of illnesses and losses; • Defines types and methods of fauna use, including hunting and fishery; • Establishes rights and social protection of the persons responsible for fauna protection; • Concerns traditional methods of use and protection of fauna.
<p>Federal Law on</p>	<ul style="list-style-type: none"> • Defines principles of environmental expertise, including presumption of

<p>Environmental Expertise, 1995, as amended</p>	<p>guilt of any planned economic activity, complexity of the EIA, obligation of the environmental expertise of the project before its realization, public participations, independence of the experts and others;</p> <ul style="list-style-type: none"> • Power of different levels of state authority in the field of environmental expertise; • Defines two kinds of the environmental expertise – state and public; • Defines objects and order of the state environmental expertise and divides objects into federal and regional levels; • Determines requirements for expert commission; • Determines requirements for conclusion of the state environmental expertise; • Defines conditions for realization of public environmental expertise; • describes rights and responsibilities of the initiator of the projects, who present the projects to the state expertise.
<p>Federal Law about sanitary-epidemiological well-being of population, 1999 as amended</p>	<ul style="list-style-type: none"> • Gives main definitions; • Defines the power of the state authority in the field of the provision of human health; • Rights and responsibilities of citizens and organizations, including rights for a favorable environment, on control for compliance with regulations, compensation, and on obtaining information; • Determines general sanitary requirements for: <ul style="list-style-type: none"> - planning and building of urban and country settlements; - goods; - foodstuffs; - organization of the population’s food; - water bodies, including drinking water; - air; - soils of residential areas; - storage and disposal of wastes; - living quarters; - labour conditions; • Defines health-preventive measures; • Determines methods of state regulation in the field of health protection
<p>Federal Law on the subsurface, 1992 as amended</p>	<p>At the present time, an updated law is under consideration, but the main changes deal with procedures for obtaining a mining licence and state rights. In the field of environmental protection, the existing law defines:</p> <ul style="list-style-type: none"> • Main requirements on rational use and protection of the subsurface; • Main requirements on safety in subsurface development; • General statements about liquidation of mining operations;
<p>Federal Law on the safety of dangerous industrial units, 1997, as amended</p>	<ul style="list-style-type: none"> • Lists operations which can be considered as dangerous, including mining and ore processing and storage and use of explosive materials; • Defines that before the operational stage, a project must have the conclusions of an expertise in industrial safety; • Defines the need to provide follow-on supervision of the design organization at the construction stage; • Defines the requirements for the undertaking a dangerous operation, including: <ul style="list-style-type: none"> - to have a licence for the exact type of work;

	<ul style="list-style-type: none"> - to employ only skilled personnel and provide training; - to have all statutory requirements for the operation; - prevention of access of strangers to the operation; - to have a contract for liability risk insurance and other. <ul style="list-style-type: none"> • Determines general requirements on readiness to react to accidents, control, technical investigation of the reasons for accidents; • Defines that industrial safety expertise must be provided for: <ul style="list-style-type: none"> - project documentation; - technical facilities used; - buildings of the dangerous operation; • Defines operational units which require development of a Declaration of industrial safety and its reviewing. For the Kuranah project, this is explosive material storage; • Defines the sum of insurance required for different types of the operations.
Federal Law on the safety of hydrotechnical facilities, 1997, as amended	<p>With reference to mining, this Law defines a tailing dam as a hydrotechnical facility requiring special attention, and particularly determines:</p> <ul style="list-style-type: none"> • The need to develop a document entitled “declaration of industrial safety” for tailings dams; • Continuity of the facility operation; • Responsibilities of the owner of the hydrotechnical facility, including: <ul style="list-style-type: none"> - to provide monitoring and control of the condition, environmental and technical impacts on the facility; - to provide regular inspections; - to keep the warning system ready for emergency situations; - to inform the population about possible risks and others.

Subordinate environmental legislation is commonly divided into the different areas, including air, water, wastes, rare and endangered species of flora and fauna, conservation areas, and some other issues.

Questions of health and safety are traditionally considered separately from the questions of environmental protection in a great number of standards, both general and particular for every branch of industry and type of operation.

Social issues are considered with environmental protection if there is a threat to people’s health because of environmental pollution. Social issues are also considered formally during the process of environmental impact assessment.

Protection of cultural values relates only to archeological objects, and the developer is required to conduct investigations, preservation or removal (through organization of an archeological dig) of objects of archeological value in the case of their presence on the area of future activity.

3.2.2. Russian procedure for Environmental Impact Assessment

The main document which defines Environmental Impact Assessment (EIA) in Russia is the “Regulation on Environmental Impact Assessment of Planned Economic and Other Types of Activities in the Russian Federation”, 2000, issued by the former State Committee on environmental protection. The EIA procedure in Russia has the abbreviation OVOS and this abbreviation will be

used in this document for the description of Russian procedure to distinguish it from international EIA.

In accordance with “The Regulation” OVOS is connected with State Environmental Expertise (SEE). SEE is the state procedure of approval for different proposals in relation to environmental impacts, and an OVOS should be provided for the activity, which is subject to consideration under SEE. Objects required under SEE are defined in the Federal Law on Environmental Expertise, including project documentation for the economic activity which can impact on the environment.

The Regulation defines the customer as a person or organization which is responsible for preparation of the documentation for the planned activity and presents it to the SEE.

The Regulation says that results of the OVOS process are:

- information about the types and degree of environmental impacts, assessment of the environmental and related to them social-economical consequences, and the possibilities for minimization of such consequences;
- disclosure and taking account of public preferences during the decision making process;
- choice of the best option.

OVOS results are documented in the OVOS materials which are the part of the project documentation for SEE consideration.

The OVOS process is carried out in the following stages:

1. Notification stage, preliminary assessment and drawing up of the Requirements Specification for the environmental assessment process. At this stage the customer;

- publishes a summary of the proposed activities and provides a preliminary assessment. On the basis of the preliminary assessment, the customer develops a draft Requirements Specification and introduces it for public consideration. The client (customer) accepts and records comments and proposals from community representatives within 30 days of the date of publication of the information.

2. Assessment stage

At this stage the customer provides an OVOS, including:

- analysis of background conditions of the project area;
- environmental impact assessment of the planned activity (risks, rate, character, scale, extent of impact and socio-economical consequences) taking into account and comparing different options;
- Definition of mitigation measures;
- Assessment of residual impacts;
- Proposals for environmental monitoring, control and post-project analysis;
- Preparation of preliminary OVOS documentation (draft version).

The preliminary draft of the OVOS documentation is introduced to the public for consideration, and the decision regarding holding public consultations is made.

The Regulation is the only document which defines any requirements for a public hearing. The document defines that at the assessment stage, a decision is made regarding a public hearing, and if public consultations are deemed necessary, the information about a hearing should be provided to the general public at least 30 days before the public hearing. The draft of the OVOS documentation is introduced to the public for consideration not later than two weeks before the hearing. The public hearing procedure is specified by local authorities together with the customer. The local authorities also conduct the public hearing sessions. Comments and proposals are accepted from the citizens and non-governmental organizations within 30 days of completion of the hearings.

The final OVOS documentation is prepared on the basis of the preliminary OVOS documentation, taking account of the public consultation process results, and presented to the SEE as a part of the project design documentation.

3.2.3. Environmental standards

The basis for environmental evaluation is a great number of maximum admissible concentrations (MACs), which cover the issues listed below. Almost every MAC is issued by the sanitary service and has the health of a person as the criteria for determination. In contrast to the concentrations adopted in the World Bank and IFC guidelines, Russian MACs were developed for the components of the environment, and not for the discharge itself, so sometimes direct comparison is not appropriate and comparison with other international MACs can be undertaken.

- drinking water

The criteria for drinking water were established by the Ministry of health in the standard SanPiN 2.1.4.1074-01. The list of MACs contains about 1500 parameters. The most common parameters, in comparison with international standards, are given in Table 3.2.

Table 3.2. MAC for drinking water

Parameter	Russian standard, mg/l	International standards ¹ , mg/l
pH	6 – 9	- ²
Dry residual	1000	-
Oil products	0.1	-
Ba	0.1	0.7
B	0.5	0.5
Fe	0.3	-
Cd	0.001	0.003
Mn	0.1	-
Cu	1.0	2
As	0.05	0.01
Nitrates	45	50
Hg	0.0005	0.001
Pb	0.03	0.01
Sulfates	500	-
Fluorides	1.5	1.5
Chlorides	350	-
Al	0.5	-

- fishery water MACs

The list of fishery MACs was approved in 1999 by the State Committee of Russian Federation on fishery, on the basis of investigations of specialist organizations. The list includes

¹ Guidelines for drinking water quality, third edition, WHO, 2004.

² No guideline value is propose for the parameter by WHO, because of the absence of direct health hazards

1204 MAC in all. These MACs are applicable for water bodies which have an officially approved fishery water body status. It is important to note that a lot of water bodies in Russia have fishery status, sometimes independently of the presence of fish. The most common MACs, and comparison of some MACs with WB's standards, is presented in Table 3.3.

Table 3.3. MAC for fishery water

Parameter	Russian MAC, mg/l	International MACs ³ , mg/l
pH	6.5-8.5	-
BOD	3 (full)	-
Oil products	0.05	-
Total suspended solids	Increase in control point < 0.25	0,05
Cadmium	0.005	0.00006
Copper	0.001	0.001
Iron	0.1	-
Lead	0.006	0.001
Mercury	Absent	0.00006
Zinc	0.01	0.0024
Nickel	0.01	0.008
Ammonia	0.5	0.32
Chlorine	Absent	0.004

- water of economic, domestic and cultural use

The list of MACs for water of economic, domestic and cultural use was issued by the Ministry of Health in standard GN 2.1.5.1315-03 and contains about 1500 parameters. This document is used for a natural water body if it has no fishery water body status. The preamble of this standard says that this standard is also used for assessment of the quality of drinking water and this fact brings uncertainty to the understanding of the regulation. Besides, some of the MACs of this standard are even stricter than for the same parameters in the SanPiN 2.1.4.1074-01. Clarification can be obtained from authorities through the inquiry of the company. A list of most common parameters in comparison with international requirements is given in Table 3.4.

Table 3.4. Water of economic, domestic and cultural use

Parameter	Russian MAC, mg/l	International requirements ⁴ , mg/l
pH	-	6.5 – 8.5
BOD	-	-
Oil products (oil)	0.3	-

³ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)

⁴ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000), water for recreation

Total suspended solids	-	1000
Cadmium	0.001	0,005
Copper	1	1
Iron	0.3	0.3
Lead	0.01	0,05
Mercury	0.0005	0.001
Zinc	1	5
Nickel	0.02	0.1
Ammonia	1.5	0.01
Chlorine	Absence	400

- ambient air

In Russia, the maximum admissible concentrations for air are defined for residential areas and issued by the Ministry of Health. The list of MACs includes more than 700 parameters. Some of the MACs for the air of residential areas, in comparison with international standards, are presented in Table 3.5.

Table 3.5. MACs for ambient air

Parameter	Russian MAC, mg/m ³		International standards, mg/m ³	
	Maximum single-time	Average per day	Maximum 24-hour average	Annual arithmetic mean
Particulate matter	0.3	0.1	0,07*	0,05*
Nitrogen oxides	0.4	0.06	0,15*	0,04**
Sulfur dioxide	0.5	0.05	0,125*	0,05*,**
CO	5	3		10 mg/m ³ (during 8 hours)**

*WB guidelines, **WHO guidelines

- workplace environment air

Maximum admissible concentrations for the workplace are adopted by the Ministry of Health. The main list of MACs was issued in 2003, but some additions and changes are made periodically. At the present time more than 2400 MACs have been determined for the workplace. Every parameter has either a maximum single-time concentration (MAC_{max}), or average concentration per shift (MAC_{aver}), or both.

Table 3.6 presents some of the MACs in comparison with international standards. There is no specification in the WB guidelines on the type of the MAC (average or maximum).

Table 3.6. MACs for workplace environment air

Parameter	Russian MAC, mg/m ³	World Bank guidelines ⁵ , mg/m ³
Arsenic	0.04 _{max} / 0.01 _{aver}	0.5
Carbon Monoxide	20 _{max}	29

⁵ World Bank Environmental, Health and Safety Guidelines, Mining and Milling – open pit, 1995

Copper	$1_{\max} / 0.5_{\text{aver}}$	1
Free Silica	$3_{\max} / 1_{\text{aver}}$	5.0
Hydrogen Cyanide	-	11
Hydrogen Sulfide	-	14
Lead, Dusts & Fumes, as Pb	0.05_{aver}	0.15
Nitrogen Dioxide	2_{\max}	6
Particulate (Inert or Nuisance Dusts)	4_{aver}	10
Sulfur Dioxide	10_{\max}	5
Mercury	$0.01_{\max} / 0.005_{\text{aver}}$	-
Tobacco	3_{\max}	-
tetraethyl lead	0.005_{\max}	-
Titanium dioxide	10_{aver}	-
Phosphor	$0.1_{\max} / 0.03_{\text{aver}}$	-

- soils

A new standard on soils was issued at the end of 2005 and was implemented on 1st April 2006. The MACs listed in the standard apply to the soils of settlements, agricultural lands, buffer (protection) zones for water supply sources, health resort areas and other special lands (not defined exactly). MACs are defined for 39 parameters, some of which are listed in Table 3.7.

Table 3.7. Maximum admissible concentrations for soil

Parameter	Concentration, mg/kg
Total content	
Benzpyrene	0.02
Manganese	1500
Arsenic	2.0
Nitrates	130.0
Mercury	2.1
Lead	32.0
Mobile forms	
Copper	3.0
Lead	6.0
Nickel	4.0
Chromium 3 ⁺	6.0

3.3. Institutional framework and permitting

3.3.1. Pre-design stage

The first step of the permitting procedure is approval of the location of the future operations. Only a short description of the future activity is presented to the authority at this stage, to give a general understanding. The location for the Kuranah mining and processing enterprise was approved by the authorities listed in Table 3.8.

Table 3.8. Approvals of the project location

Name of the Federal body	Regional subdivision responsible for approval
-	Administration of Amur oblast
-	Administration of Tundinskiy district
Ministry of natural resources (MNR) / Federal service for supervision in the field of use of the natural resources	Department for supervision in the field of use of the natural resources in Amur oblast
MNR	Forestry Agency of Amur oblast
	Water resources section in Amur oblast
Ministry of Agriculture / Federal service for veterinary and phyto-sanitary control	Department for veterinary and phyto-sanitary control in Amur oblast
Ministry of Defence	Staff of the Far East army department
Russian telecommunication company	Department of the company in Amur oblast
Ministry of transport	Far East department of air transport
State Russian company “Russian railways”	Far East department of the company, Tundinskaya section
Ministry of health and social development / Federal service for the control of protection of consumers and human welfare	Department of the service in Amur oblast
Ministry of emergency situations	Department of the Ministry in Amur oblast
Russian energy company	Subdivision in Amur oblast “Amurenergo”

3.3.2. Design stage

The main approval of any project at design stage in relation to environmental protection is State Environmental Expertise. Before consideration by the experts, the project must obtain a number of approvals from different executive authorities, which are responsible for different aspects of the environment, health and safety. The number of authorities varies according to the nature and location of the project.

Generally, the permitting procedure (including State Environmental Expertise) can be at a federal or regional level. Federal level of approval is required for projects that are significant for the state, or projects which extend beyond or impact on more than one region. In addition, according to Russian law, projects with a total cost of more than US \$500 000 are subject to state environmental expertise at the federal level. However, this rule was introduced in 1995 and is not currently important. In practice the cost of the project now does not play any role in defining the level for approval. In some cases, for projects which cost more than US \$500 thousand dollars, the regional authorities ask for approval at the regional level. On the basis of previous consultation with Department for ecological, technological and nuclear inspection in Amur region, the Kuranah project will be considered at the regional level.

At the time of writing this report, the permitting process had just been begun and the project had not been granted all the necessary permits. In the process of obtaining approvals, some additional approvals can be (but are unlikely to be) required, especially during State environmental expertise. A list of the government bodies responsible for approval of design details for the Kuranah project is given in Table 3.9.

Table 3.9. Approvals of design details

Federal ministry/service	Name of regional division responsible for the permit	Type of approval
Ministry of natural resources/ Federal service for supervision in the field of use of natural resources	Department for supervision in the field of use of natural resources in Amur oblast	<ul style="list-style-type: none"> • General approval of the project design; • Approval of the rehabilitation plans;
Ministry of natural resources	Water resources section in Amur region	<ul style="list-style-type: none"> • Approval of the project in relation to water resources;
	Forestry section in Amur region	<ul style="list-style-type: none"> • Changing the category of the forest land; • Permit for felling;
	Subsoil use section in Amur region	<ul style="list-style-type: none"> • Approval of the project in relation to subsoil resources;
Ministry of health and social development/ Federal service for protection of consumers and human welfare	Department of the service for protection of consumers and human welfare in Amur region	<ul style="list-style-type: none"> • Approval of health-related conditions, provided in the project;
Ministry of agriculture	Department on veterinary and phyto- sanitary inspection in Amur region	<ul style="list-style-type: none"> • impact on and compensation for fishery
		<ul style="list-style-type: none"> • impact on game species and definition of compensation;
Federal service for ecological, technological and nuclear inspection	Department for ecological, technological and nuclear inspection in Amur region	<ul style="list-style-type: none"> • Approval of the safety conditions for the tailings dump; • State environmental expertise; • Industrial safety expertise for the project;
Ministry of regional development	Department of Federal service for construction and housing and communal services	<ul style="list-style-type: none"> • Consideration and approval of constructional proposals
-	Administration of Amur region	<ul style="list-style-type: none"> • Approval of the project working conditions

Once all the necessary approvals have been obtained, the final OVOS document is submitted to the “State Environmental Expertise” (SEE) for review by a panel of experts under the supervision of a chairman appointed by the Ministry of Natural Resources and comprising relevant regional and national “experts”. The OVOS may also be subject to a Public Environmental Review by interested parties, public organizations and local citizens. Whilst the Expert Review is a fundamental part of the permitting process, the Public Environmental Review is dependent upon whether or not there is a demand from local people for such a review and whether or not the regional authorities endorse this demand. Acceptance of the OVOS by the SEE (and, if required, by the Public Review) enables the developer to undertake detailed engineering design, initiate procurement and begin construction.

The construction stage usually is not a separate part for environmental assessment in the Russian OVOS. Before beginning construction, in relation to environmental issues, the company needs to have special permits for air emissions, water discharge and waste disposal, as for the

operational stage (see below), but based on the calculations and assumptions which were made in the OVOS.

3.3.2. Operational stage

In order to operate, the company needs to have the following permits, which are provided by the local subdivision of the Ministry of Natural Resources and the Federal service for ecological, technological and nuclear inspection:

- Air emission permit

This permit is provided on the basis of detailed calculations in accordance with Russian state or state-approved methods, taking equipment and production volume into account. Usually an air emission permit is granted for five years on the stipulation that production volume or the type/quantity of equipment are not changed significantly, mainly are not increased.

- Permit for water use

This permit defines the rights both for water consumption and water discharge for a period from 1 to 5 years. The quantity of water consumed is approved by the authority on the basis of substantiation, provided by company. The quantity and quality of discharged water is defined on the basis of a separate document that is developed, entitled “Maximum admissible discharge”. The document contains calculations of water contaminant parameters, starting from the requirement that the maximum admissible concentration (MAC) must not be exceeded in the receiving water body.

- Permit for waste production and disposal

This permit is provided on the basis of a separate document that is developed entitled “Normal project waste production and limits of waste disposal”. This document defines the quantity of each type of waste produced by the operation, the places where these wastes will be disposed (temporary or permanently) and some management requirements.

Pollution payment is based on the actual quantity of the pollutant discharged to the environment, in accordance with state rates. The rates are determined for 1 ton of each contaminant discharged. Discharge within the permitted limits is paid on initial rates. In the case of exceeding of permitted levels, the company pays for exceeded pollution in 5 times more. In the case of an accident which causes additional pollution, all pollution is paid as for exceeded pollution.

The actual quantity of contaminants discharged is determined by monitoring. In practice, only water discharges are monitored regularly. Actual air emissions are usually defined by the measurement of every possible source of emission once every five years, and the result of this measurement remains valid for five years, and is used as the basis for payment. The actual quantity of wastes is defined as a result of the registration of the wastes which were produced, treated, disposed, used or delivered to other organizations.

During the operational stage, different state supervisory authorities control the company’s activity in relation to environmental law and permit compliance.

For Kuranah project Aricom has completed pre-design stage and is now in design stage part of process.

4. BASELINE ENVIRONMENTAL CONDITIONS

4.1. Introduction

The baseline environmental information for the Kuranah project was obtained from several sources. The main documents which were used in assembling this information are listed below:

- Report on the management and performance of geo-ecological monitoring for the Kuranah titaniferous magnetite deposit site during the feasibility and design stage of the project, Amurgeology, 2005;
- Report entitled “Identification and evaluation of underground water reserves for drinking water supply during the operational phase of the Kuranah mining project”, dated 1 September 2005, GIDEK;
- Report entitled “Evaluation of the potential water supply for the Kuranah mining and process plant”, GIDEK, 2005;
- Report on the results of prospecting, evaluation and exploration works within the Kuranah titanium ore zone between the years 2001 and 2005, with reserve calculations dated 1 January 2006 (in four books), book 1, report text, Dalgeophysika, Regis, 2005;
- Feasibility study of reserves for mining the ilmenite-magnetite ores of the Kuranah deposit, Dalgeophysika, 2004;
- Technical report on the engineering survey for the “Olekma – Kuranah deposit site” road and technical report on the engineering survey for the “Olekma – plant site” road, VNIPIpromtechnology, 2004.

In addition, some references from specialist organizations and authorities were used to provide baseline information as well as site reconnaissance and discussions with Aricom and Olekminskiy Rudnik personnel. A list of all sources used is presented in Attachment 1. The description of the baseline environmental conditions of the project area brings together information reported in all of the information sources identified above.

The project area includes the mine site (deposit site), the plant site, the road between these, and the road that connects the plant site with the nearest railway station at Olekma, as shown on Figure 4.

Figure 4. Location of the components of the project



4.2. Regional setting

The Kuranah titanium-magnetite deposit site is located in the Tundinskiy district in the north-west part of Amur oblast on the east of the Russian Federation. The Amur river provides a natural border with China to the south. The Amur oblast borders the Republic of Saha (Yakutia) to the north, Chita oblast to the west and the Jewish Autonomous Oblast and Khabarovsk Krai to the east.

A considerable part of the Amur oblast (64 %) is covered by taiga forest, which is important for the economy and ecology of the region. From north-west to south-east, Amur oblast is crossed by important transport routes – the Baikal-Amur Railroad and the Trans-Siberian Railroad which are the main transport routes to the east of Russia.

The deposit site is located in close proximity to the boundary of Amur oblast with two other Russian regions – Chita oblast and Republic of Saha (Yakutia). In spite of the presence of official administrative divisions, Chita oblast and Yakutia in the area close to the Amur oblast, are similar to the project area with respect to environmental, social and economic issues. The north-west part of Amur oblast and the parts of Yakutia and Chita oblast bordering with it are sparsely populated – the population density of the Tundinskiy district is 0.2 people per km². The distance between settlements with a population of several hundred people is usually 50 km or more.

The deposit is located 40 km from Olekma railway station, which lies on the Baikal-Amur Railroad. Station settlement Olekma is the nearest settlement to the deposit site. Olekma station is located 480 km from the district centre town of Tunda. The distance from Tunda to the regional centre of Blagoveshensk is 840 km.

Figures 1, 2 and 3 in the Introduction section of this report show the location of the deposit site.

The landscape of the Kuranah project area is mountain taiga with mountain relief ranging between 400-1500 m above sea level (12). The area is mainly covered by forest.

4.3. Climate

4.3.1. Overview

The Tundinskiy district has a strongly continental climate with large temperature differences on a seasonal basis. Winter is cold and long with a little snow cover, summer is hot and short. Permafrost occurs throughout the area.

The climate of the project area is described in several reports (1-9). Meteorological data are available from a meteorological station which is located 70 km to the south-east of deposit site in the settlement of Ust-Nukzha. This permanent monitoring station has the same name as the settlement. It is the closest station to the deposit site. It is situated at an elevation of 430 metres above sea level. Meteorological conditions at the station are considered to be similar to those at the project area, since its elevation is comparable to Kuranah. Monitoring data for period since 1938 till 2004 (7) are available from this station and all data presented in this section are provided by this period of monitoring (if there are no another references). Parameters are recorded 8 times per day at 0000, 0300, 0600, 0900, 1200, 1500, 1800, 2100 Greenwich Mean Time.

4.3.2. Temperature

Average monthly temperatures are shown in Table 4.1 (7).

Table 4.1. Average monthly temperatures

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
T°C	-32.3	-26.4	-15.2	-3.1	6.5	14.3	17.6	14.3	6.8	-14.9	-21.2	-31.1	-6.2

The absolute minimum temperature for the whole monitoring period was -54°C; the absolute maximum temperature was +37°C. Average daytime temperature crosses 0°C in the middle of April and the average daytime temperature typically increases during spring. Spring lasts until the date of the last frost which is 2 June. The average period without frost is 92 days, the warmest month is July with average temperature of 17.6°C. Autumn comes rapidly and the freeze begins at the time of comparatively high daytime temperatures. The period with average daytime temperatures below zero is 204 days (7).

The project area is located in the permafrost zone. Average monthly and annual soil temperatures are shown in Table 4.2.

Table 4.2. Monthly and annual soil temperatures

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
t°C	-33	-29	-18	-4	7	16	20	17	7	-6	-22	-32	-6

The absolute minimum soil temperature was below zero even in the warmest months, being -2°C in July and August. The average depth of the seasonal thaw is from 1.7 to 2.6 metres, depending on the type of ground, but can achieve 5 metres in some places (7).

4.3.3. Solar radiation

Total solar radiation is 3821.3 megajoule/m². The maximum radiation occurs in June (average 585.4 megajoule/m²); the minimum in December (46.4 megajoule/m²). The annual radiation balance is 1131.3 megajoule/m² and it is negative from October until April. Its value changes significantly with altitude.

4.3.4. Wind speed and direction

Atmospheric circulation above Amur oblast is influenced by the Asiatic continent and Pacific Ocean, and is characterized by clear patterns. During the long winter, a broad anticyclone defines the wind regime and western transfer of air. In summer, a field of high pressure situated above the Okhotskoye sea and a field of depression above China and Mongolia cause east and south-east air circulation.

Data on the monthly distribution of wind direction are represented in Table 4.3.

Table 4.3. Average wind direction in percent including all conditions except calm

Wind Direction	North %	North-east %	East %	South-east %	South %	South-west %	West %	North-west %	Calm % of total
Month									
Jan	46	17	3	2	2	1	5	24	67
Feb	41	23	6	1	1	1	6	21	40
Mar	33	30	8	2	2	2	8	15	44
Apr	31	21	7	4	6	3	12	16	47
May	23	21	9	3	7	5	14	18	39
Jun	17	20	15	5	9	5	16	13	45
Jul	15	21	17	5	10	5	15	12	52
Aug	16	21	19	6	8	4	14	12	48
Sept	20	21	15	4	6	4	16	14	50
Oct	26	27	13	3	4	2	10	15	61
Nov	30	27	12	3	2	2	6	18	70
Dec	42	19	5	2	3	2	5	22	69
Year	28	22	11	3	5	3	11	17	50

Average monthly and annual wind speeds are shown in Table 4.4 (7). Maximum speeds are presented for the period from 1938 to 1980. The average number of days with wind speed greater than 15 m/sec was 3.8 days per year.

Table 4.4 Monthly and annual wind speeds

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Average Wind Speed m/sec	1.0	1.2	1.4	1.8	2.0	1.4	1.2	1.1	1.3	1.1	0.9	0.9	1.3
Maximum Wind Speed m/sec	20	20	17	20	20	17	14	14	17	17	17	20	20

4.3.5. Precipitation, evaporation and air moisture

The average monthly and annual precipitation is presented in Table 4.5.

Table 4.5. Monthly and annual precipitation

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sep-Mar	Apr-Oct	Year
h, mm	7	4	5	15	39	73	100	104	55	16	10	11	37	402	439

The project area has a continental climate and in spite of the fact that winter lasts more than 5 months, only 8-15 % of precipitation lands as a solid. More than 46 % of year norm precipitates in July and August. The average height of snow cover for forest and open sites is shown in Table 4.6.

Table 4.6. Height of snow cover

month	Oct	Nov	Dec	Jan	Feb	Mar	Maximum height per winter		
							average	max	Min
forest (h,cm)	5	12	18	21	22	21	24	37	11
open (h,cm)	13	21	28	29	31	30	33	52	19

The average height of the snow cover achieves maximum in the middle of February and keeps till the second decade of March.

The density of snow cover increases during winter from 110 kg/m³ at the beginning to 210 kg/m³ at the end. Water storage in snow cover for the last day of each month is shown in Table 4.7.

Table 4.7. Water storage in snow

month	Oct	Nov	Dec	Jan	Feb	Mar	Apr
h, mm	17	25	34	39	43	46	31

Average evaporation is 65 % of atmospheric precipitation. Total average annual evaporation from river basins is 275 mm.

Relative air humidity changes during the year from 55 to 78 %. The longest period with high humidity is in cold season from November to January (75-77 %). However, according to data from the hydrometric station, there is one more peak of humidity in August (78 %). Lowest humidity occurs during the period March-June, with humidity in May at 55 %. Average monthly and annual relative humidity data are shown in Table 4.8.

Table 4.8. Monthly and annual relative humidity

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Relative humidity, %	75	71	62	56	55	65	73	78	73	71	77	77	60

4.3.6. Atmospheric phenomena

4.3.6.1. Fog

Average and maximum numbers of days with fog, as well as the average length of time of the fog in hours, are shown in Table 4.9.

Table 4.9. Numbers of days with fog

Number of days with fog	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Average	1	0.4	0.02	0.2	0.4	3	6	11	7	1	0.1	1	31
Maximum	10	4	1	1	3	7	14	18	13	5	1	6	47
Average time (hours)	3	0.8	0.1	0.1	2	13	29	55	36	4	0.4	3	146

4.3.6.2. Drifting snow

Table 4.10. shows average and maximum numbers of days with drifting snow for the Ust-Nukzha weather station.

Table 4.10. Numbers of days with drifting snow

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Year
Average (days)	0.3	0.4	0.6	0.5	0.5	0.9	0.6	0.2	4
Max (days)	2	2	3	4	4	7	6	2	13

In mountain valleys protected from the wind, drifting snow is less frequent than open places and on slopes. The latter are therefore characterized by more days with drifting snow.

4.3.6.3. Thunderstorms

Thunderstorms occur in the warm season, mainly from May to September. Average and maximum numbers of days with thunderstorms, and the average length of time of the thunderstorms, are shown in Table 4.11.

Table 4.11. Numbers of days with thunderstorms

Month	Apr	May	Jun	Jul	Aug	Sept	Year
Average (days)	0.02	0.7	6	9	5	0.9	22
Maximum (days)	1	3	13	15	11	4	35
Time (hours)	0.01	1	9.1	16.7	7.7	0.8	35.3

4.3.6.4. Hail

Hail occurs mainly in the warm season and it is relatively rare. The most likely period for hail is May to July. Average and maximum numbers of days with hail are shown in Table 4.12.

Table 4.12. Numbers of days with hail

Month	May	Jun	Jul	Aug	Sep	Year
Average (days)	0.2	0.3	0.2	0.05	0.03	0.8
Maximum (days)	2	3	2	1	1	7

4.4. Air quality

There are no industrial projects within 100 km of the proposed mine site. The nearest settlement of Olekma and its railway station are located 40 km from the proposed mine site and 5 km from the proposed process plant site. Air emission sources include one boiler that uses coal as a fuel in Olekma and diesel oil powered trains on the railroad.

The Amur oblast hydro-meteorological Agency has provided monitoring data obtained from sampling at the proposed mine site (40 km from settlement/station), process plant site and area of existing settlement Olekma. Information about exact location of the sampling points are not

available. Air sampling was conducted at four locations, seven times from 14th July to 23^d October 2004. The timing of the sampling was dictated by the fact that the mine site was inaccessible during the remainder of the year due to inclement weather. Parameters measured include particulate matter, nitrogen dioxide (NO₂), sulphur dioxide (SO₂) and carbon monoxide (CO). Average concentrations are shown in Table 4.13.

Table 4.13. Air quality

Component	Concentration (average)	WHO guidelines* (average during year)
Particulate matter	0.08 mg/m ³	-
NO ₂	20 µg/ m ³	40 µg/ m ³
SO ₂	70 µg/ m ³	50 µg/ m ³
CO	0.4 mg/m ³	10 mg/ m ³ (over 8 hours)

*Air quality guidelines for Europe, second edition, 2000, World Health Organization.

Elevated levels can be explained by the impact of emissions from the boiler and vehicles on the railroad.

Information on air quality can also be obtained from the results of laboratory analysis of snow. Fifty seven samples of snow were collected from the deposit site before snow melted, from 3-6 April 2004. The snow was accumulated at the site for approximately 166-169 days. Snow water was analyzed for elements through chemical, mass-spectrum and atomic-emission analysis and solid residue was analyzed through mineral and spectral semi-quantitative analysis. Analytical results for the snow water are shown in Table 4.14 and results for the solid residue are shown in Table 4.15 (1).

Table 4.14. Concentrations of the elements in snow water

Elements	Units	Minimum	Maximum	Average
pH	pH	3.7	5.7	4.8
Eh	mV	45.2	150.0	90.6
HCO ₃	mg/l	9.8	18.3	13.6
Cl	mg/l	2.6	6.5	3.9
F	mg/l	0.10	0.27	0.13
SO ₄	mg/l	0.20	2.05	1.02
CO ₃	mg/l	4.00	4.00	4.00
NO ₃	mg/l	0.10	3.56	0.37
Na	mg/l	0.00	1.00	0.13
K	mg/l	0.00	1.30	0.34
Ca	mg/l	0.40	1.20	0.61
Mg	mg/l	0.12	0.73	0.21
Fe	mg/l	0.05	0.14	0.06
NO ₂	mg/l	0.00	0.03	0.01
NH ₄	mg/l	0.05	0.18	0.07
CO ₂	mg/l	6.6	22.0	9.6
Mineralization	mg/l	14.8	28.1	19.7
Water hardness	mg.eq./l	0.04	0.12	0.05
Permanganate	mg/l	1.1	6.1	2.8

oxidation				
Na	mg/l	0.04	14.66	0.68
Mg	mg/l	0.017	1.706	0.121
Li	mg/l	0.00004	0.0017	0.00008
Be	mg/l	0.000004	0.000083	0.000007
B	mg/l	0.0015	0.0218	0.0019
Al	mg/l	0.005	0.575	0.045
Si	mg/l	0.02	0.86	0.06
P	mg/l	0.09	0.20	0.14
K	mg/l	0.06	7.70	0.33
Ca	mg/l	0.13	36.41	1.10
Ti	mg/l	0.0004	0.0194	0.0008
V	mg/l	0.0001	0.0035	0.0002
Cr	mg/l	0.001	0.029	0.001
Mn	mg/l	0.003	0.487	0.031
Fe	mg/l	0.002	3.27	0.118
Co	mg/l	0.00002	0.0023	0.00011
Ni	mg/l	0.0005	0.0835	0.0023
Cu	mg/l	0.0005	0.0279	0.0035
Zn	mg/l	0.006	1.902	0.063
As	mg/l	0.00002	0.00073	0.00009
Se	mg/l	0.0003	0.0003	0.0003
Br	mg/l	0.0105	0.155	0.0135
Rb	mg/l	0.000075	0.00533	0.0004
Sr	mg/l	0.00047	0.107	0.0041
Zr	mg/l	0.000005	0.00041	0.000031
Nb	mg/l	0.000001	0.000021	0.000002
Mo	mg/l	0.00003	0.02540	0.00086
Ag	mg/l	0.000004	0.00024	0.00001
Cd	mg/l	0.00001	0.0039	0.0002
Sn	mg/l	0.00004	0.00440	0.00018
Sb	mg/l	0.000004	0.00037	0.00003
Cs	mg/l	0.000002	0.000064	0.000008
Ba	mg/l	0.0016	0.0563	0.0067
Sm	mg/l	0.00002	0.00031	0.000011
Eu	mg/l	0.000002	0.000062	0.000003
W	mg/l	0.00001	0.00010	0.00001
Tl	mg/l	0.000002	0.000041	0.000007
Pb	mg/l	0.00020	0.01160	0.00118
Bi	mg/l	0.000002	0.000018	0.000005
Th	mg/l	0.000002	0.000086	0.000006
U	mg/l	0.000002	0.00012	0.000007
Hg	mg/l	0.00003	0.00024	0.00006

Table 4.15. Concentrations of the elements in snow solid residue

Element	Unit	Min	max	Average	Elem.	Unit	Min,	Max.	Average.
As	mg/kg	15	100	24	Ga	mg/kg	2.5	8	2.7
Pb	mg/kg	2.5	1500	60.5	Be	mg/kg	0.5	3	0.6
Sn	mg/kg	0.5	2000	37.5	Ba	mg/kg	15	4000	237
Mo	mg/kg	0.3	20.0	0.5	Zr	mg/kg	1.5	200	26
Ag	mg/kg	0.015	2.0	0.28	Y	mg/kg	0.15	20	3
Cu	mg/kg	2.5	200	24.8	Yb	mg/kg	0.15	1.5	0.34
Zn	mg/kg	10	700	152	La	mg/kg	5	40	14.5
Sb	mg/kg	15.0	30.0	16.7	Nb	mg/kg	1.5	30	3.6
W	mg/kg	1.5	5.0	1.6	Li	mg/kg	5	20	6.7
Bi	mg/kg	0.15	3.0	0.48	B	mg/kg	2	900	24
Ni	mg/kg	3.5	60.0	11.0	Cd	mg/kg	0.5	300	10
Co	mg/kg	0.3	10.0	0.9	Sr	mg/kg	5	500	33
Cr	mg/kg	2.5	100.0	13.5	Hg	mg/kg		100	
V	mg/kg	1.0	40.0	7.0	Fe	%	0.1	30.0	2.1
Mn	mg/kg	20.0	10000	1104.0	Ca	%	0.005	5.0	0.446
Ti	mg/kg	15.0	10000	819.0	Na	%	0.01	1.5	0.18
P	mg/kg	150	2000	457.0	Mg	%	0.001	1.0	0.248
	mg/kg	0.5	1.0	0.5	Si	%	0.05	40.0	4.62
Sc	mg/kg	0.5	4	1.2	Al	%	0.02	6.0	0.99
					K	%	1.0	2.0	1.67

There are no maximum admissible concentrations (MACs) or other data for comparison for concentrations of contaminants in snow water and snow solid residue. Nevertheless these data can be used in the future to compare pre-mining and post-mining levels of these parameters.

4.5. Geology

The Kuranah deposit site belongs to the Kalanar massif, one of the andesine type massifs of the Amur region. The Kalanar massif consists of two branches – Imangakitskaya and Kuranahskaya, which are separated by tectonic blocks and zones of granitization. Both branches are formed mainly of feldspar rocks (labradorite, andesinite) with the presence of basic rock (gabbro, gabbro-norite, norite) (5).

Rocks of various compositions occur in the geological subsurface of the Kuranah deposit. Metamorphic rocks are Lower and Upper Archaean and Lower Proterozoic in age, and intrusive rocks are Pre-Cambrian, Paleozoic and Mesozoic in age. Friable overburden is spread insignificantly.

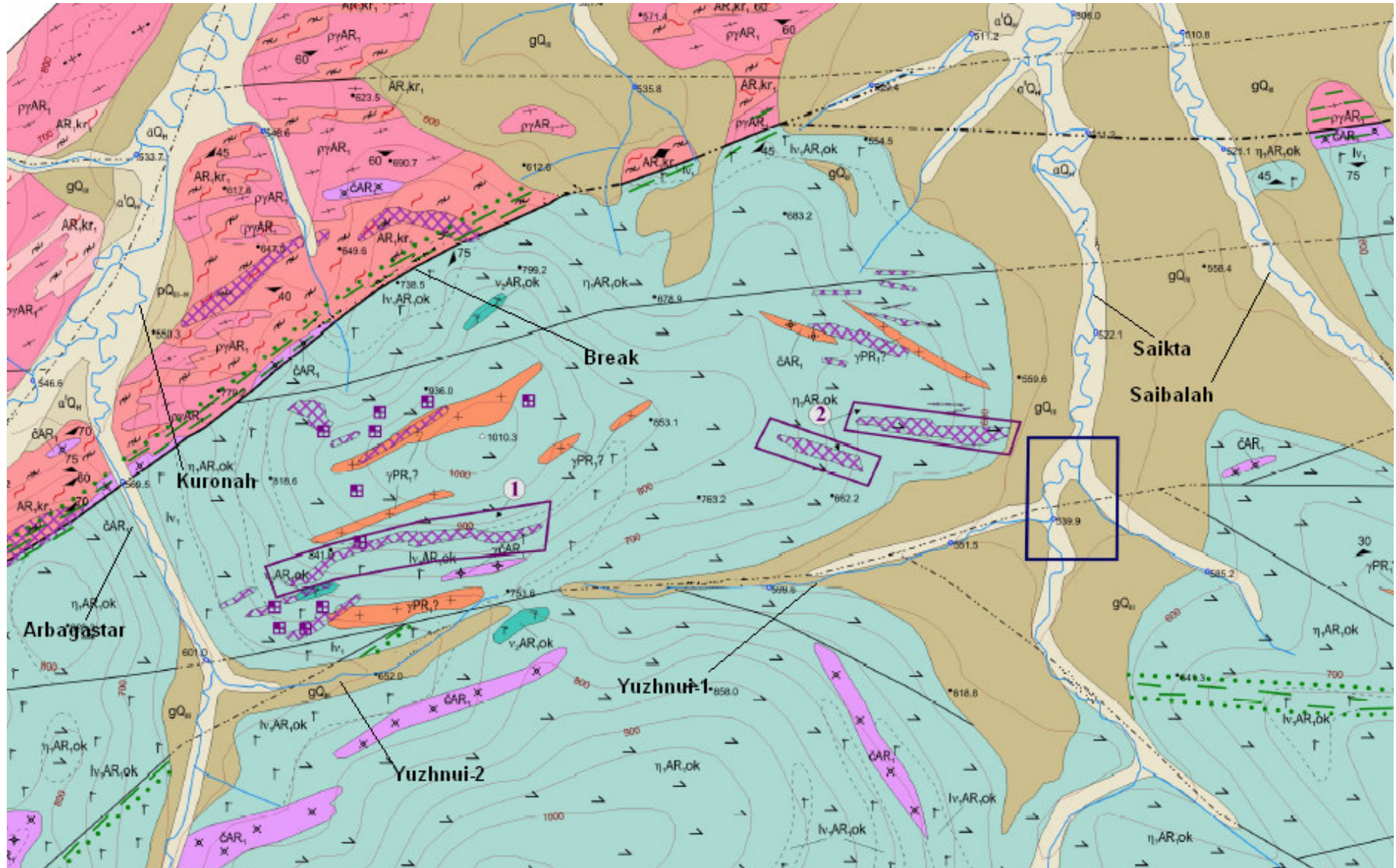
The generalized stratigraphy is described in Table 4.16, and all the geological characteristics are shown on Figure 4.

Table 4.16. Stratigraphy of the Kuranah deposit site





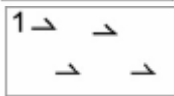
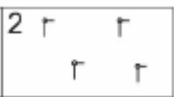


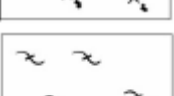
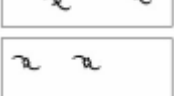
Group		Thickness, m	Comments
Low Archaean	Karurukskaya suite	3175	Pyroxene-amphibolite and amphibolite's crystal shale, garnet-biotite and hypersthene-biotite plagiogneisses with streaks of high-alumina gneisses and crystal gneisses, amphibolites, magnetite-quartz rock, quartzites.
	Imangrakanskaya	3275	Pyroxene-amphibolites crystal shales with streaks

	suite		of biotite-amphibole and garnet-biotite plagiogneisses, amphibolites, garnet granulites. A property of the suite is the presence of plagioclase crystal shale.
	Chebarkasskaya suite	725	Garnet-biotite plagiogneisses with streaks of amphibole and pyroxene-amphibole crystal shale, biotite-hypersthene plagiogneisses, garnet granulites, quartzite
Upper Archaean		>230	Present in the south-west part of the deposit site and characterised mainly by biotite and biotite-amphibole plagiogneisses and streaks of biotite-amphibole crystal shale, amphibole and quartzite.
Upper Proterozoic	Archaean-low	500	Present in the south-west part of the deposit site as “tectonic wedge” and characterised by mica graphite-garnet plagioclase-quartz shale with streaks of quartzite-shale, mica quartzite, magnetite quartzite, marble, amphibolites. A property of this suite is the presence of horizons with an increased content of graphite.
Quaternary	Upper quaternary	from 2.5-3 to 30 40	Ice-borne sediments of moraine origin, mainly in valleys.
	Upper quaternary and modern nonsegmented formations	up to 5	Sediments which form valley train and weakly convex surfaces longitudinally steep slopes
	Modern formations	2.2 - 8	Alluvial deposition of canal, floodplain and first over-floodplain terrace as well as alluvial-dealluvial depositions of the watersheds and slopes

Figure 5 Geology of the Kurinah deposit site



Legend

αQ_H	Modern unit. Alluvial sediments: boulders, pebbles, sands of low flood-land and river-beds (thickness 5-8 m)		Nonsegmented medium- and coarse-grained garnet
$\alpha^1 Q_H$	Modern unit. Alluvial sediments: boulders, pebbles, sands of first terrace (thickness 2-4 m)		Medium- and coarse-grained mangerite, charnockite
ρQ_{III-H}	Upper-modern unit. Proalluvial sediments: boulders, detritus, rubbly loam (thickness 2-5 m)		Coarse-grained hastingsite
gQ_{III}	Upper unit, ice-borne sediments: boulders, pebbly boulders, sands, loamy soils (thickness 10-40 m)		Small-grained gabbro and gabbronorite
$\gamma PR_1?$	Nonsegmented coarse- and medium-grained granite		Medium- and coarse-grained andesite, coarse-grained labradorite
$\check{c}AR_1$	Medium- and coarse-grained mangerite, charnockite, coarse-grained hastingsite granite		Coarse-grained leucocratic gabbro
$v_2 AR_{1,ok}$	Second phase – small-grained gabbro, gabbronorite		Small- and medium-grained plagio-garnet, enderbite, enderbite-gneiss
$\eta_1 AR_{1,ok}$	First phase – medium- and coarse-grained andesinite, coarse-grained labradorite, coarse-grained leucocratic gabbro		Plagio-granite-gneiss
$\rho\gamma AR_1$	Small- and medium-grained plagio-granite, enderbite, enderbite-gneiss, plagio-granite-gneiss		Two-pyroxene-amphibole, biotite-amphibole, hypersthene-amphibole crystal shale
$AR_{1,im}$	Imangrakan suite – amphibole, biotite-amphibole, hypersthene-amphibole crystal shale, streaks of amphibole-biotite, granite-biotite plagio-gneiss, garnet granulite, seams of amphibolite, biotite-amphibole gneiss, plagioclase crystal shale (thickness 3275 m)		Garnet-biotite, hypersthene-biotite, garnet-pyroxene-biotite plagio-gneiss, high aluminium plagio-gneiss

AR₁kr₂

Upper sub-suite – garnet-biotite, hypersthene-biotite plagio-gneiss, high-aluminous plagio-gneiss and crystal shale, streaks of pyroxene-amphibole, hypersthene-amphibole, biotite-amphibole crystal shale. Lens and seams of amphibolite, magnetite-quartz hypersthene rocks, quartzite (thickness 1350 m)



Pyroxene-amphibole and amphibole, two-pyroxene-amphibole crystal shale

AR₁kr₁

Low sub-suite – pyroxene-amphibole, amphibole, two-pyroxene-amphibole crystal shale, biotite-amphibole, hypersthene-amphibole, hypersthene, hypersthene-biotite plagio-gneiss; streaks of garnet-biotite, garnet-pyroxene biotite plagio-gneiss. Lens and seams of amphibolite, granulite quartzite rocks (thickness 1825 m);



Intensively magmatogene rocks



Sites of planned open pit



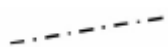
Cataclastic rocks and boundaries of its expansion



Reliable discontinuity



Ilmenite-magnetite ores



Discontinuity covered by sediments

4.6. Seismicity

The Kuranah deposit site is located within the Olekma seismic zone. Regionally, the deposit site is connected with Baikal seismic zone, reaching in a latitudinal direction for more than 1500 km.

As is typical for earthquakes with an epicentre in the Amur region, the depth of the earthquake sources within the Olekma seismic zone is generally 5–10 km below ground level, and seldom 15–30 km below ground level.

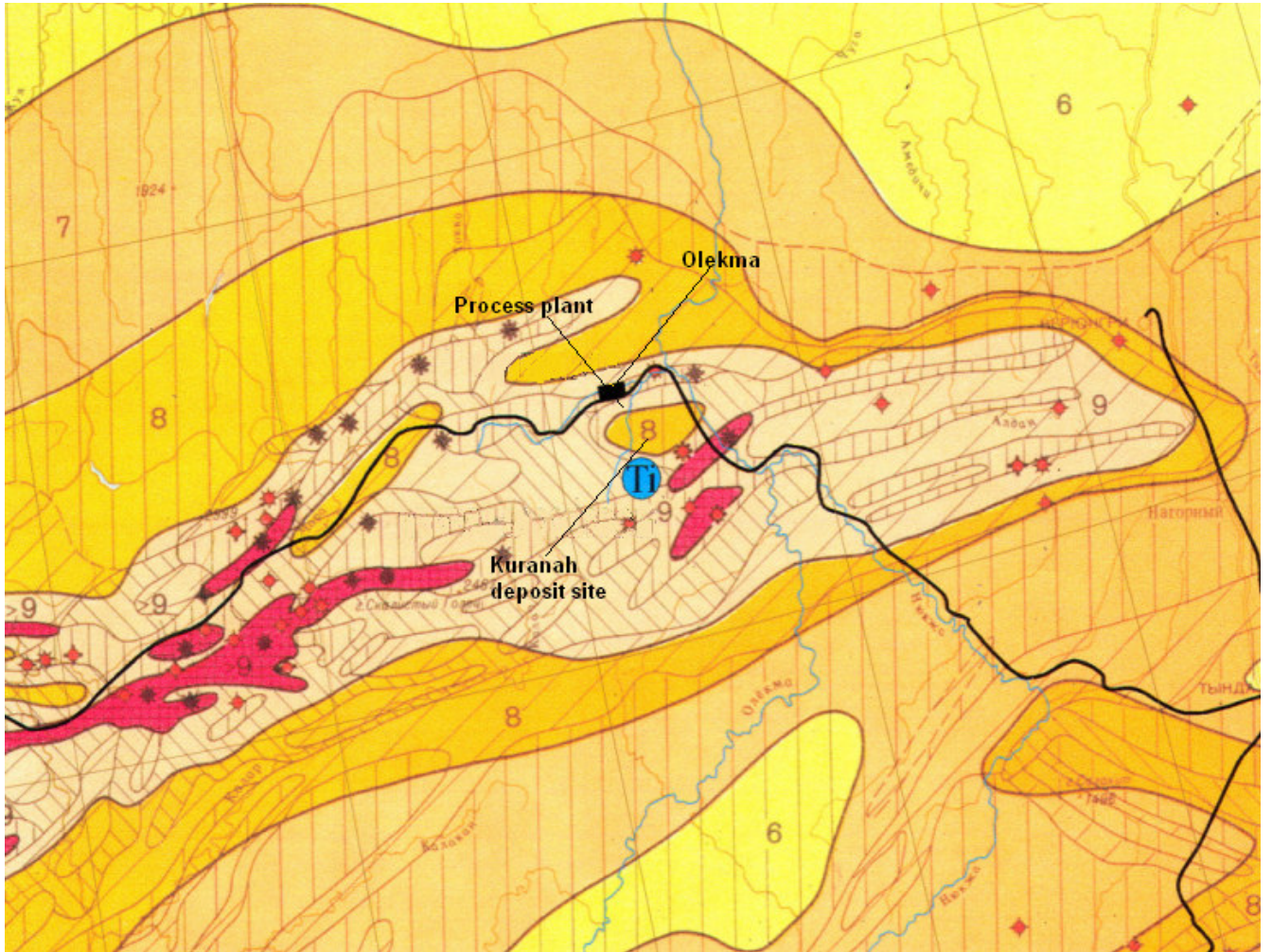
This seismic characteristic corresponds to the seismic zoning scheme prepared by the Institute of the Earth's Crust in the town of Irkutsk, for the Baikal-Amur Railroad.

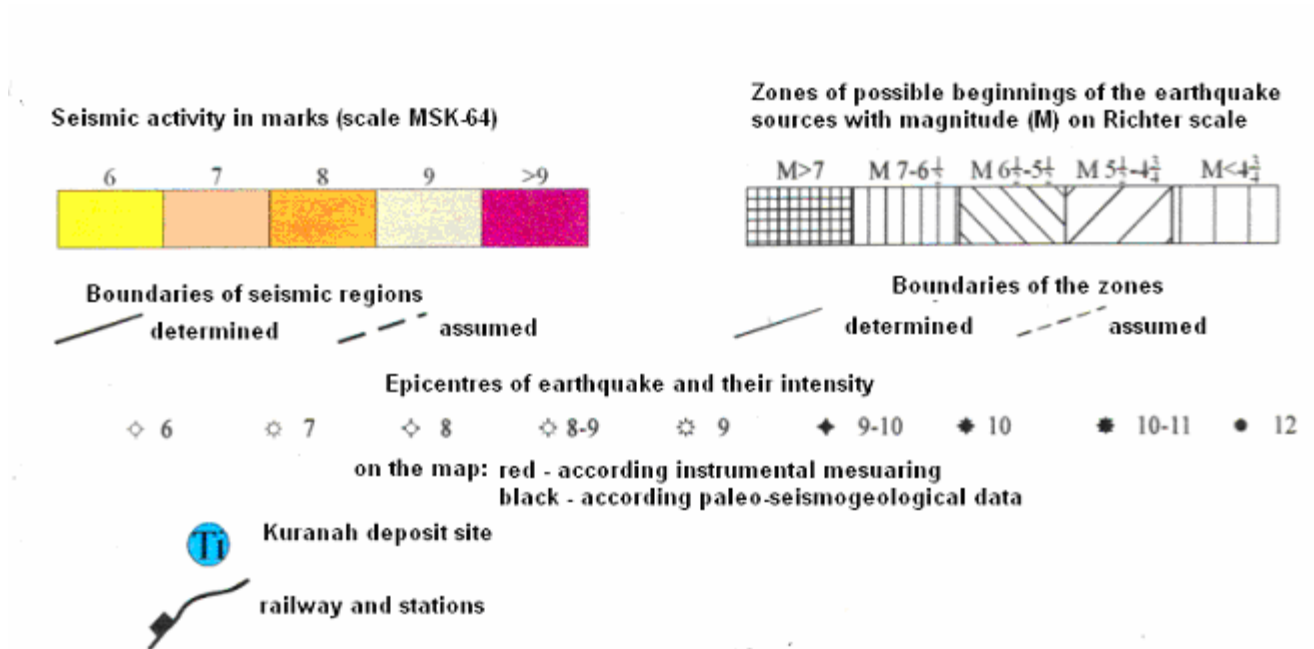
The Olekma seismic zone is characterized by sizeable earthquakes. The following earthquakes took place here:

- Nyukzhinskoye (1958) and Olekminskoye (1958) earthquakes with a magnitude of 6.4 on the Richter scale;
- Tass-Yuryakskoye (1967) with a magnitude of 6.4 on the Richter scale;
- South-Yakutskoye (1989) with a magnitude of 6.6 on the Richter scale.

So the area close to the proposed Kuranah mine site is characterized by increased seismic activity. Earthquakes of magnitude 7 and more on the Richter scale are possible. Seismic zoning scheme is on the Figure 6.

Figure 6. Seismic zoning scheme (according to Solonenko)





4.7. Permafrost

The main factors which determine frozen conditions are climate and the physical geography of mountains. Permafrost is present on the Kuranah deposit site due to a strongly continental climate with negative average annual temperature, and its location within the mountain system of Kalar mountain ridge.

Exploration drilling showed that the rocks of the friable layer are frozen everywhere. The frozen rocks of the cover layer include lenses, streaks and veins of ice with thicknesses up to 10 metres, and of width and length up to tens of metres. Rocks under the friable cover contain ice inclusions in the upper 5-metres, but are mainly characterized as frozen.

A hole which was drilled on the top of Arbagastur mountain showed a temperature of -0.2 °C at a depth of 300 metres, providing evidence that the thickness of permafrost is more than 300 metres.

In a 301.7 metre deep hole drilled on the slope of the mountain, and crossing ore zone № 3, the minimum temperature was at a depth of 60 metres and it was -1.3 °C. A temperature of 0 °C was registered at a depth of 280 metres, and at 300 metres depth, the temperature was + 0.2 °C.

During the engineering survey for the Baikal-Amur Railroad on the contiguous area at the confluence with the River Hany near the bottom of the slope, the temperature in the hole at a depth of 10 metres changed from - 4.1 to - 5.6 °C (12).

4.8. Radiology

Radiological investigations were conducted for two sites – the proposed mine site and the site of the proposed process plant. These investigations included route measurement of the gamma activity and soil sampling.

For the mine site, line measurements were conducted for a length of 8.3 km, with continuous measurement and fixing of results every 50 metres. Figure 8 presents the gamma-activity of the mine site. The majority of the area has an activity of 5-10 microrentgen/hour (0.05 – 0.1 µSv/hour) with small areas with an activity of 15-20 microrentgen/hour (0.15 – 0.2 µSv/hour) and more on the slope of hill Arbagastur, and with activity more than 20 (0.2 µSv/hour) on the banks of the River Saybalah. There are six radioactive anomalies on the area of the Kuranah deposit site. All anomalies

are small in aerial extent and are associated with veins of pegmatite. The exposure dose rate of gamma radiation is from 60 to 182 microrentgen/hour (0.6 – 1.82 μ Sv/hour).

Line measurement of the gamma activity for the process plant site (Figure 7) was conducted along the profile of the site from south-east to north-west, with the total length of the route being 2.2 km. There has been no previous radiological investigation for this area. The results of the measurements showed gamma-radiation activity for the whole area to be 6-12 microrentgen/hour (0.06 – 0.12 μ Sv/hour).

In accordance with the Russian standard for radiation safety NRB-99, the gamma ray dose rate for the work place must not exceed 2.5 μ Sv/hour, so the background natural level of gamma radioactivity does not exceed the permitted levels.

Soil sampling was conducted at sixteen points on the deposit site, and samples were analyzed for Cs¹³⁷, Sr⁹⁰, Th²³², K⁴⁰, Ra²²⁶. The results for all samples are available in the environmental monitoring report (1). In June 2005 soil sampling was conducted at the process plant site. Soils were sampled at two points and samples were analyzed for Cs¹³⁷, Th²³², K⁴⁰, Ra²²⁶. The results of the analyses are available in report (2).

A summary of the results is shown in Table 4.16.

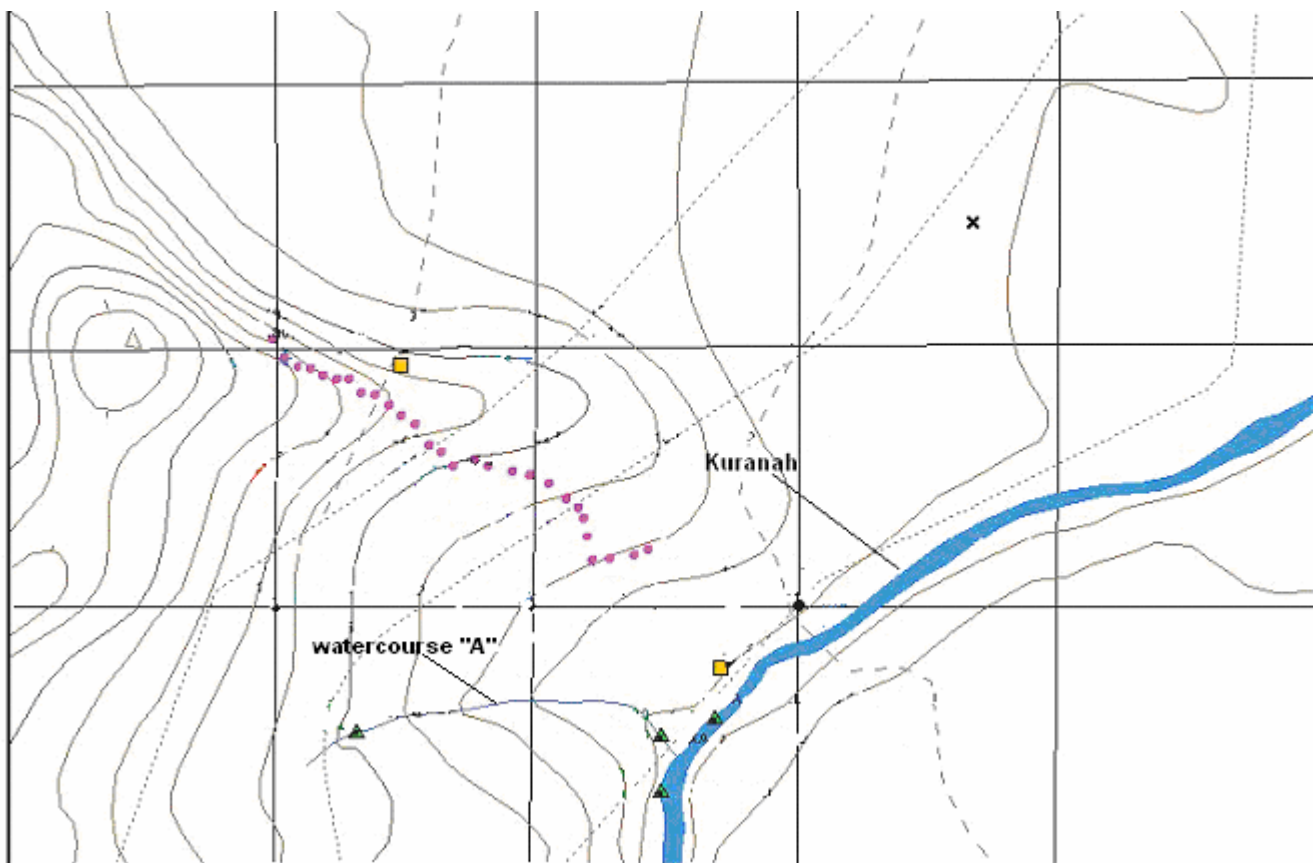
Table 4.16. Analysis results for soil radioactivity

Name of the element	Units	Average results for plant site	Results for mine site		
			Average	Maximum	Minimum
Ra ²²⁶	Bq/kg	12.4	12.1	16.4	7.8
Th ²³²	Bq/kg	15.5	9.8	17.2	5.7
K ⁴⁰	Bq/kg	610.3	324.1	598.0	136.6
Cs ¹³⁷	Bq/kg	2.4	7.6	14.1	3.2

The Russian standard for radiation safety NRB-99 does not contain any limits for soil itself, but contains limits for the level of radiation in building materials (crushed stone, gravel, sand, cement and brick raw materials and so on) which are used to evaluate soil. In accordance with NRB-99 the total activity of natural radioactive nuclides in building materials used for residential construction must not exceed the following: $A = A_{Ra} + 1.3 A_{Th} + 0.09 A_k \leq 370$ Bq/kg, where A_{Ra} , A_{Th} , A_k - specific activities of ²²⁶Ra and ²³²Th, K-40 (Bq/kg).

So the total average activity for the mine site of 54.01 Bq/kg, and 87.48 Bq/kg for the process plant site, are much less than the permitted limit.

Figure 7. Radiation investigations on the process plant site



Soil sampling

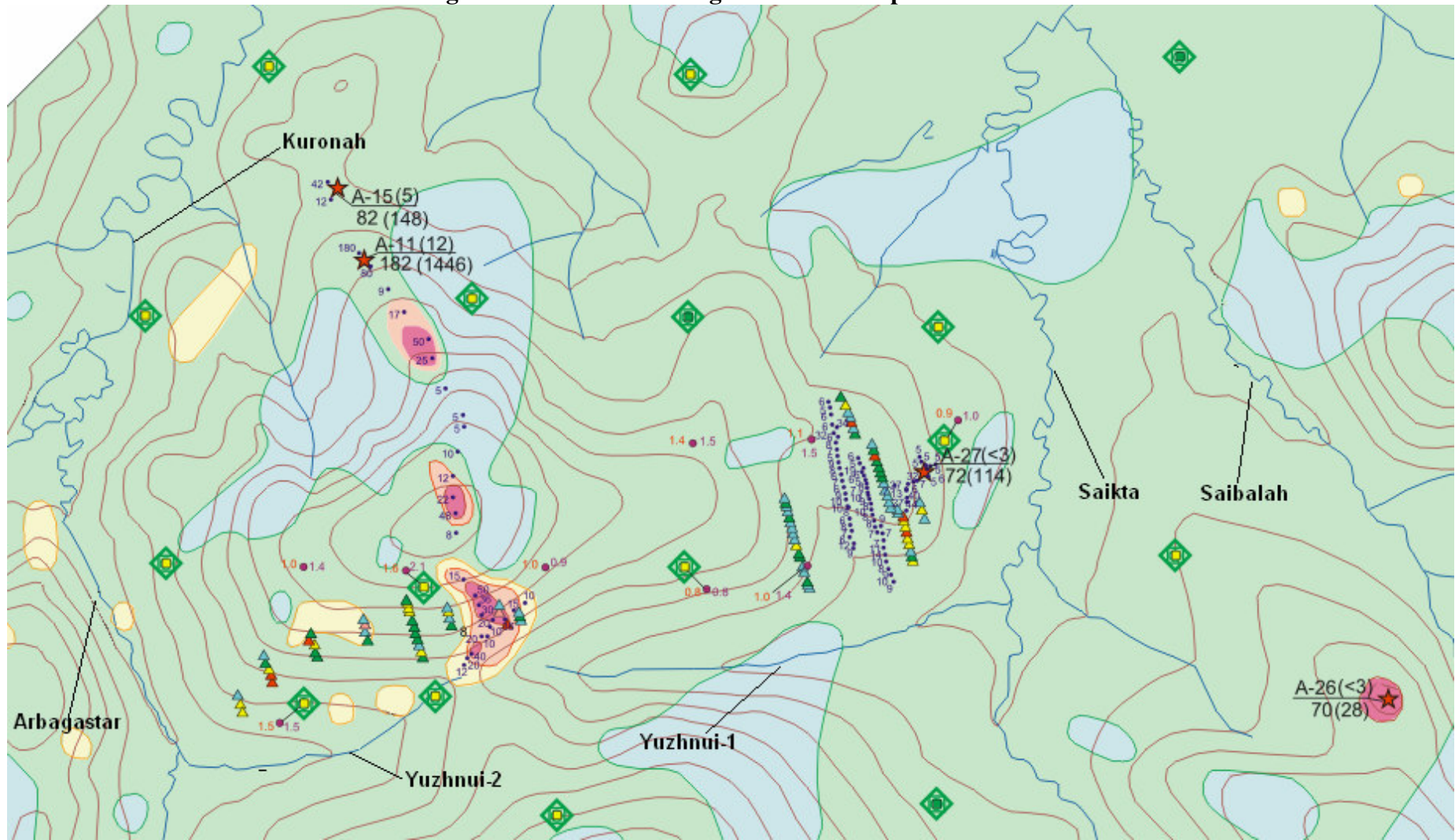


Gamma activity measuring

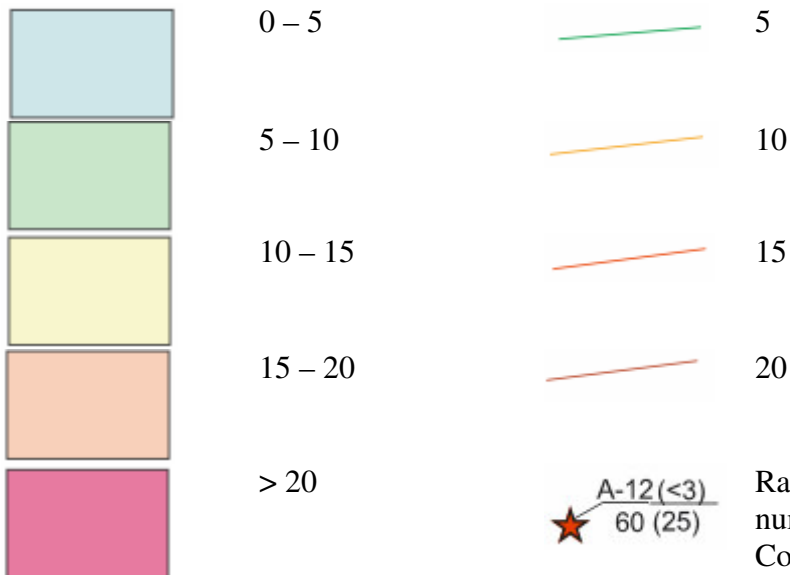


Surface water sampling

Figure 8. Radiation investigations on the deposit site



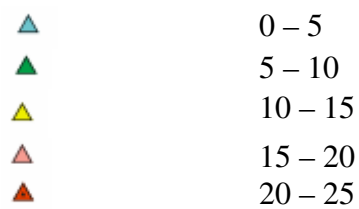
Intensity of gamma rays, Isolines of radioactivity of rocks
microrentgen per hour



★ $\frac{A-12(<3)}{60(25)}$

Radioactive anomaly – number in numerator, intensity in denominator;
 Content of uranium ($n \cdot 10^{-4}$ in percents) in brackets in numerator, content of thorium ($n \cdot 10^{-4}$ in percents) in denominator

Points of measurements in excavations



4.9. Ground water

4.9.1. Hydrogeology

The hydrogeology of the project area is mainly defined by the presence of permafrost over the whole region. Taking this fact into account, over permafrost, inter-permafrost and under permafrost ground waters were identified, associated with different hydrogeological formations.

- Over permafrost water

Over permafrost water is mainly associated with the friable overburden. It is fed by precipitation, surface water, and rarely from under permafrost water through taliks (areas of ground with temperature above zero). The water is free flowing or weakly under pressure. Permafrost rocks are the under confining layer for this water, and sands, pebbles and rubbly-dross materials are the host. The thickness of this layer on the watersheds and south slopes is 0.5-1 metre, on the north slopes is 0.1-0.3 metres; the thickest layer is in the alluvium of large streams. The water emerges on floodplains, terraces, at the foot of slopes and at concave areas on the slopes. The flow rate is in the range 0.04-0.3 l/sec, with the flow rate rising sharply during rain.

Over permafrost water related to fracture zones and residual soils in the Archaean metamorphic and intrusive rocks does not occur to a significant extent. In winter the over permafrost water horizon freezes completely.

- talik (inter-permafrost) water

Inter-permafrost water relates to fracture zones and river valleys. The water-bearing rocks are fractured metamorphic and intrusive formations, divided by a network of fissures, which creates good conditions for ground water accumulation and flow. In the warm season inter-permafrost water comes to the active layer and creates a unified groundwater system. This water is fed by precipitation, surface and, probably, under-permafrost waters.

- under permafrost water

Under permafrost fracture-vein water, related to zones of fissuring in the Archaean metamorphic and intrusive formations, occurs to the largest extent. This water usually is under pressure and its flow rate depends on the degree of rock fissuring. In contrast to the previous two types, under permafrost water is in the liquid state all year. It is fed by precipitation seeping through tectonic fractures and fissures and by surface water through zones under river-beds. This water discharges near and under river-beds where they cross with fracture zones. In winter, frazils (ice formations on the surface) are developed where water discharges (valleys of the River Kuranah and Saikta Stream) covering an area from 47 to 932 thousand square meters (1).

Depending on the stratigraphy, lithologic-petrographic composition of the host rock and frozen conditions, the following hydrogeological sub-units occur in the area (Figure 9):

- Seasonal-water-bearing horizon of upper Neopleistocene and Holocene alluvial sediments (Q_{III-IV}).

This horizon extends everywhere on the watersheds and slopes. Almost every spring is connected with this horizon. The water-bearing rocks are lumps, crushed stones, gruss with sandy-

loamy fill. The horizon is fed with water during the warm season because of partial thawing of the permafrost and infiltration of precipitation. The thickness of the layer is from 0.5 to 2.5 metres. Discharge rates of mapped springs from this horizon are from 0.01 to 0.8 l/sec. The mineral content of the ground water is usually 0.07-0.11 g/l. The chemical composition of the water is characterized by hydrocarbonate-chlorite anions and mixed cations. The horizon is water-bearing only during the warm season from May until October. Ground water from this horizon feeds seasonal springs. The horizon is not shown on the hydrogeological map.

- Water-bearing cryogenic-talik horizon of alluvial sediments (aQ_{IV})

This horizon is located at the deepest part of the river valleys and is connected with riverbeds and floodplain terraces. The horizon is elongate in shape, following river valleys, with a width of 100-150 metres in the valleys of the streams of Arbagastur, Caybalah and upper Saikta, and 500-600 metres in the valleys of the lower Saikta and River Kuranah. Underflows develop within this water-bearing horizon and they absorb part of surface flow. Two large frazils that have been mapped in the Saikta Stream valley are evidence of the discharge zones of the underflows. An artesian well used for water supply previously existed on the high flood-land of Saikta Stream. The well was decommissioned after the field base was closed in 1990. The thickness of the modern alluvial sediments in the river valleys is not more than 10 metres. The majority of the horizon is frozen. Taliks exist locally as narrow vertical cracks. Mineralization of the ground water is 0.1 g/l. The water composition is characterized by the chlorite-hydrocarbonate anion and mixed cations.

- Locally-water-bearing cryogenic-talik fractured zone of Low Archaean metamorphic rocks (AR_I).

This zone is located in the north-west part of the project area. Metamorphic rocks are characterised by amphibole, biotite-amphibole, hypersthene-biotite crystal shale, gneisses, streaks of the garnet-hypersthene-biotite plagiogneisses, lenses of amphibolites, garnet granulites, and hypersthene quartzite. The fractured zone is frozen in outcrops. Rocks can be thawed and hold water in the underflow of the flood-land of River Kuranah. Ground water of the fractured zone is fed by infiltration of surface water and precipitation through the talik zones.

- Locally-water-bearing cryogenic-talik fractured zone of Low Archaean intrusive rocks (AR_I).

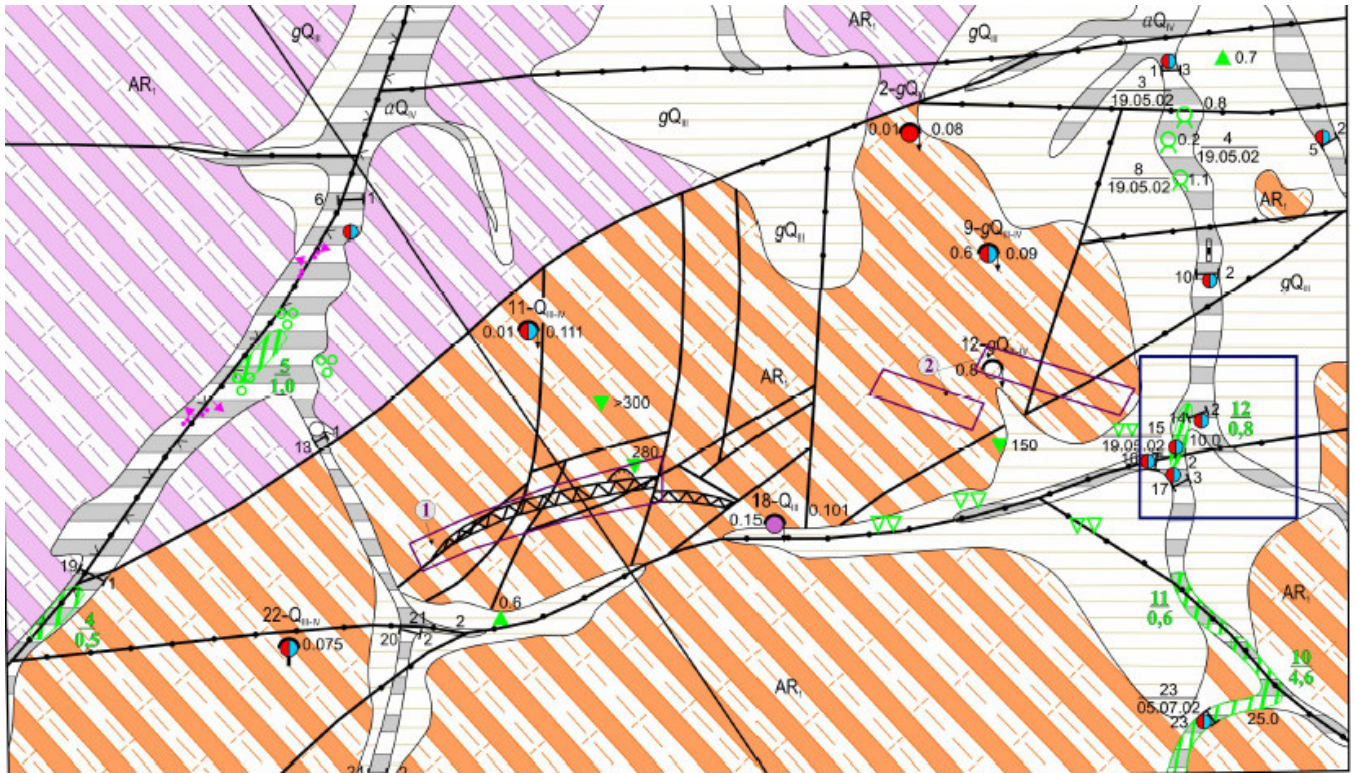
Intrusive rocks are prevalent on the proposed mining area and characterised by gabbro, andesinite, labradorite, anorthosite, garnet, and pegmatite, and they are frozen throughout the area. Hole № 13 with a depth of 300 meters, drilled from the top of Arbagastur mountain, showed the thickness of the permafrost to be more than 300 meters. Hole № 8 on the slope showed the permafrost thickness to be 280 metres. In the lower part of the permafrost layer with fractured frozen rocks, and beneath the base of the permafrost on the watershed, the rocks are drained, which is confirmed by many cases of full absorption of the fluid during drilling the holes. Water-bearing sites can be connected with the bases of river flood-lands under the layer of friable Neopleistocene and Holocene sediments.

- Cryogenic water confining horizon of Upper Neopleistocene glacial formations (gQ_{III}).

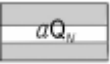





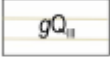













A cryogenic water confining horizon is developed at the periphery of the river valleys and others areas of falls in relief. The horizon is associated with formations of ground, side and terminal

moraines. The sediments consist of coarse material with sandy-loamy and sandy fill, with lenses and streaks of ice up to 10 metres thick. This horizon is completely frozen, and the sediments are very icy. The horizon is up to 38 metres thick.

Figure 9. Scheme of frozen-hydrogeological conditions of the upper river Kuranah (3)



Legend

<p>1. Water-bearing horizons and fractured zones</p>		<p>5. Chemical type of water at sampling points</p>	
	<p>waterbearing cryogenic-talik horizon of modern alluvium. Boulders, pebble, gravel, sands, loamy sands, loamy soils, thickness up to 10-12 metres</p>		<p>Water of ternary composition</p>
	<p>Locally-waterbearing cryogenic-talik fractured zone of low Archaean metamorphic rocks</p>		<p>Chloride water</p>
	<p>Locally-waterbearing cryogenic-talik fractured zone of Archaean-Proterozoic intrusive rocks.</p>		<p>Chloride-hydrocarbonate water</p>
	<p>Waterbearing cryogenic-talik horizon of upper-pleistocene glacial origin. Lumps, boulders, detritus minerals, pebble, sand, loamy soils, ice lenses, thickness is up to 40 metres;</p>		<p>Composition is unknown</p>
<p>2. Break zones</p>		<p>6. Permafrost</p>	
	<p>Presumably water-bearing</p>		<p>Frazil to scale of map. Numerator is a number of frazil, denominator – average flow of the generative source, thousand m³/day</p>
	<p>Hydrogeological details are unknown</p>		<p>Frazil not to scale</p>
<p>3. Water inflows</p>			<p>Measured permafrost thickness, m</p>
	<p>Spring of over-permafrost water</p>		<p>Measured seasonal thawing thickness, m</p>
	<p>Hollows</p>		<p>Ground ice</p>
<p>4. Other annotations</p>			<p>Thermokarst</p>
	<p>Sites of planned open pits</p>		<p>Site of the hydrogeological exploration work for water supply</p>

4.9.2. Ground water quality

Sampling of the ground water was conducted on the area of the deposit site at the end of August and beginning of September 2004.

Sampling on the deposit site was conducted from springs (right bank of the River Kuranah and Arbagastur Stream, watershed of the South-1 and South-2 streams), providing four samples in total. It is considered to be most likely that the sampled springs comprise water connected with fractured zones and residual soil in Archaean metamorphic and intrusive formations.

The water in the springs is chlorite-hydrogen-carbonate, sulphate-hydrogen-carbonate with a mixed cation composition, mineralization 0.03–0.07 g/l, very soft (total water hardness 0.2-0.7 mg-equiv/l), and acidic (pH 4.2-6.4).

The chemical composition of the water, its physical properties, organoleptic and sanitary-toxicological characteristics in general comply with the Russian standard for drinking water (SanPiN 2.1.4.1074-01 “Drinking water”), with the exception of an elevated level of organic matter (11.2-45 mg/l oxidisable), total iron in two samples (0.4-1.4 mg/l), phenol in one (0.002 mg/l), nickel (0.2 mg/l) and reduced content of fluorine – 0.4 mg/l, which is typical for the region of the Russian Far East for drinking water. The presence of phenol can be caused by the decomposition of oil products, which may have resulted from the use of machinery at the site during previous works.

The analytical results for most important parameters are shown in Table 4.17.

Table 4.17. Analysis results of ground water quality

Concentration, mg/l	Min	Average	Max	Russian MAC ⁶	WHO standard ⁷⁸
HCO ₃	18.3	29.3	36.6		-
Cl,	4.8	5.6	6.5	350	-
F	0.4	0.4	0.4	1.2	1.5
SO ₄	0.6	3.7	12.1	500	-
NO ₃	0.4	1.6	2.9	45	50
Na	2.4	2.7	3.4	200	-
K	0.3	0.6	0.9	50	-
Ca	2.0	4.2	6.0	180	-
Mg	1.2	3.0	5.6	40	-
Fe	0.2	0.6	1.4	0.3	-
NO ₂	0.002	0.002	0.003	3	3
NH ₄	0.03	0.6	1.25	2	-
Oxidation permanganate	11.2	24.2	44.8	5	-
Phenol	0.0003	0.001	0.0019	0.001	-
Phosphates	0.003	0.003	0.003	3.5	-
B	0.001	0.002	0.003	0.5	0.5
Al	0.2	0.3	0.5	0.5	-

⁶ SanPiN 2.1.4.1074-01

⁷ Guidelines for drinking water quality, third edition, WHO, 2004.

⁸ Admissible levels not indicated for parameters are not determined by WHO

Si	2.7	4.7	6.9	10	-
S	0.04	1.05	3.60	10	-
Ti	0.0004	0.001	0.003	0.1	-
Mn	0.006	0.03	0.06	0.1	0,4
Co	0.0002	0.01	0.04	0.1	-
Ni	0.0005	0.05	0.19	0.1	0,02
Cu	0.0006	0.02	0.09	1	2
Zn	0.0005	0.01	0.02	5	-
As	0.0001	0.0001	0.0001	0.1	0.01
Br	0.0116	0.01	0.01	0.2	-
Sr	0.007	0.01	0.02	7	-
Zr	0.00002	0.0002	0.0002	0.07	-
Mo	0.00002	0.0001	0.0001	0.3	0,07
Cd	0.00001	0.00005	0.00008	0.001	0.003

4.10. Surface water

4.10.1. Hydrology

The River Kuranah and its tributaries form the drainage network of the study area.

The flow of the rivers is very irregular throughout the year and practically absent in winter. Small rivers and streams freeze completely. The duration of the period without flow is about 90-100 days for the River Kuranah and 110-120 days for Saikta Stream (12).

Snowmelt usually starts at the beginning of May and continues for 35-50 days. The water stored in the snow cover varies a lot from one year to the next, causing great inconsistency in the maximum water flow and levels of spring tide.

Summer floods occur every year. They are caused not only by frequent and abundant rains, but by thawing of the frazils, snowfields and ice on the north slopes. There can be up to fifteen floods during the summer-autumn period. The duration of the floods varies from five to twenty three days, but is typically eight to eleven days. For most of the rivers, long-term monitoring shows that the maximum water flows are recorded during the rain floods from June to August, but maximum water flow can occur during the spring snowmelt.

Monitoring data show that the average duration of lowest water flow for this region is 17 days. Long-term monitoring shows that the beginning of the longest period of lowest water flow is usually at the end of June (12).

- mining area

The main watercourses on the proposed mine site are the River Kuranah with its tributary Arbagastar (and its tributary stream Yuzhnuy-2 (South-2)) and un-named tributaries, and Saikta Stream (which flows into the River Kuranah outside the mining area) with its tributary Yuzhnuy-2 (South-2) Stream and other un-named tributaries (Figure 10). The general length of the River Kuranah is 78 km, and of Saikta Stream is 23 km. The characteristics of the watercourses on the mining area are shown in Table 4.18 (12).

The valleys of the rivers and streams have asymmetrical channels at confluence parts and V-shaped form in the upper watercourse. The width of river-beds is up to 2-5 metres, depth is 0.5 – 1

metre, and flow velocity is 1-1.5 m/sec (13). Precipitation, deep valleys and steep slopes of the river valleys define good conditions for drainage, which in turn results in relatively high average annual river flow, up to 11 l/sec×km². Underground water plays an important role in feeding the rivers and provides up to 40-50 % of river flow (4).

Table 4.18. characteristics of the watercourses on the mining area

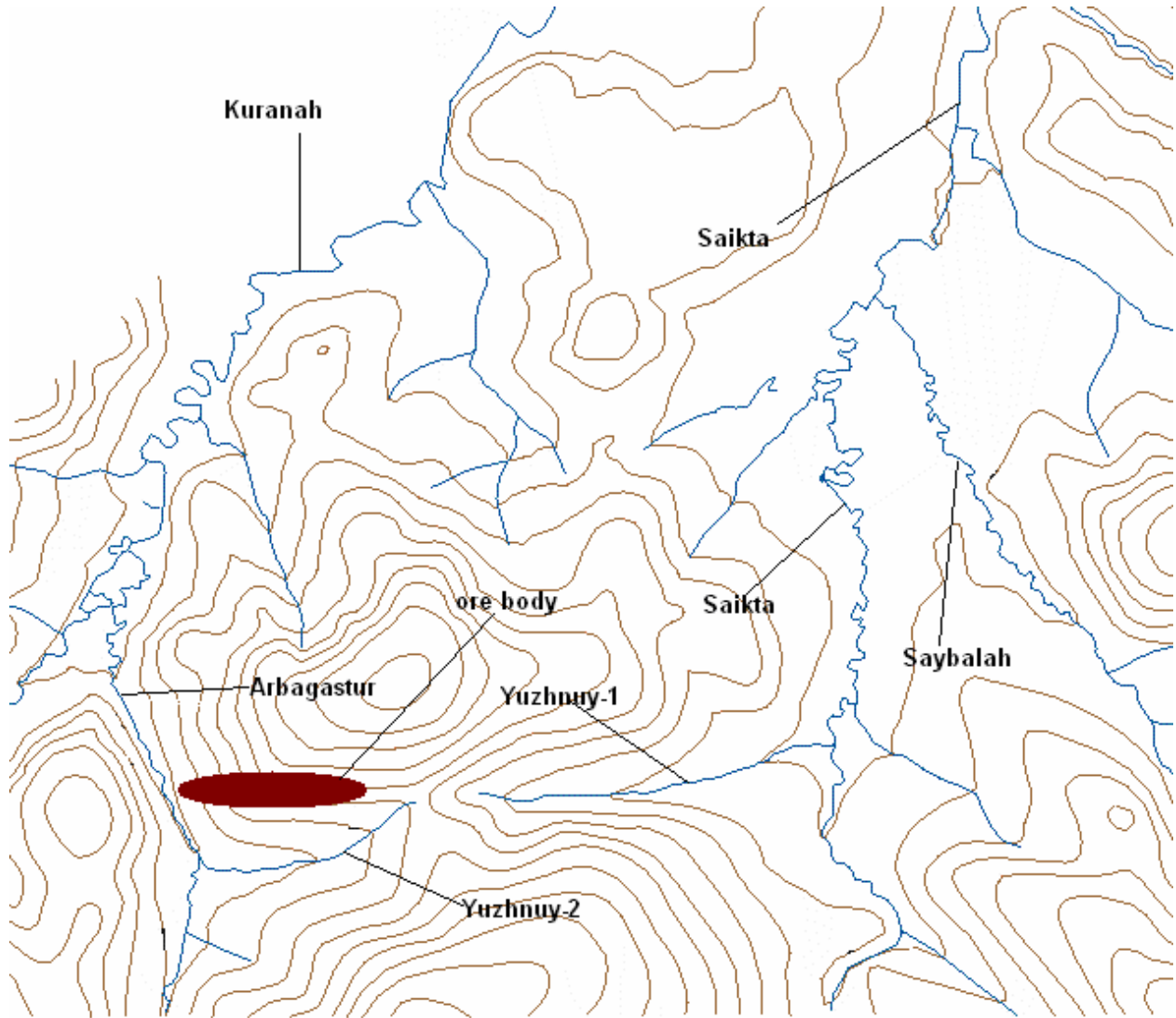
Watercourse	Catchment area, km ²	Average annual flow m ³ /sec	Annual flow of 95 % probability m ³ /sec
R.Kuranah at confluence with Saikta Stream:			
– Including Saikta catchment	871	9.54	4.30
– Excluding Saikta catchment	702	7.72	3.50
Saikta at confluence	169	1.3	0.63

The main calculated characteristics (5) of Saikta Stream and River Kuranah flow are shown in Table 4.19.

Table 4.19 main calculated characteristics of Saikta Stream and River Kuranah

Characteristic	R.Kuranah with Saikta Stream (catchment area is 871 km ²)			Saikta Stream (catchment area is 169 km ²)		
	l/sec×km ²	Mm	Thousand m ³ /day	l/sec×km ²	Mm	Thousand m ³ /day
Annual flow						
Average	10.95	345	824	7.49	236	109
95 % probability	4.92	155	370	3.71	117	54
Flow during warm season						
Average	5.11	161	384	2.32	73	34
95 % probability	2.41	76	181	1.08	34	16
Flow during winter						
Average	0.2	6.3	15	0.003	0.1	0.044
95 % probability	0.03	1.1	2.2	0.0001	0.003	0.001

Figure 10. Watercourses on the Kuranah mining site



The estimated monthly and seasonal flow distribution for the River Kuranah, as a percentage of the annual flow, is shown in Table 4.20 (12).

Table 4.20. Monthly and seasonal flow distribution for the River Kuranah

Quantity of water per year	M o n t h												Apr-Sep	Oct-Nov	Dec-Mar
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar			
Average	0.6	24.3	33.9	16.5	12.0	6.9	5.0	0.7	0.1	0	0	0	94.2	5.7	0.1
Dry	1.6	27.1	10.0	17.0	24.0	17.0	2.8	0.5	0	0	0	0	96.7	3.3	0

No hydrological investigation data are available for the tributaries of the River Kuranah or for Saikta Stream.

- Road from mine site to the process plant and station Olekma

Hydrological investigations for route of the proposed road took place in 2004 and 2005 by design institute VNIPIpromtehnology (VNIPI) and were divided into two parts – investigation for the section from station till process plant site and for section from plant site till mine site.

There are ten watercourses between Olekma station and the proposed process plant site. All of them are temporary and indeed are the lowering in relief, flowing only during the spring tide, summer thawing of the upper permafrost layer or during rainstorms. Watercourses are shown on the plan in Attachment 2-a. Maximum water flow rates and flow velocities are shown in Table 4.21.

Table 4.21. Maximum water flow rates and flow velocities of the watercourses crossed by road between Olekma station and the proposed process plant site

№ in accordance with plan in Attachment 2-a	Maximum water flow, m ³ /sec		Average flow velocity, m/sec	
	2% probability	10% probability	2% probability	10% probability
1	0.015	0.009	0.04	0.04
2	0.07	0.045	0.10	0.08
3	3.83	2.64	0.22	0.20
4	0.43	0.29	0.09	0.08
5	0.7	0.48	0.08	0.07
6	2.62	1.81	0.12	0.10
7	1.64	1.06	0.28	0.25
8	4.10	2.64	0.54	0.47
9	6.30	4.06	0.72	0.62
10	7.43	4.78	1.33	1.21

A plan of the watercourses along the route for section “mine site – plant site” is shown in Attachment 2-b. The main (permanent) watercourses that will be traversed are listed in the Table 4.22. All other watercourses which are shown on the plan in Attachment 2-b are temporary and indeed are the lowering of relief.

Table 4.22. Maximum water flow of the watercourses crossed by road mine site – plant site

№ in accordance with plan in Attachment 2-b	Name	Maximum water flow m ³ /sec
14	River Khoha	28.7
21	un-named	7.50
33	un-named	23.6
36	Charu Stream	24.6
40	un-named	17.1
45	un-named	32.2
46	un-named	9.76
50	un-named	19.3
59	River Horguybut	9.76
61	River Kuranah	627

In different parts the River Kuranah displays characteristics of both a lowland and a mountain river. A wide valley upstream of the confluence of River Kuranah and River Horguybut, with the presence of a wide floodplain, former river-beds, and a small incline, are typical of a lowland valley character. At the same time a rock bed, alternation of bends and small rapids with fast flow, which is typical for the whole river, is characteristic of a mountain river. There are parts where the river-bed meanders, which is associated with significant undermining of the banks and the presence of river-bed deformation.

The width of the River Kuranah, in its middle and lower part, changes from 35 to 100 metres.

The River Kuranah is fed by a combination of sources. Its annual flow consists of 20-50 % rain water, 25-35 % snow and 20-40 % underground water.

In winter, the flow rate sharply decreases and the river freezes in shallow areas. At the same time the head of water causes the creation of frazils, which continue to grow during winter.

At the beginning of May, the water level starts to rise as a result of snow thawing. However, ice jams and a high water level rise are not typical for the River Kuranah, due to small snow reserves, located at different altitudes and slopes and thawing at different times.

The largest water level rise occurs during the summer-autumn floods, resulting in an average exceedence of the mean water level of 2-2.3 metres.

In the zone of the proposed bridge, the River Kuranah flows on flat waterlogged lowland. The river valley in this part has a width of approximately 1.2 km, the flow velocity is 0.3 – 0.5 m/sec, but can be more than 2 m/sec during floods.

To define the flood boundaries for the River Kuranah, ten transverse cross-sections were allocated to the section of river from the proposed bridge (30th km of the road) to the bridge near the settlement of Olekma, and a series of field hydrographical works was conducted. As a result of this field work, the water flows for 2% (one time per 50 years) and 10 % probability (one time per 10 years), separately for rain floods and spring tide, were calculated. The results of the field work and calculations are shown in Table 4.23 (7).

- process plant site

There are two watercourses on the proposed process plant site – the River Kuranah and its left un-named tributary stream (watercourse 9 on the plan of watercourses, Attachment 2-a). The river-bed of the Kuranah within the area is up to 70-90 metres wide, the right bank is flat, left bank is steep with an elevation of approximately 12 metres. Flow velocity is 0.2-0.5 m/sec.

The un-named stream arises in the south of the site, where a spring emerges from the slope. Its upper course is not well defined and divides into several branches in thick marsh vegetation. The sides are peat, the bottom is sandy-marshy. In the lower reaches, the width of the river-bed is up to 1 metre, and the stream is strong (2).

Table 4.23. Characteristics of river Kuranah

Distance from proposed bridge, km	Catchment area	Width of the river-bed, m		Maximum depth, m		Rise of water level, m	Maximum water flow, m ³ /sec				Absolute levels of rain flood water, abs.m	
		Operating level	10 % probability	Operating level	10 % probability		Spring tide		Autumn flood		10 %	2 %
							10 %	2 %	10 %	2 %		
0	704	37.3	480	1.03	3.98	2.95	197	278	403	627	492.45	492.90
7.6	954	67.8	133	0.03	4.22	4.19	253	358	495	769	482.65	483.58
10.6	1010	41.1	265	0.12	3.38	3.26	265	375	513	797	479.20	479.80
18.4	1090	75.0	98	0.79	4.26	3.47	284	401	541	840	467.90	468.80
21.7	1120	43.1	113	1.47	5.40	3.93	289	408	548	851	461.60	462.40
23.8	1120	69.0	96	0.45	3.14	2.69	290	410	550	854	457.00	457.70
24.9	1130	56.5	77	1.10	4.03	2.93	291	411	551	856	455.30	456.05
29.4	1150	93.4	135	0.41	3.66	3.25	296	418	559	868	448.30	449.12
31.3	1180	56.6	92	2.19	4.60	2.41	303	428	569	884	443.27	444.15
32.9	1190	55.8	78	1.32	4.75	3.43	304	430	571	887	436.28	437.35

4.10.2. Water quality

Surface water quality investigations were conducted mainly by two organizations – design institute VNIPIpromtehnology and organization Amurgeology. The scope of the studies was as follows:

- 1) Sampling of streams on the area of the Kuranah deposit site.

The deposit site area is divided into two catchments: the western part is drained by the River Kuranah and its tributaries, and the eastern part is drained by Saikta Stream and its tributaries. Saikta Stream is also a tributary of the River Kuranah, but flows into the Kuranah downstream of the deposit area.

A single sampling exercise was conducted in August-September 2004 at thirty two locations on the River Kuranah, Saikta Stream and their tributaries. In addition, four locations were sampled several times during May to October 2004. The location of the sampling points is shown on Figure 11 (1). No relevant historical data for the area could be obtained.

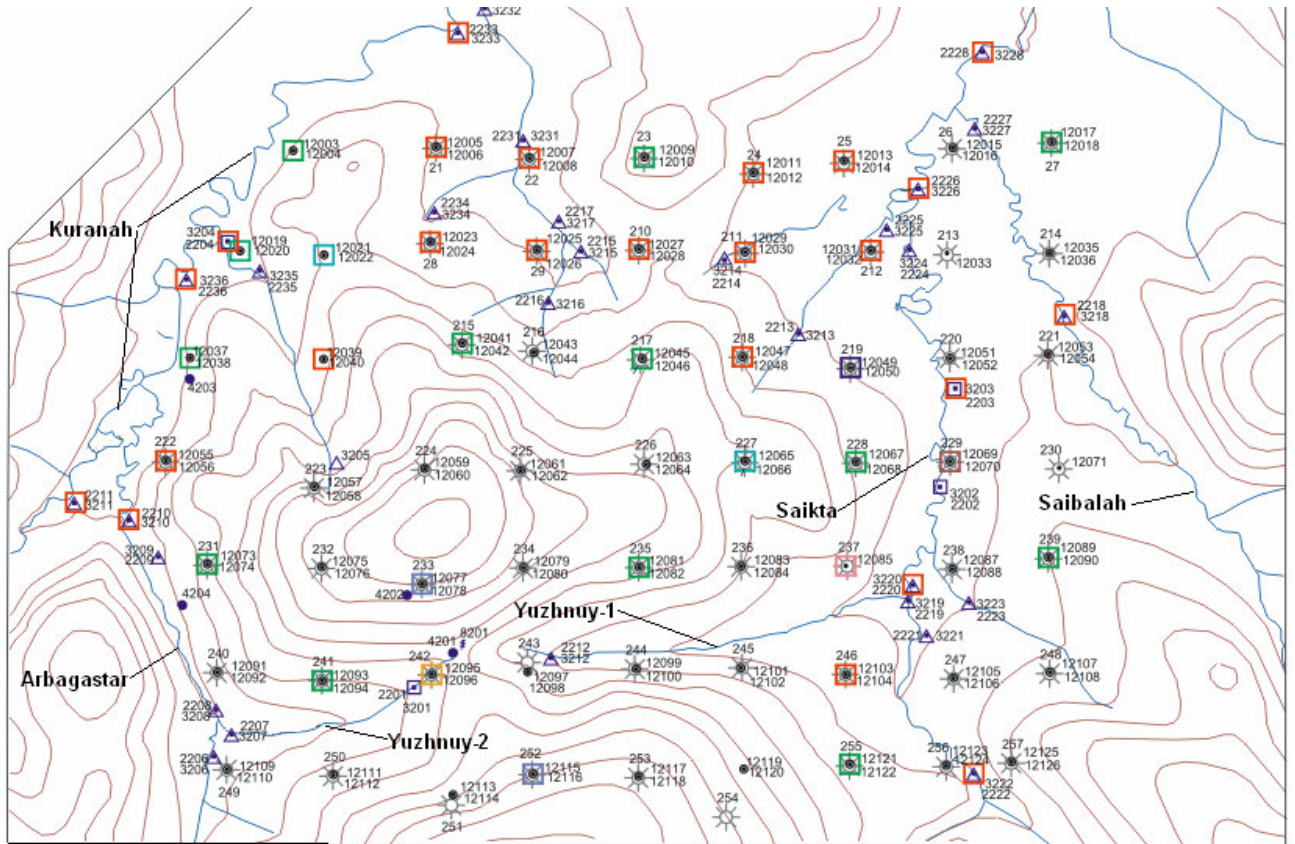
All samples were subjected to detailed analysis, conducted in three stages. Some on-site field measurements including Eh, pH and electrical conductivity were undertaken by the organization responsible for the monitoring (the state organization “Amurgeology”). General chemical analysis⁹, physical properties of the water, phenols and oil products were analyzed in the “Amurgeology” specialized laboratory. An additional seventy one minor components were determined by another specialist organization – the Institute of Microelectronic Technologies and Particularly Pure Materials of the Russian Academy of Sciences. The results of the analysis are presented in Attachment 3. A summary of the analytical results is shown in Table 4.24.

The repeated sampling at four points did not show any significant change in chemical composition with time.

Widespread poor drainage associated with permafrost, and a large amount of undecomposed organic acids in the surface of the catchment area, create oxidising conditions, confirmed by the redox potential (Eh 216-395 mV) and pH (3.8-6.6). These factors determine the content of organics (oxidation 10 – 57.6 mg/l), ammonium (0.13-1.3 mg/l), Fe (0.3-10.1 mg/l), and Mn (0.01-0.13 mg/l). Elevated concentrations of aluminium (0.05-2.9 mg/l) are due to it being leached from silica-alumina rocks and clays (1).

Elevated concentrations were identified for phosphorus (in one of the Kuranah’s tributaries) at a concentration of 0.2 mg/l, oil products at 0.07 – 0.18 mg/l (Saikta Stream and its tributary) and phenol at 0.0016 mg/l (Saikta Stream). The elevated concentrations of oil products and phenols are most likely due to human activity, as these sampling points are located in close proximity to sources of pollution (storage facility for oil products, ore dump, waste). At the same time, such concentrations can be the result of decaying organics.

Figure 11. Location of the sampling points



Legends

- 12011 • 12012 ○ Soil samples from A and B horizons and their reference numbers
- ☀ 218 Snow sample and its reference number
- 2208 Bottom sediment sample and its reference number
- △ 3208 Surface water sample and its reference number
- 4201 Ground water sample and its reference number
- 3202 Surface water monitoring point and its reference number
- ⚡ 8201 Atmospheric precipitation monitoring point and its reference number

Definition:

- Mobile forms
- Radioactive nuclear
- Mobile forms and radioactive nuclear
- Mobile forms, radioactive nuclear and C_{org}.
- Mobile forms, radioactive nuclear and oil products
- Mobile forms, C_{org} and Hg
- Mobile forms, C_{org}, Hg and oil products
- Mobile forms, oil products and Hg

Table 4.24. Summary results of the water quality analysis for some parameters for deposit site

Element, mg/l	Concentrations				Element, mg/l	Concentrations			
	Min	Average	Max	MAC for fishery water		Min	Average	Max	MAC for fishery water
pH	3.8	5.2	6.6	6.5 – 8.5	Cd	0.00015	0.00016	0.00030	0.005
HCO₃⁻	12.20	21.55	36.60	-	B	0.00121	0.00200	0.01409	0.5
Cl⁻	2.79	4.91	6.70	300	Li	0.000040	0.000274	0.000754	0.08
F⁻	0.11	0.31	0.57	0.05	Be	0.0000047	0.0000247	0.0001403	0.0003
SO₄²⁻	0.30	1.16	3.90	100	Ti	0.000400	0.002161	0.021694	0.06
CO₃²⁻	2.00	2.00	2.00		V	0.000108	0.001426	0.018598	0.001
NO₃⁻	0.05	0.63	5.60	40	Cr	0.0006	0.0007	0.0020	0.02
NO₂⁻	0.0015	0.0030	0.0200	0.08	Mn	0.00178	0.02050	0.13168	0.01
NH₄⁺	0.025	0.782	1.330	0.5	Fe	0.02256	0.80441	10.12879	0.1
Oil pr.	0.003	0.017	0.176	0.05	Co	0.00002	0.00037	0.00135	0.01
BOD-5	0.11	1.27	3.10	3 (compl)	Ni	0.00054	0.00065	0.00307	0.01
Sus.mat.	0.00	5.16	22.50	Increase above control point < 0.25	Cu	0.00040	0.00130	0.00641	0.001
Phenol	0.00025	0.00032	0.00160	0.001	As	0.00007	0.00015	0.00254	0.05
Sum of minerals	21.51	36.30	53.01	-	Se	0.0003	0.0003	0.0004	0.002
Density, general	0.10	0.28	0.50	-	Br	0.01	0.01	0.01	
Permanganate oxidation	10.08	34.82	57.60	-	Sr	0.00182	0.01203	0.03901	0.4
Zn	0.00047	0.00229	0.02060	0.01	Zr	0.000019	0.000227	0.000888	0.07
Al	0.04849	0.76441	2.87108	0.04	Mo	0.000016	0.000036	0.000104	0.001
Mg	0.06492	0.44881	2.34258	40	Hg	0.00003	0.00004	0.00004	Absent
Na	0.04680	0.97044	3.73470	120	Ba	0.00295	0.01042	0.09797	0.74
K	0.07827	0.13909	0.55157	50	La	0.00006	0.00323	0.02041	-
Ca	0.25562	2.43018	7.22208	180	Pb	0.000042	0.000240	0.003462	0.006

2) Sampling of streams on the area of the process plant site

The main watercourse in the study area is the River Kuranah which lies to the east of the site. The left tributary of the River Kuranah (un-named stream “A”) drains the southern part of the site. A single sampling exercise was conducted on 29 June, 2005 at four locations. The locations of the four sampling points are shown in Figure 7 (1). No relevant historical data for the area could be obtained.

All samples were analyzed for general chemical analysis, physical water properties and for 71 minor components by the same organizations as in 2004 during the baseline study of the deposit site. The results of the analysis are presented in Attachment 4.

The water in stream “A” is soft (water hardness is 0.3 mg*equiv/l) and weakly acid (pH 5.4-5.9). It has elevated concentrations of Fe (1.3 mg/l), Al (0.51 – 0.72 mg/l), organics (permanganate oxidation is 5.6 – 56.8 mg/l) and, a sample from the upper stream shows the presence of phenol (0.016 mg/l). The organic content of the stream water has a natural origin – the stream flows through marshland and has peaty banks, and so it is rich in natural organic matter.

The stream water has generally higher background levels of the measured parameters than the River Kuranah. However, in general terms, the River Kuranah has the same characteristics, it is soft and weakly acid (pH 5.8 – 6.0). The concentrations of some elements are Fe 0.4 – 1.1 mg/l, Al 0.50-0.7 mg/l, and permanganate oxidation up to 48 mg/l. A summary of the analytical results for the four samples is shown in Table 4.25.

Table 4.25. Summary of the water quality analysis for the process plant site

Element, mg/l	MAC for fishery water	min	aver	max	Element, mg/l	MAC for fishery water	min	Aver	Max
pH	6.5-8.5	4.8	5.6	6.0	Ti	0.06	0.003227	0.004978	0.007931
Eh, mV	-	188	216	259	V	0.001	0.000476	0.000791	0.001412
HCO ₃ ⁻	-	18.30	19.52	20.74	Be	0.0003	0.000033	0.000033	0.000034
Cl ⁻	300	3.35	4.00	4.84	Mn	0.01	0.006747	0.013556	0.023542
F ⁻	0.05	no	0.11	0.11	Fe	0.1	0.426077	0.737102	1.113804
SO ₄ ²⁻	100	2.25	3.74	5.45	Co	0.01	0.000172	0.000382	0.000739
CO ₃ ²⁻	-	no	no	no	Ni	0.01	no		0.001146
NO ₃ ⁻	40	no	1.08	1.47	Cu	0.001	0.001175	0.001327	0.001524
K	50	no	no	no	Zn	0.01	0.001247	0.002797	0.005431
Ca	180	2.00	3.11	4.01	As	0.05	0.000077	0.000139	0.000201
Fe	0.1	0.40	0.79	1.3	Sr	7	0.012229	0.016203	0.024581
NO ₂ ⁻	0.08	no	no	no	Zr	0.07	0.000490	0.001401	0.002389
NH ₄ ⁺	0.5	no		0.06	Mo	0.001	0.000040	0.000063	0.000081
pH	6.5-8.5	5.42	5.78	6.03	Cd	0.005	0.000009	0.000027	0.000070
phenol	0.001	no		0.0016	Ba	0.74	0.008589	0.010843	0.013528
Oil pr.	0.05	0.01	0.02	0.02	Pb	0.006	<n.o.	0.000107	0.000158
Sus.mat.	Increase above control point < 0.25	0.60	0.60	0.6	B	0.5	0.000956	0.001245	0.001474
BOD-5	3	0.27	0.72	1.16	Na	120	1.183599	1.418181	1.525331
Mg	40	0.427748	0.513392	0.592892	Si	10	2.736342	3.271224	4.218997
Al	0.04	0.502993	0.564751	0.718799	Li	0.08	0.000489	0.000676	0.000968

- 3) Sampling of the streams along the proposed roads from Olekma to the deposit site and from Olekma to the process plant site.

Most of the watercourses crossed by the roads are ephemeral, and samples were collected from only some of the watercourses. A total of eight watercourses were sampled along the road from deposit site to process plant site and two along the road from Olekma to the process plant site. Analytical results are shown in Table 4.26. The watercourses are sulphate-sodium, and weakly mineralized. Solids range from 109 to 201 mg/l, and the water is acid (pH 5.0 – 6.0).

Table 4.26. Summary results of the water quality analysis for the streams along the proposed roads

Date of sampling	Concentration, mg/l														
	solids	pH	CO ₂	HCO ₃ ³⁻	SO ₄ ²⁻	Cl ⁻	Ca ²⁺	Mg ²⁺	Na+K	Fe	Oxid.	NO ₂	F	NO ₃	NH ₄
Road from deposit site to process plant site															
04.07.04	135	5.0	17.6	48.8	54.3	7.1	8.0	2.4	34.3	0.8	26.9	-	0.4	-	0.3
05.07.04	109	5.6	19.6	36.6	44.4	7.1	8.0	2.4	25.3	0.3	19.6	-	0.1	-	0.1

11.11.04	124	5.7	17.6	24.4	54.3	14.2	8.0	2.4	31.0	0.14	15.5	-	0.5	-	0.08
18.11.04	147	5.8	17.6	24.4	74.1	10.6	8.0	2.4	38.2	0.06	14.5	0.21	0.1	0,34	-
18.11.04	149	5.7	17.6	36.6	75.4	7.1	12.0	2.4	36.6	-	11.4	-	0.3	-	0.07
22.11.04	114	6.0	17.6	24.4	59.2	7.1	8.0	2.4	28.8	-	7.2	-	0.3	-	-
01.12.04	115	5.9	17.6	24.4	54.3	7.1	4.0	2.4	30.2	0.1	10.3	0.16	0.2	0,40	-
01.12.04	201	6.1	17.6	36.6	98.8	14.2	20.0	2.4	43.0	0.1	10.3	-	0.3	-	-
Road from Olekma to process plant site															
22.04.04	126	5.8		24.4	62.5	7.1	4.0	2.4	33.1	1.5	14.5	-	0.5	-	0.1
24.04.04	148	5.7		24.4	75.7	8.9	8.0	2.4	37.5	0.4	5.2	-	0.3	-	0.02

4.11. Soils

Inclement climatic conditions, permafrost and the composition of the rocks result in an acid and acid gley type of residual soil and low biological activity. Typical bed rock is a rubbly-loamy mass, passing to metamorphic or igneous rocks, showing no changes due to weathering. Soils in these conditions are characterized by stoniness and a short profile. Mechanical processes of soil creation and development prevail over chemical processes. Because of the low biological activity and specifics of the bed rocks, the soils have a thin fertile layer.

The formation of the soil-vegetation cover is characterised by vertical zoning. In sparse coniferous forests with a mossy undershrub cover, organic residue reaches the soil surface mainly in conditions where there is a prevalence of overground biomass. Overwetting and low temperatures promote slow decay of the tree waste, and its accumulation on the forest floor and its storage exceeds the annual tree waste by many times. As a result of these conditions, a small quantity of the organic substances accumulates in the soils, mainly as coarse humus material and fulvic acid. Neutralization of the acids does not occur (1,2).

Site specific soil investigations were conducted for the area of the mine site (2004) and for the area of the proposed process plant site, tailings damp and camp (2005).

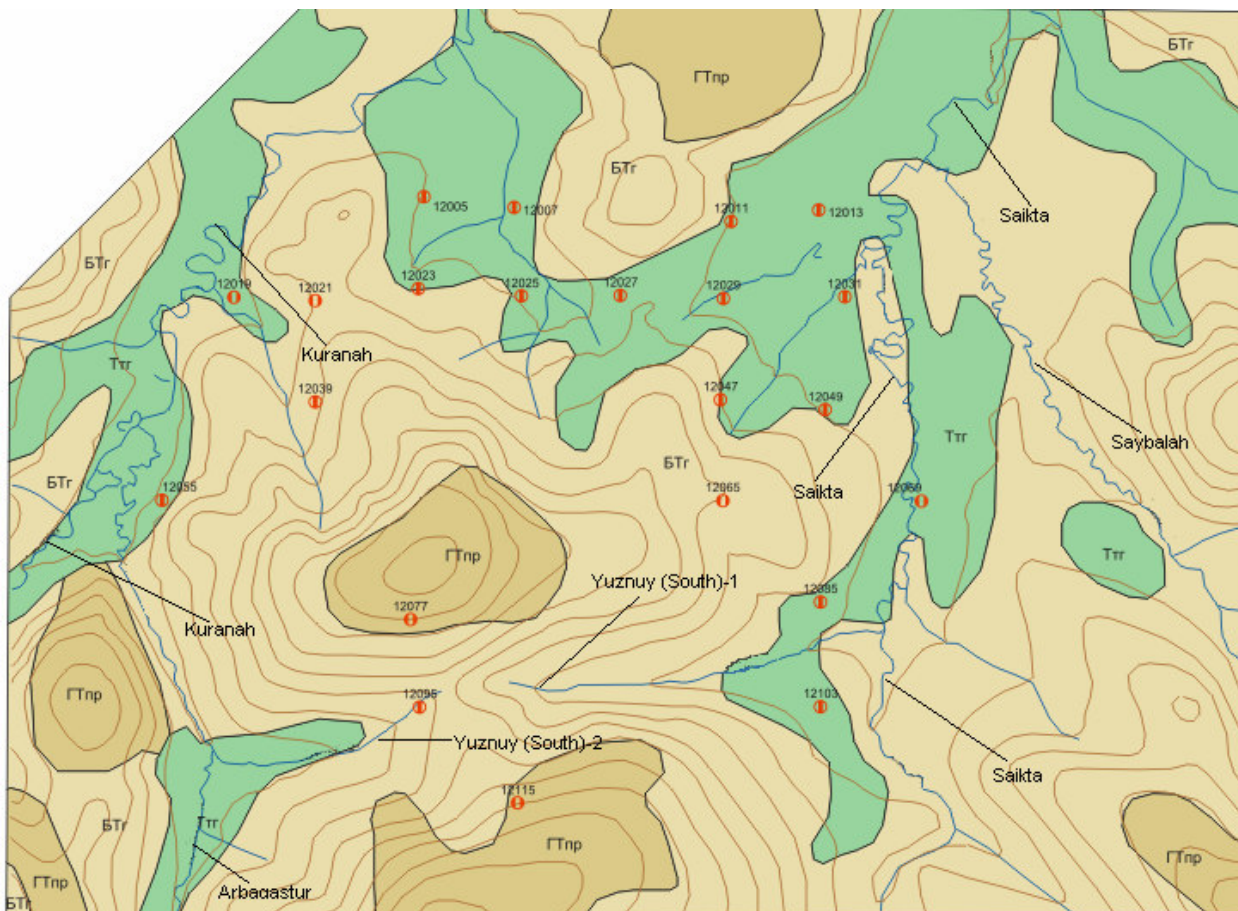
- mine site

Soil investigations for the deposit site included lithochemical sampling of the A and B horizons over a 50 km² area, on a 1x1 km grid, from sixty two points. Sixty two samples were collected from horizon A, and fifty nine from horizon B, resulting in one hundred and twenty one samples in total. The samples were analyzed as follows:

- 1) all samples were analyzed by semi-quantitative spectral analysis for 44 elements;
- 2) 22 samples from A horizon were analyzed for mobile forms of 70 elements;
- 3) 6 samples were analyzed for C organic, cation-exchange capacity and mercury;
- 4) 5 samples were analyzed for oil products.

Three soil types are found in the study area: mountain-tundra raw soil, mountain-brown-taiga alluvial-humus soils and mountain-taiga peat-gley soils (5). Soils types allocations are shown on the Figure 12.

Figure 12. Soil types of the deposit site



Legend

Index and colour	Soil name	Mechanical composition	Relief
БТр	mountain-brown-taiga alluvial-humus soils	Peaty loam, loam with gruss	Top and slope of the hills
Ттр	mountain-taiga peat-gley soils	Peaty loam, loamy sand and loam with gruss	Valleys of the taiga rivers and streams
ГТнр	mountain-tundra raw soil	Loamy sand with gruss, loamy soil	Tops of the hills

Type of analysis

- 12039  definition of mobile forms 12021  definition of mobile forms, Corg.

Mountain-tundra raw soil occupies 15 % of the study area. It has weak soddy cover (A_0 0–2 cm), humus-peat (A_1 1–4 cm), loamy (B 4–20 cm) and rubbly (C) horizons. The general location of mountain-tundra soils close to the surface of dense rocks defines its coarse sand-stone character. Because of the extreme depression of chemical and biological processes, the soil profile for these rocks is often measured by several tens of centimetres, and sometimes by several centimetres.

Mountain-brown-taiga alluvial-humus soil covers the largest part of the study area (65 %). It has the profile: A_0 – forest floor (0–6 cm), A_1 – humus-loamy layer (6–9 cm), B_1 – alluvial with coarse sand and rubble (9–22 cm), B_2 – loamy sand (22–42 cm) and C – loamy sand with crushed rock (42 cm). An insignificant content of the mobile form of phosphorus and potassium is typical for this type of soil.

Mountain-taiga peat-gley soils (20 % of the area) occupy river valleys and northern slopes of Arbagastur mountain. They are characterized by a small peat layer (up to 10 cm), with a gley horizon on the frozen ground under it (5).

The whole area is characterized by acid conditions and reactions (pH ranges from 3.6 to 5.4). The lower pH levels occur in the A horizon. The average results of the redox potential measurements exceed + 250 mV. Leaching processes are intensive. (5).

The results of the analysis of soil samples are presented in Table 4.27.

Table 4.27. Total contents of the elements of the soils of the deposit area.

Element	Meas. unit	Russian MACs	Horizon A			Horizon B		
			C_{min}	C_{max}	C_{aver}	C_{min}	C_{max}	C_{aver}
As	mg/kg	2	30	30	30	30	30	30
Pb	mg/kg	32	8	150	18.8	8	30	17.8
Sn	mg/kg	-	1	5	1.7	1	4	2
Mo	mg/kg	-	0.6	3	0.73	0.6	1	0.68
Ag	mg/kg	-	0.03	0.2	0.07	0.03	0.08	0.04
Cu	mg/kg	3*	5	60	14.7	5	30	14.4
Zn	mg/kg	23*	20	300	47.9	20	150	60
Sb	mg/kg	4.5	30	40	35	30	30	30
W	mg/kg	-	2	10	4.5	3	5	3.8
Bi	mg/kg	-	0.3	2	0.54	0.3	0.7	0.42
Ni	mg/kg	4*	7	40	14.5	8	50	17.5
Co	mg/kg	5*	0.6	20	6.4	1	20	8.9
Cr	mg/kg	6*	10	70	31.6	15	100	37.4
V	mg/kg	150	30	150	59.4	30	150	68.5
Mn	mg/kg	1500	100	700	335	100	600	328
Ti	mg/kg	-	700	4000	1362	700	4000	1468
P	mg/kg	-	300	2000	679	300	1500	649
Hg	mg/kg	2.1	0.03	0.05	0.04	0.02	0.03	0.02

Fe	mg/kg	-	1.5	4	2.23	2	5	2.68
Ca	mg/kg	-	0.3	4	1.12	0.3	3	1.16
Na	mg/kg	-	0.2	3	1.13	0.4	4	1.62
Mg	mg/kg	-	0.1	2	0.34	0.1	3	0.37
Si	mg/kg	-	5	40	21.1	5	40	24.75
Al	mg/kg	-	3	11	5.4	3	11	5.88
K	mg/kg	-	0.3	3	1.51	0.5	4	2.03
Oil prod.	Mg/kg	-	0.04	0.15	0.1	0.02	0.04	0.03

*MAC is defined for mobile form

Besides, the **content of the mobile forms** of the elements was defined to determine the provision of the plants to available elements. The analytical results showed:

- all soils of the study area are unsaturated by bases (11 – 42 mg-equiv./100 g);
- all soils are provided with humus (~12-14%). The humus content is typical for waterlogged areas with peat sediments;
- none of the soil types contain mobile phosphorus, with the exception of the valley of Saikta Stream.
- the presence of mobile potassium is not homogeneous, ranging from 58.2 to 240 mg/kg.
- low concentration of manganese – average concentration is 7.28 mg/kg;
- very low concentration of molybdenum – average concentration 0.013 mg/kg;
- low concentration of cobalt – average concentration 1.05 mg/kg, with the exception of the site in the valley of Saikta Stream, where the mobile cobalt content is 2.0 mg/kg;
- average concentration of mobile boron is 0.12 mg/kg;
- variable concentrations of copper, with copper content being very low in the mountain-tundra raw soil (<0.9 mg/kg) to average (2.1-4.0 mg/kg) on the slopes with mountain-taiga peat-gley soil, and high in the valleys of the River Kuranah and Saikta stream;
- zinc concentration ranges from 0.8-2.0 mg/kg for the mountain-tundra raw soil to >4.0 mg/kg for other areas.

The results of the work conducted show that the land at the Kuranah deposit site can be characterized by low potential fertility and is of low productivity.

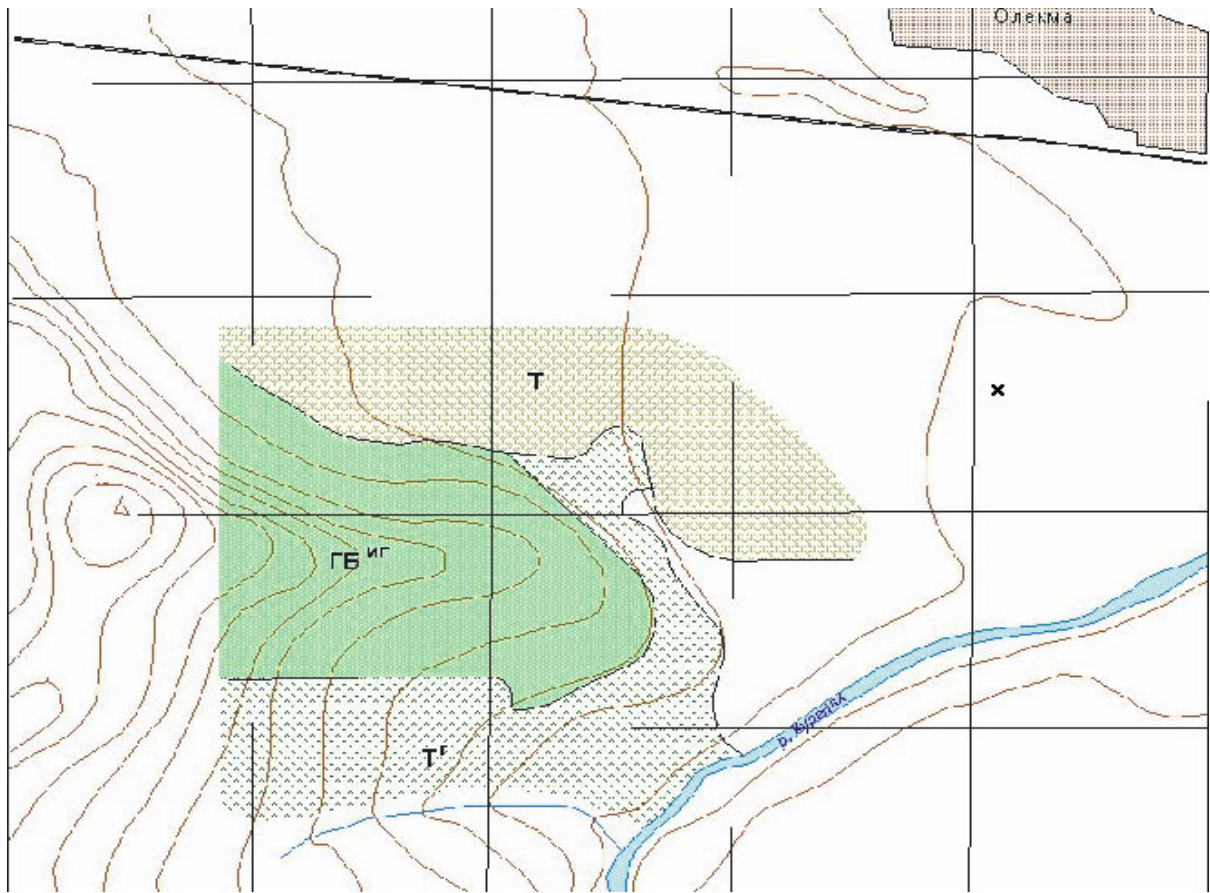
- process plant site, tailings damp and camp

Lithochemical sampling on this area was conducted for a 3 km² area for two horizons (A and B) on a 500 x 250 m grid from 34 sampling points. Samples were analyzed as follows:




- pH and Eh were measured on all samples in the field, and also laboratory spectral semi-quantitative analysis was conducted for 44 elements;
- 3 samples of the A horizon were analyzed for organic carbon and cation-exchange capacity;
- 5 samples were analyzed for the mobile forms of 72 elements.

The soils of the study area are characterised by three types: mountain brown-taiga alluvial-gley soils, peat-gley soils and peat soils (on the north and north-east part of the site) (Figure 13).

Figure 13. Soil types on the process plant and camp site



Legend

	mountain-brown-taiga alluvial-gley soils
	Peaty and peaty-gley soils
	Peaty soils

The analytical results for total contents of chemicals are presented in Table 4.28.

The whole area is characterized by acid conditions (pH ranges from 4.6 to 5.3), changing gradually from one horizon the next. The average redox potential does not exceed + 250 mV. The area with oxidizing conditions occurs as a narrow strip along the bottom of the slope. There are processes of acid gley leaching in the area, with cations strongly removed from the alluvial sediments.

All the land in the study area is frozen and characterized by a very small thickness of humus top soil (average thickness 5cm), the presence of peat, and a humus content of 5-14%. Fine-grained sands prevail in the humus horizon, and rarely there are marshy loam and peat loam.

On the peat sites, the upper horizon is formed by peat with a thickness to 0.6 metres with marshy loamy soil and vegetation residue on the bottom. The high humus content is typical for peat (lowland peat-gley soils) and waterlogged lands with peat sediments.

The average thickness of the sampled alluvial layer is 10 cm. The horizon consists of sand and coarse sand, loamy soil with coarse sand and clay sand, and seldom – peat loamy soil.

Table 4.28 Total content of the elements

Element	Unit	Russian MAC	max	min	average	max	min	average
			A horizon			B horizon		
Pb	mg/kg	32	30	10	19.71	30.00	10.00	24.26
Sn	mg/kg	-	5	2	3.32	5.00	2.00	3.59
Mo	mg/kg	-	2	0.7	1.19	2.00	0.70	1.12
Ag	mg/kg	-	0.5	0.03	0.10	0.15	0.03	0.06
Cu	mg/kg	3*	50	10	20.74	50.00	10.00	22.50
Zn	mg/kg	23*	100	1	27.68	100.00	1.00	46.65
W	mg/kg	-	8	0.75	2.23	5.00	0.75	1.63
Bi	mg/kg	-	3	0.4	0.81	3.00	0.40	0.66
Ni	mg/kg	4*	30	10	15.15	30.00	7.00	21.68
Co	mg/kg	5*	7	1	3.91	10.00	0.60	6.05
Cr	mg/kg	6*	50	15	29.26	50.00	10.00	37.94
V	mg/kg	150	100	30	61.18	100	30	77.06
Mn	mg/kg	1500	400	100	197.06	400	100	219.12
Ti	mg/kg	-	4000	700	1688.24	3000	500	1838.24
P	mg/kg	-	4000	300	1023.53	2000	300	850.00
Ge	mg/kg	-	1.5	0.5	0.77	1.5	0.5	0.93
Sc	mg/kg	-	10	2	3.85	7	2	3.71
Ga	mg/kg	-	60	8	27.38	40	5	28.38
Be	mg/kg	-	7	0.5	1.50	4	0.5	1.01
Ba	mg/kg	-	500	300	388.24	500	300	344.12
Zr	mg/kg	-	300	80	148.82	200	80	123.24
Y	mg/kg	-	50	7	19.12	30	8	18.03
La	mg/kg	-	80	10	22.94	50	10	21.47
Ce	mg/kg	-	70	25	35.15	50	25	36.03
Li	mg/kg	-	30	10	15.44	50	10	26.62
B	mg/kg	-	30	7	15.41	30	7	19.21
Sr	mg/kg	-	100	15	64.85	150	20	51.47
Fe	%	-	4	0.2	2.27	5	1.5	3.21
Ca	%	-	1.5	0.2	0.83	1.5	0.2	0.70
Na	%	-	4	0.3	2.39	4	0.1	2.86
Mg	%	-	0.8	0.1	0.34	0.8	0.2	0.42
Si	%	-	30	24	27.53	3	2.4	2.86
Al	%	-	8	5	7.03	8	5	6.85
K	%	-	4	0.5	2.31	5	0.68	2.63

*MAC is defined for mobile forms

The analytical results **for the mobile forms** of elements showed:

- none of the soil types contain mobile phosphorus (less than 100 mg/kg),
- concentration of mobile potassium changes from 21.4 to 108 mg/kg;
- low concentration of manganese – up to 11.7 mg/kg;
- low concentration of molybdenum - < 0.1 mg/kg;
- low concentration of cobalt - 0.05-0.16 mg/kg;
- low concentration of boron - <1 mg/kg;

- low concentration of copper - <0.06 – 0.2 mg/kg;
- concentration of zinc is from 2.57 to 0.68 mg/kg.

The results of the work conducted show that the land at the process plant site can be characterized by low potential fertility and is of low productivity.

4.12. Flora

The east part of Russia is a zone of wild coniferous forests, with the presence of deciduous species, which changes to arctic flora at the north of Yakutia. The area of forest in Amur oblast is 30.5 million ha, that is about half of the Amur oblast area. The percentage of forest land decreases from north to south. Marsh lands are also prevalent, particularly because of the permafrost. The vegetation of the Amur region is boreal (relating to the forest areas of the northern North Temperate Zone, dominated by coniferous trees) and includes elements of Eastern Siberian, Okhotsky-Kamchatsky, Manchurian and Dahurian flora, totaling around a thousand species of vascular plants. Around the oblast, the vegetation is situated in zones; in mountain districts the zoning is vertical.

Amur oblast forests are primarily Dahurian larch (60 %), together with broadleaved species such as birch and aspen (22.3 %), Japanese stone pine (5.7 %), Siberian spruce (*Picea obovata*) and East Siberian fir (*Abies nephrolepis*) (2.3 %), and other broadleaved species (2.1 %). Mountain larch usually occurs in pure stands, occasionally interspersed with small stands of Japanese stone pine. Larch forests in the foothills and valleys grow with smaller bushes such as rhododendron, foxberry (*Vaccinium vitis-idaea*), and Labrador tea (*Ledum*), or grow as mari (sparse larch forest and marsh-land). Broadleaved species grow in mountain valleys. Silver birch and aspen regenerate on land burned by forest fires or after logging. Fir and spruce forests have a very limited distribution and grow with moss, sedge and foxberry. Japanese stone pine, mountain mosses and tundra lichen (*goltsi*) cover the highest mountain slopes (15).

The majority of the project area is covered by mountain taiga forest. The forest is light as the trees do not grow very close together, and almost everywhere the trees are not tall and their development is suppressed by permafrost. Many sites are rehabilitating naturally after fire or previous disturbance. The main species are Dahurian larch, birch, which is mainly present on disturbed sites, and mountain pine. Additional species are Archangel fir, alder-tree and others. Bushes such as Arctic birch, Labrador tea and great bilberry are prevalent. Bluejoint (*Calamagrostis*), green mosses and shrubby lichen prevail on the surface. There are pigweeds and marshes on the low lands (9). Many sites are waterlogged.

There are a lot of berries over this area – foxberry, cranberry, blueberry, bilberry, honeysuckle, currant, raspberry, cloudberry.

In accordance with the reference from the Far East Department of the Russian Academy of Science (botanical gardens directorate, letter № 3283/04-16) the flora of the project site are not diverse or site specific. The reference says that many sites are impacted by the activity of people, and the degree of impact increases approaching the Baikal-Amur railroad and settlement.

The Imangra botanic reserve area is located on the western boundary of the project area. This reserve area was established in 2002, after the company Olekminskiy Rudnik had been granted a licence for mine development. The Imangra reserve area was created to protect and conserve:

- mountain ecosystems;
- ecosystems of upper courses of mountain rivers and streams with fragments of mountain and forb meadows (meadow with many species of grass), mountain and valley forests;
- fauna of outcrops.

Most of the protected species in Imangra are mountain species and they are weakly represented in other reserve areas of Amur oblast. It is of note that on the reserve area, close to

the proposed mine site, the only in Amur oblast grove of Siberian cedar (*Pinus sibirica*) is found.

Two flora species registered in the Red Book of Amur oblast were found on the study area: *Lilium Pennsylvanicum* Ker-Gawl and *Rhododendron Dauricum* L. Data in the literature show that three other protected flora species can be encountered: *Gastrolychnis saxatilis* Peschkova, *Iris Laevigata* Fisch and *Rhodiola rosea* L. *Rhododendron Dauricum* L is a mass species and occupies about 1 % of project area, or about 5 ha. The quantity of the other protected species is not large.

4.13. Wildlife

The climatic conditions, the geographical location of Amur oblast and the presence of vast areas of undisturbed forest define the diversity of wildlife. In total, at 31 December 2002, 64 mammal species, 326 bird species, 10 reptile species, 7 amphibian species and 68 fish species inhabited the Amur oblast (received from official web-site of Amur oblast Administration). The most studied group of wildlife is the mammals.

Most of the species are hunted. The most important species for hunting are ungulate animals – elk, roe deer, Manchurian deer, wild boar, bear, and fur-covered animals – sable, Siberian weasel, fox, lynx (17).

The data on the fauna of the project area are derived from the conclusion of the Far East branch of the All-Russian Scientific Research Institute of Hunting and Animal Breeding (9) (VNII), and concern mostly game animals and birds. In its turn VNII used official and literature sources and material from the Hunting Office of Amur oblast for the winter calculation of game animals in the Tundinskiy district in 2005.

According to their conclusions, the project area constitutes habitat for wolf, fox, bear, bobcat, sable, weasel, ermine, Siberian weasel, otter, glutton, mountain hare, chipmunk, flying squirrel, squirrel, musk-deer, roe, elk, Manchurian deer, wild north deer, hazel grouse, willow grouse, partridge, and wood-grouse.

Besides the species listed, it is possible to find badger, black-capped marmot and black grouse, but there is no reliable information on these species. In the floodplain of the River Kuranah, when there is no snow, it is possible to find waterfowl (merganser, teal) and sandpiper. Table 4.29 presents the population density for game animals based on the winter calculation in 2005.

Table 4.29. Population density of game animals

Species	Population density per 1000 ha
Sable	1.28
Squirrel	5.85
Siberian weasel	0.74
Ermine	0.71
Mountain hare	1.88
Fox	0.26
Wolf	0.07
Bobcat	0.01
Glutton	0.003
Elk	0.48
Manchurian deer	0.49
Roe	0.23
Musk-deer	0.27
Hazel grouse	33.12
Partridge	36.78
Black grouse	10.40
Wood-grouse	6.08

Among the listed species:

- sable, squirrel, elk and north deer have the greatest economic value for hunters;
- sable is a prevalent species. The best habitat for sable is dark coniferous forest with a touch of hardwood. In larch forest, the population density of sable is lower. Sable hunting forms the basis of hunting in the region and has great importance for the indigenous people of the North.
- squirrel is the second most important fur-covered animal, traditional for the economy of the indigenous people;
- elk and wild north deer are typical species of the Amur region;
- Manchurian deer, roe and otter can sometimes be found in the region.

According to information from VNII, other species besides game animals inhabit the zone of the proposed project (about 200 species), including rare and protected species, and several amphibious and reptile species. The population density of small perching birds is approximately 100 individuals per 1000 ha in mountain districts (altitude of greater than 500 meters above sea level), and up to 250 individuals per 1000 ha in the river valleys.

There are no important sites for seasonal concentrations of animals or large seasonal migration habits.

In accordance with information from VNII, the following rare protected species can be found on the area of the proposed project:

- Black stork (*Ciconia nigra*) (The Red Book of Russian Federation, SITES);
- golden eagle (The Red Book of Russian Federation, SITES);
- peregrin (The Red Book of Russian Federation);
- little curlew (*Numenius minutus*) (The Red Book of Russian Federation);
- solitary snipe (Attachment to The Red Book of Russian Federation).

There are no data concerning the numbers of these species and, according to available information, other rare and protected species are absent on the area of the proposed project.

4.14. Aquatic biology

The River Kuranah, the main watercourse of the project area, has characteristics of both a mountain and a lowland river, and its tributaries are mountain streams. The river bottom is rocky, and aquatic vegetation is almost absent. The river and streams freeze completely right to the bottom during the cold season, and seasonal migration of fish is typical for watercourses like this.

A specific fish investigation was not conducted for the project area, but forecasts made based on similar watercourses in Amur oblast by a specialist organization (Zeyskiy conservation area) (20) showed that such watercourses are of low importance for fish production.

Seasonally, the lower reaches of the River Kuranah are a habitat and place of fattening for young lenok and grayling. Also it is possible to find minnow, pike and barbot (eel-pot). In Autumn, with a decrease in the water level and the beginning of icy conditions, fish go downstream to the spawning grounds and return later in spring.

4.15. Reserve areas

Up to the present time, forty natural reserve areas of different status have been established in Amur oblast. Information about the natural reserve areas of Amur oblast is included in Attachment 5 (scheme of natural reserve areas of Amur oblast). The total area of reserve areas in Amur oblast in February 2004 was 3 483 808 ha or 9.6 % of the Amur oblast area.

A botanic reserve area named "Imangra" is located in close proximity to the proposed project site. The reserve area was created by decree of the Chief of Administration of Amur oblast 13/06/2002 on the territory of Nyukzhinskiy forest of the Tundinskiy district in the head

rivers Imangra and Yus-Kuel. The reserve covers a general area of 250 000 ha. Protected ecosystems were discussed above.

A section of the eastern boundary of the Imangra reserve area follows the River Kuranah to the confluence with Arbagastar Stream, and then upstream of Arbagastar Stream to the source of the river.

The western part of the licensed mining area (the area within which work is permitted in accordance with the mining licence) occupies the reserve area. However the following circumstances apply:

- the reserve area was created on 12.06.2002, after “Olekminskiy Rudnik” had been granted its mining licence (mining licence was granted 25.06.01);
- the statute of the reserve area says that the particular status of the area does not entail requisitioning of the land from forest lands and from land and water users. The statute allows geological survey on the reserve area, and mining is “limited” but not prohibited on this area;
- all designed project components are situated outside the reserve area;

4.16. Social-economic conditions and land use

4.16.1. Amur oblast

In 1991, a reduction in industrial production began in Amur oblast, as well as generally in Russia. Up to 1999, the volume of production decreased more than threefold. Since 1990, during the general decrease in industrial production, there were significant changes in structure and part of the extractive industry essentially increased and now it is about 50 % of general production. Mining of gold, coal and building materials (gravel, sand, kaolin, crushed stone and others) are prevalent. A small quantity of mineral water is also extracted.

The presence of vast forest resources define the role of the forestry industry in the economy of Amur oblast. However in spite of the great resources, wood processing has not developed in oblast. In addition, most of the forests are in districts which are difficult to access, which makes felling and further processing more difficult.

Agriculture represents 15% of production in the oblast economy. It comes mainly from the allotments of residents (about 60 %), agricultural enterprises contribute 35 % and farms contribute 5 %. In general agriculture is profitable, but cattle breeding remains unprofitable. The oblast grows grains (rye, wheat, oats), potato and other vegetables, and it is a leader in growing soy and produces about 60-65% of all Russian production.

Because of the features of the territory, the transport system plays an important role in the oblast's economy. The large territory of the oblast is accessed by a network of railroads which, in 2002, covered 3,295 km. Trans-Siberian railroad and Baikal-Amur railroad go through the oblast and they have spare capacity.

The population of the oblast on 1st January 2002 was 989 800 people, with 64.7% of the population living in cities. The population density is 2.7 people per km². Currently the demographical situation in the oblast is characterized by decreasing living standards, worsening of the population's health, high death rate, and major migration of population away to other regions. Since 1982 there has been a constant decrease in the birthrate. In general, between 1992 and 2002 the population of the oblast decreased by 85 000 people (8 %). Migration processes impact a lot on the population. Between 1992 and 2001, the oblast lost more than 63 000 people as a result of migration out of the oblast.

4.16.2. Tundinskiy district

Tundinskiy district is located in the north-west part of Amur oblast. The area of Tundinskiy district is 83 300 km², that is almost twenty percent of the Amur oblast. There are 23 settlements in the district, located mainly along the Baikal-Amur Railroad.

The district centre is the town of Tunda, located 430 km south-east of the Kuranah deposit site. According to a reference of Tundinskiy inter-district office of state statistics, on 1 January 2004, 39 900 people lived in the town of Tunda, and the population of the remainder of Tundinskiy district was 16 600 people. The population density of Tundinskiy district is less than 1.5 per square kilometre, including the town of Tunda. During the last 10 years, the population of the district decreased significantly, as for Amur oblast overall.

The town of Tunda is a big transport centre in the north-west of the Amur oblast, being most important for transportation of goods. Railways Tayshet – Urgal (approximate length 4,300 km) and Baikal-Amur Railroad cross here (see Figure 3 in Introduction). In addition, there are roads connecting Tunda with the nearest towns:

- Scovorodino (175 km) and Mogoichi of Chita oblast to the south-west;
- Nerungry (228 km) and Aldan (478 km) of the Republic of Saha (Yakutia) to the north;
- Shimanovskiy and Zeya to the south east.

Boats are used on the River Olekma to the town of Olekminsk, located on the left bank of river Lena.

Tundinskiy district is one of the main industrial districts of Amur oblast. Transport, logging, gold mining and the building industry form the basis of the economy. As for all Amur oblast, extractive industry is the main component in the economy of the district. During the last three years, there have been positive moves for industrial development in the district.

The district is rich in natural resources. Many iron ore deposits are situated in this area (Kalarskoye, Hyukzhinskoye, Larbinskoye, Horogochinskaya and Burpalinskaya zones), Urusha-Oldoyskiy molybdenum region, gold-bearing areas (Kirovskiy, Bamskiy, Nyukzhinskiy, Solovyevskiy and others), Elkaganskiy coal deposit site, ore zones of tungsten, silver, limestone, apatite and others.

There are mineral water deposits in the district, the Maluy Elgakan deposit of carbonic hydro-carbonate Mg-Na-Ca water with mineralization 1.6–3.4 g/l, and the Injuk deposit of carbonic hydro-carbonate Na-Mg water with mineralization up to 6.1 g/l.

4.16.3. Olekma Settlement

The nearest and the only settlement within a radius of 50 km from the deposit site is the settlement of Olekma. The settlement was established in 1980 as a station settlement for Olekma Station on the Baikal-Amur Railroad.

According to a reference of the Administration of Tundinskiy district, on 1 January 2006 there were 517 people in Olekma, including:

- railroad workers - 164 people;
- employees of state organizations - 46 people;
- unemployed – 56 people;
- pensioners – 52 people;
- children (under 18) - 125 people;
- number of families with children - 82

At the settlement there are a boiler, medical service, post office, school, library, kindergarten, and bakery. Water from the River Hani is used for technical needs, ground water from the water supply point is used for domestic-drinking needs (5). Housing in Olekma comprises ten 3-storey buildings, and almost every family has allotments close to the settlement or in the area around Olekma.

4.16.4. Indigenous people

According to the All-Russia census in 2002, the population of indigenous people in Amur oblast was 1,501 people (0.2 % of the total population of oblast), including 700 men and 801 women. All indigenous people in Amur oblast are Evenk. Traditionally the main occupations of

Evenks are deer farming and hunting. Evenks live around East Siberia and the Far East of Russia. The demographic situation is that the population of Evenks has decreased by 15 % during the last 10 years. The main reason for the decrease is a high death rate because of accidents and illness.

According to the official web-site of the Administration of Amur oblast, the population of indigenous people in Amur oblast in January 2005 was 1,269 people, including 32.2 % children under 16, 61.8 % - of able-bodied age (from 16 till 55 for women and 60 for men) and 5.9% of elder age.

The main employment for the indigenous people nowadays is the traditional areas of deer farming and hunting, which are the main sources of income. Indigenous people are also involved with state organizations, settlement authorities, industrial enterprises and the service industries. In 2004 (according to the Labor offices of the regional Administrations), 441 indigenous people were employed, that was 59 % of the total number of indigenous people in the able-bodied age group. Therefore, 41 % of able-bodied age indigenous people remain unemployed.

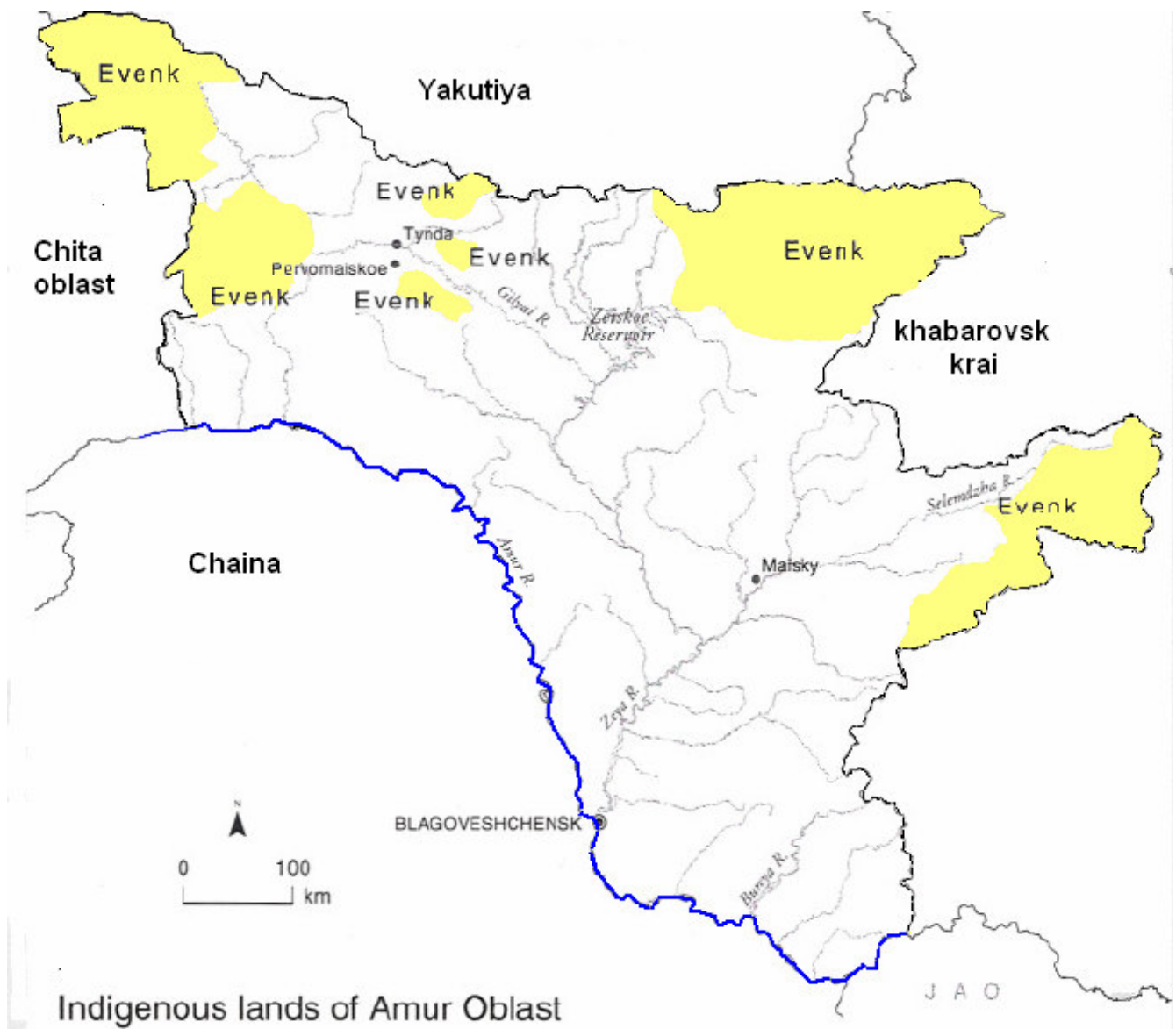
In Amur oblast indigenous people live in the settlements of Bomnak (Zeyskiy district), Ivanovskoye (Selemzhinskiy district), Pervomayskoye, Ust-Nyukzha and Ust-Urikma (Tundinskiy district). According to book "The Russian Far East" (15) a small group of indigenous people lives in the settlement of Mayskoye in the Mazanovskiy district. At present, nine official tribal communities are registered in Amur oblast. The places where Evenks live are shown on Figures 14 and 15.

The nearest settlement to the Kuranah deposit site with an indigenous population is Ust-Nyukzha, located 70 km south-east of the deposit site. According to a reference of the Administration of Tundinskiy district, 634 people, including 352 Evenks live in Ust-Nyukzha. Evenks work in the "Nyukzha" collective farm, located in the settlement Ust-Nyukzha.

The Kuranah deposit site is located on an area which is used by indigenous people. The Imangra natural reserve area, bordering with the licensed area of the Kuranah deposit site, and the adjacent territory are used as a deer pastures and hunting grounds by "Nyukzha" collective farm. The potential for indigenous people to use the Imangra area is identified by the statute of the reserve area.

Calculations of the losses for hunting due to mining were performed as part of the conclusion of the Far East branch of the All-Russian Scientific Research Institute of Hunting and Animal Breeding, representing estimated assumed monetary losses for hunting according to the state rate. Losses for spoiling and requisitioning of deer pastures were estimated by the Tundinskiy Committee on land resources and organization of land use (official letter № 69 20.09.2004). More detailed information will be given in the chapter on environmental assessment.

Figure 14. Places Inhabited by Evenks in Amur oblast¹⁰



¹⁰ The Russian Far East, 2nd edition, Josh Newell, Published by Daniel & Daniel, California 2004.

Figure 15. Settlements of the Tundinskiy district¹¹



4.16.5. Land use

The project area is located on the land of Nyukzhinskiy forestry and, accordingly, all the land is forest land.

In addition, the “Nyukzha” collective farm has a right to use this area for grazing and hunting.

The area and border of the Nyukzha collective farm hunting area are defined by the Amur oblast Administration Resolution of 04.11.96 № 530. According to this resolution, a total hunting ground of 2.200 million ha has been given to the collective farm for a period of 10 years, that is, until 4 November 2006. This area occupies a large part of the Tundinskiy district and the project area is within the hunting ground as a small part of it.

The pasture area of the collective farm was defined by the Amur oblast Administration Resolution of 25.05.1984 № 233. According to this resolution, a total pasture area of 1 933 070 ha has been given to the collective farm for a period of 25 years, that is, until 2009 and the proposed project area occupies a very small part of these pastures.

The route of the Baikal-Amur Railroad comprises transport land, and the user of this land is a subdivision of state company Russian railways.

The area of settlement Olekma comprising the land of settlements and their occupiers is the municipality of “Olekma”.

4.16.6. Cultural heritage

Although native people use the deposit territory as their hunting ground, there is no evidence of historic settlements in this area. According to official letter of Department of culture of the Administration of Amur oblast, there are no historical and cultural objects on the area of

¹¹ Official web-site of the Tundinskiy district <http://www.tynda.net/>

deposit site as well as objects of cultural heritage. Nevertheless, Department notices, that final conclusion about absence of cultural and historical objects can be made after the special archeological investigation.

4.16.7. Public consultation process

The requirements of the World Bank and available information regarding baseline conditions showed it was necessary to begin a public consultation process at the earliest stage, to take the initial results of such consultation into account during the environmental impact assessment and to plan appropriate measures in the Environmental Management Plan (EMP). For this purpose, a Public Consultation Plan was developed and the main action of this plan was to hold a public meeting about the proposed mining project. The Public Consultation Plan was developed in March 2006 and is presented in Attachment 6.

In accordance with this Plan, a public meeting was held in Olekma settlement (the nearest settlement to the project site) on 9th April 2006.

Interested parties, identified during a preliminary assessment, were informed about the planned public meeting beforehand. Notification was sent to:

- Administration of Olekma settlement;
- Administration of Tundinskiy district;
- Director of the “Nyukzha” collective farm;
- Television channel “STS” (broadcasting around Amur oblast);

In addition, announcements regarding the planned public meeting were published in the local newspaper “BAM” and posters with information were placed in several places within Olekma settlement.

The public meeting was held in Olekma school. Ninety one people took part in the meeting, including:

Residents of Olekma	58
Representatives of the indigenous people (collective farm Nyulzha)	3
Representatives of the media	3
Representative of the company Aricom	1
Representatives of the company Olekminskiy Rudnik	4
Representatives of the company Peter Hambro Mining	3
Head of the Administration of Tundinskiy district and head of the Department of Natural Resources use	2
Head of Olekma settlement	1
Others	16

Through the social groups:

Unemployed	6
Doctors and teachers	18
Workers	13
Office workers and engineer-technical personnel	47
Pensioners	4
Pressmen	3

Valeriy Alexeev, the representative of the company Olekminskiy Rudnik began the meeting by describing the proposed project. The main issues reported were:

- information that the processing uses only physical methods and there will not be any chemicals in use;
- the need for titanium and its use in different areas of the economy;
- main project proposals and the prospects for it to work with future potential development;
- consumption of water, fuel, electrical energy, railway transport and other resources;
- payments by the company, including taxes;
- the possibility of organising special migration routes for deer;

There were not many questions from the meeting attendees, and the general response to the project was positive. The main questions asked, and the responses, are shown in Table 4.30.

Table 4.30 Main questions asked on the public hearing

№	Question	Answer
1	How much allocation to the budget of the oblast and district will be from the project?	Concrete figures were given.
2	Will there be elevated levels of radioactivity because of the development of the deposit?	No, and this is verified by investigation results.
3	Will the River Kuranah be contaminated?	No chemicals will be used in the process.
4	Is it possible to provide higher education for the young people of Olekma at the expense of company this year and generally?	This will be considered
5	Which specialties does company need now and in future?	Specialties were listed.
6	When will the company's trucks stop driving through the settlement?	It is prohibited and drivers will be fined for driving this way.

After discussion, the general idea of the project was approved by an absolute majority of those present.

After the general meeting, company specialists answered additional questions privately. Those questions mainly concerned education and employment.

Pictures made on the public hearing are available in Attachment 8.

5. PROJECT DESCRIPTION

5.1. Alternatives

5.1.1. Location of the operational units

As for all other mining enterprises, the location of the industrial units for the Kuranah mining and processing operation first of all is defined by the location of the deposit. The location of the ore body and the characteristics of the ore and host rocks have defined the proposed mining method, location of the open pit and scheme of open pit development.

The siting of all the operational units close to the open pit was considered to be the preferable option, but was not proposed because of two main reasons – the complexity of the relief and absence of sufficient area with a flat surface; and the absence of sufficient water required for the ore processing. Nevertheless, the conditions have allowed the preliminary ore concentration (grinding-sorting factory) complex to be placed close to the open pit, which allows a decrease in the flow of traffic, and accordingly allows a decrease impact on the environment. The location of the grinding-sorting factory was determined by the need for its placement on land barren of ore and a relatively flat surface.

The process plant site was chosen 35 km to the north-east of the open pit, 4 km from the existing railway station and settlement at Olekma, because of the following reasons:

- site was large enough to allow all the other necessary units to be included with the process plant;

- presence of a water supply source with sufficient capacity;

- proximity of the rail road (4 km).

The choice of the road route between Olekma station, the process plant site and the mine site was limited by relief, which allowed the road to be placed along the River Kuranah, within its valley.

The homogeneity of the natural conditions over the whole area of the project location and the surrounding area, and the absence of environmentally vulnerable objects, resulted in their being no environmental limits during the selection of the location of the operational units.

5.1.2. Technology

The choice of ore processing technology was defined by the ore characteristics, which allowed to consider only insignificant options for technology in environmental point of view. Besides, the technology proposed and described uses only physical methods, without the addition of any chemicals, and is one of the most environmentally safe.

5.1.3. “Zero option”.

The possibility of not proceeding with the project development (“zero option”) was considered as one of the alternatives. In the event of refusal, there will not be a negative impact on the environment, caused by project development. At the same time, analysis of the background conditions showed the absence of environmentally important and vulnerable receivers on the area of the proposed project location.

On the other hand, social-economic benefits from the project development would also not take place, in the event of refusal. Analysis of the background conditions showed that social-economical development would be beneficial both for the local community (for residents of the nearest settlement) and for the district (Tundinskiy district) and at regional (Amur oblast) levels. Besides, public consultations undertaken showed interest in the project development from the local community, and its support of the project.

5.2. General Provisions

In accordance with project designed by design institute VNIPromtehnology, Kuranah mining will mine ilmenite and titanium-magnetite ores by open-pit method. The planned annual ore production from the pit is 2,400,000 tons, the planned open pit life is 10 years, including pit development and closure. The finished products are titanium-magnetite and ilmenite concentrate.

The project includes the following main and auxiliary units:

- open pit with waste rock dumps;
- grinding-sorting factory;
- storage of explosive materials;
- dry tails dump;
- water supply facilities for open pit and grinding-sorting factory;
- process plant;
- tailings damp for process plant;
- repair and storage facilities;
- motor depot;
- storehouse for combustible-lubricating products with fuel station;
- rain-water treatment plant;
- domestic water treatment plant;
- electric power substations and power lines;
- camp;
- railways and roads;
- water intake facilities for the camp and process plant;
- internal engineering services.

The operational units of the project are divided between two sites, connected by road – the mine site, which includes the open pit, grinding-sorting factory, explosive materials storage and other auxiliary units; and process plant site, which includes the process plant itself, tailings dump, camp and some auxiliary units. The mining area is connected with the process plant and Olekma station by the road, the construction of which comprises a separate detailed design. External shipments will be carried out by railroad transport. The general location of the operational units is shown in the general plan (Attachment 7).

Position of grinding-sorting factory was chosen 1-1.5 km to the east of the pit. The dump for the dry tails from the factory, and the storehouse for explosive materials, are located 2 km from the factory to the north/north-west. The water intake facilities on the mine site are located in Saikta Stream valley, 2.5 km to the south-east of the factory. The mine site plan is shown on Figure 16.

The process plant site is located 35 km to the north-east of the pit (4 km from Olekma), on the watershed of Hany and Kuranah rivers. The tailings dump for wet tails of the process plant is located 0.5-1 km down gradient, to the south of the plant. Auxiliary facilities (stores, motor depot etc.) are projected to be placed to the east of the plant and to form united site with process plant. The camp is placed at walking distance (700 metres) from the concentration plant, taking account of prevailing wind direction in its positioning. The process plant site is shown on Figure 17.

The electric power substation will be placed 1 km to the west of the process plant, near an existing 220 V power line.

Domestic water treatment facilities for the concentration plant and camp will be placed 300 and 400 meters away from the plant and camp respectively. They are also placed down gradient to allow collection of domestic drainage by gravity flow.

Water intake facilities for the process plant and camp will be located 2 km to the north-west of Olekma station in the floodplain of Hany river.

Figure 16 Mine site plan

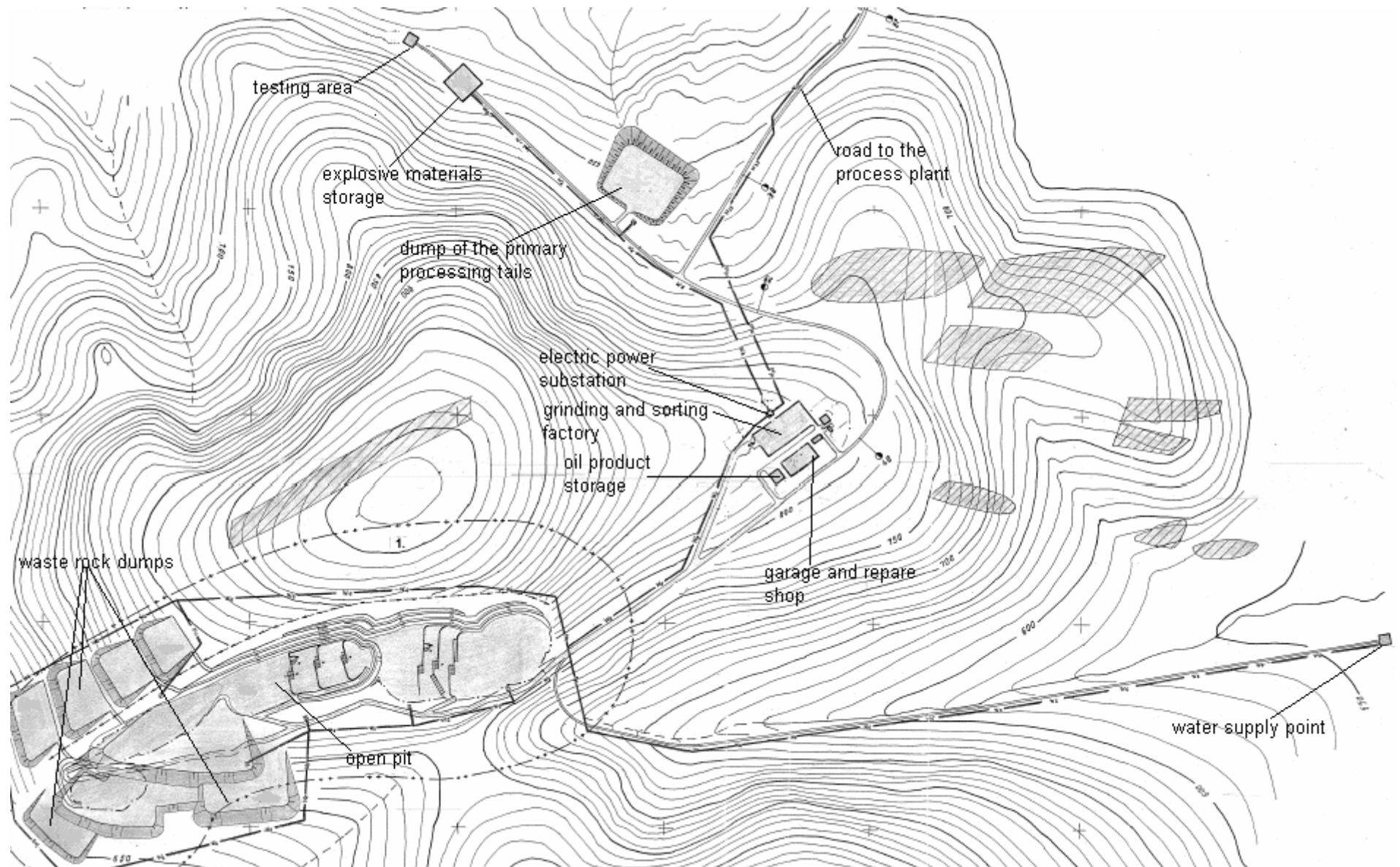
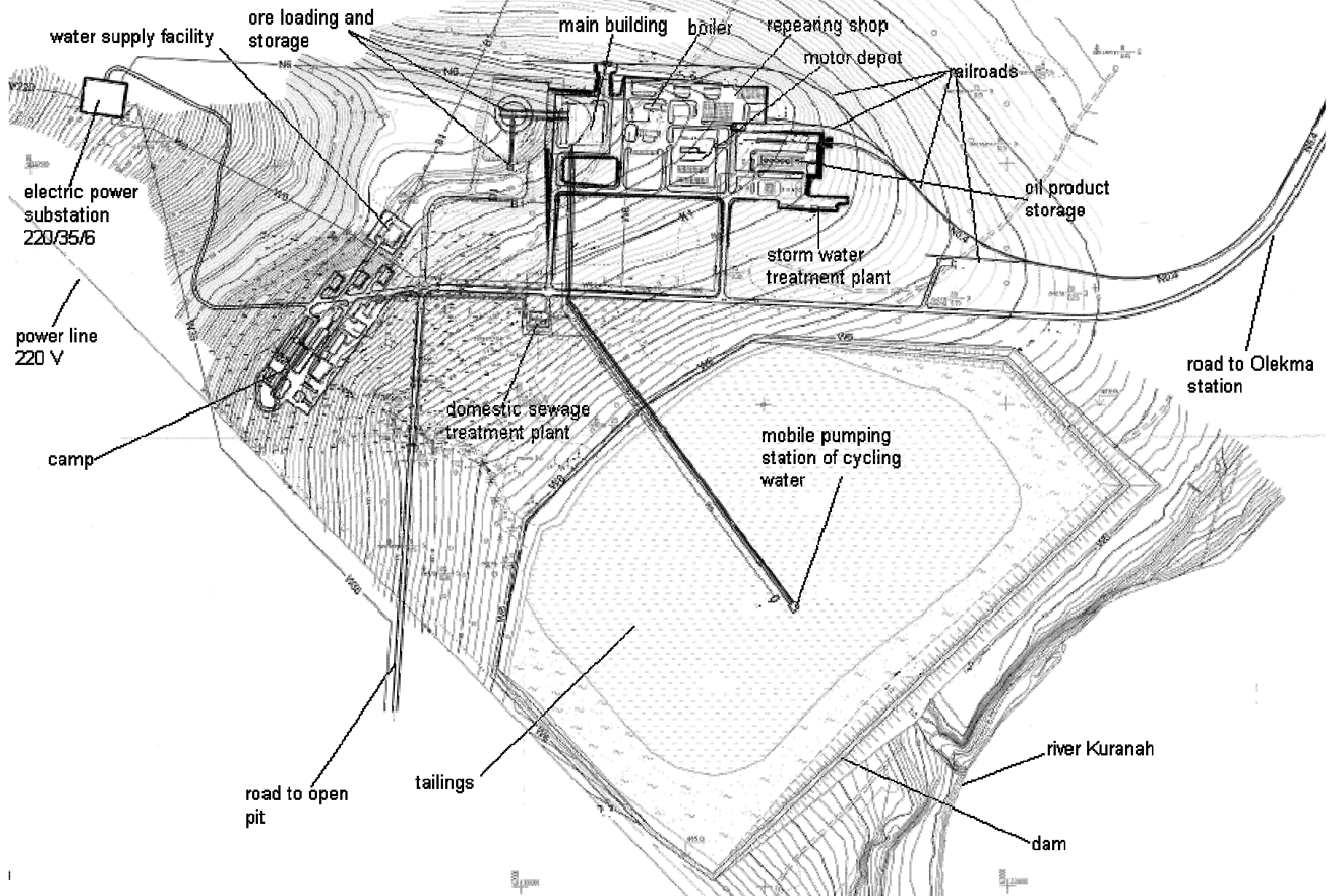


Figure 17 Plan of the process plant site



5.3. Raw materials source

The Kuranah deposit site was investigated for more than 20 years, with several breaks. From 1987 to 2004, about 4300 m of exploration drilling were bored and about 42700 m³ of trenches were excavated. In addition, geophysical and geochemical exploration were performed.

Besides the Kuranah deposit site, the Kuranahore basin also includes the Arbagastar ore body (600-700 meters to the north of the Kuranah deposit site) and Saikta ore body (2.2 kilometers to the north-east of the site).

The Kuranah project is based on the following geological data, calculated for the Kuranah deposit site in report (5), in accordance with the Russian methodology for the estimation of reserves as shown in Table 5.1:

Table 5.1. Resources of the Kuranah deposit site

Resource category	Ore volume, K m ³	Ore reserves, K tons	Average percentage (%)				Ore mineral resources, K tons			
			TiO ₂	Fe _{total}	Fe _{magn}	V ₂ O ₅	TiO ₂	Fe _{total}	Fe _{magn}	V ₂ O ₅
C ₁	895.4	3056.6	11.57	36.54	22.55	0.43	353.79	1116.97	689.30	13.2
C ₂	5001.6	16252.04	9.83	31.51	19.04	0.39	1597.88	5121.67	3094.55	62.75
C ₁ +C ₂	5896.9	19308.65	10.11	32.31	19.60	0.39	1951.67	6238.64	3783.85	75.95
P ₁	195.1	658.35	10.97	33.05	19.77	0.39	72.24	217.56	130.14	2.60
C ₁ +C ₂ +P ₁		19967	10.13	32.33	19.6	0.39	2023.31	6456.2	3913.99	78.55

5.4. Construction

For the beginning of the construction phase, a temporary camp for the construction workers and a construction base are established near the existing settlement of Olekma. The base will be decommissioned as soon as camp and storage facilities are built at the process plant site.

Before construction of any facilities, site preparation will be conducted, including:

- clearing trees and bushes from sites;

Trees felled on the sites, after removal of branches, will be transported to the temporary construction base for processing by sawing into smaller pieces. The treated wood is used in the construction of the camp and other wooden constructions, and the wood waste is utilized in the boiler.

- Leveling of the sites

Leveling is carried out using bulldozers and excavators, including uprooting of stumps and filling of the remaining holes. Material for filling is excavated from an old open pit, located 4 km to the west of Olekma.

- Transport of project elements

The main project elements for construction which must be delivered first of all are:

- props for electric power lines;
- culverts;
- transformers;

Because of the small thickness of the topsoil, it will not be removed and saved.

5.5. Deposit site development

5.5.1. Deposit site area

The Kuranah deposit site will be worked to ensure an annual production of 2,400,000 tons of ore for processing at the concentration plants. The open pit life is 10 years. The project

development requires about 540 hectares in total, including 253 hectares for the mine site. The mine site plan is presented above.

In Table 5.2, areas are given for different components of the mine area:

Table 5.2. Areas for operational units

Component	Area, hectare
Open pit and refuse tips	210
Dump for the dry tails	18
Grinding-sorting factory	20
Storehouse for explosive materials	5

Total area of the mine site is 253 hectares.

5.5.2. Ore extraction

Extraction of ore will be performed using strip mining technology to mine five-metre high benches, which will require drilling and blasting operations.

The open pit will be located on the slope of Arbagastar mountain.

The open pit has been divided into four sections for reference: South, West, Central and East. The pit length at the surface is 2500 m, and the width is 450 m. The pit sections will be worked in the following sequence: first - South, then West, Central and East. During the working of the pit sections, open worked-out areas will be used for internal dump placement. The worked-out pit plan, with planned dump locations, is shown on Figure 18.

The planned schedule for working the pit sections is shown in Table 5.3.

Table 5.3. Planned schedule for working the pit sections

Pit Section	Years									
	1	2	3	4	5	6	7	8	9	10
South	+									
West	+	+	+							
Central	+	+	+	+	+	+				
East			+	+	+	+	+	+	+	+

The primary equipment for the mining is shown in Table 5.4.

Table 5.4. Primary equipment for the mining

Item	Quantity
Excavator EKG-5A	6
Drilling machine ROC L8	4
Bulldozer CAT-D9N	3
Mix-pump truck for preparation of explosive materials	1
Stemming machine	1
Watering machine BelAZ-7547	2
Electric pump	6

5.5.3. Drilling and blasting operations

Due to the high density and hardness of the rock and ore, raw materials will be loosened using drilling and blasting operations. Since in the warm seasons the drill holes could be partly

flooded, there are three different types of explosive materials that will be used: Granipor (explosive material based on pyroxylin powder) for flooded drill holes during overburden and ore extraction, Igdanit (explosive material based on ammoniacal-saltpeter material and diesel fuel) for dry drill holes during overburden removal, and granulite AC-8B for dry drill holes during ore extraction.

5.5.4. Loading and transportation operations

Raw materials will be excavated by EKG-5A excavators with a bucket capacity of 5 m³, and will be loaded onto BelAZ-75473 dump trucks with a carrying capacity of 45 tons. The waste rock will be transported to dumps and ore will be transported to the grinding-sorting factory. It is planned to use 27 dump trucks for waste rock and ore transportation.

5.5.5. Dump Formation

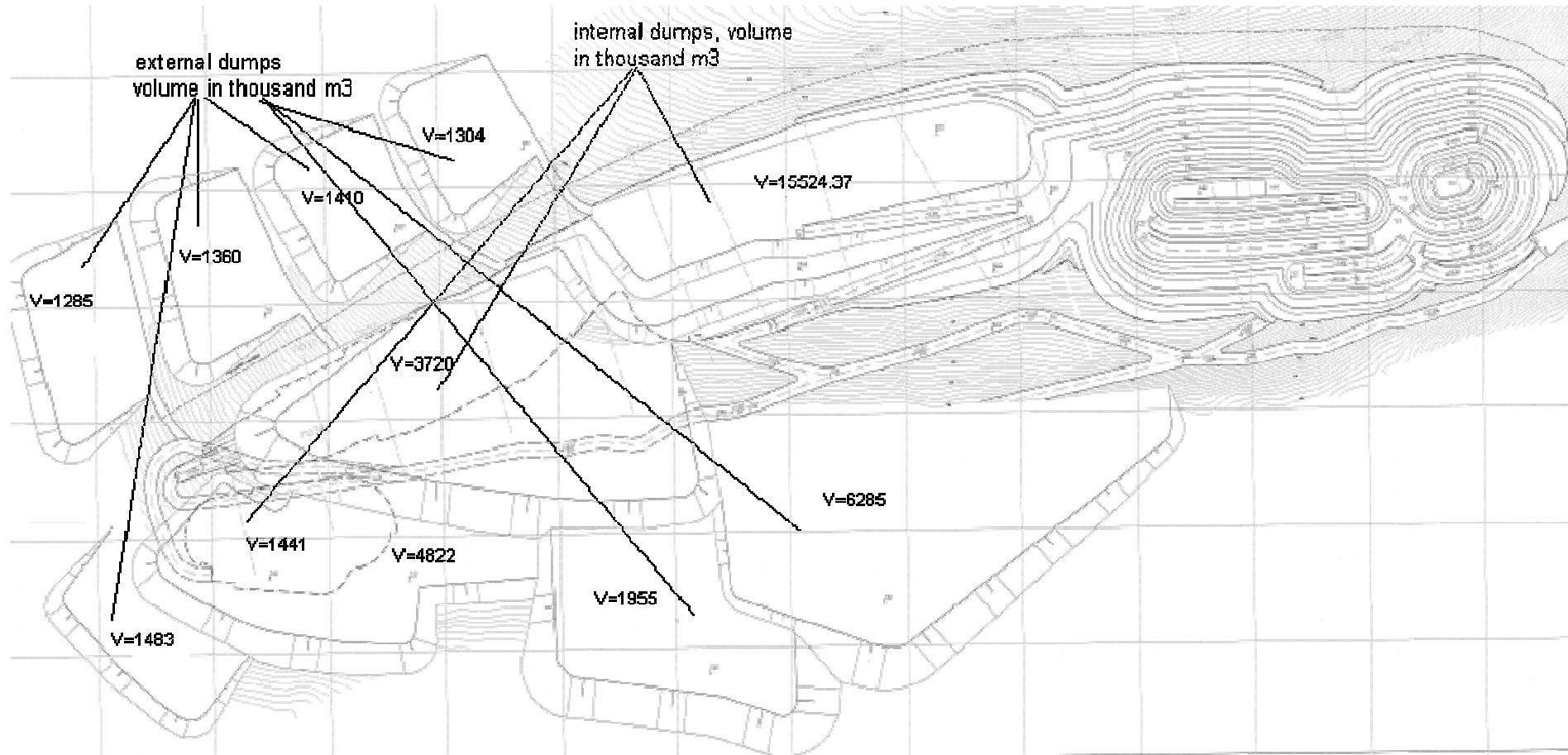
Dump formation will be carried out on a stage-by-stage basis. According to the planned schedule, mining operations will start in the South pit section. Overburden will be taken out to the external dump which is located to the south-west of the pit section. After the South pit section mining is complete, the open worked out area will be filled with overburden and waste rock from the West pit section. As the internal open area is nearing capacity, the external dumps will be used. A similar technique will be used during mining of the other pit sections. Dump layers will be constructed on top of each other, up to a common height of 90 metres. The dump surface will be formed using bulldozers.

The total waste rock dump volume is 48,719,200 m³. Internal dump volume (dumps which are located in the worked out space of the open pit) is 25,200,000 m³, external dump volume (dumps which are located out of the open pit boundaries) is 23,519,200 m³. The area of external dumps is 90 hectares.

The thawing out of the upper layer of permafrost during the spring-summer season, could negatively influence the dump formation process and lead to dump deformation. To prevent this, it is planned to form the primary dump layer during winter, to a height of 5-10 meters. This will keep the base of the dump frozen, and in the warm season dumps will be formed on top of this layer.

The waste rock consists of gabbro (about 45-50 % silica and up to 20 % iron and magnesium oxides) and andesite.

Figure 18. Plan of the open pit and dumps at the end of development



5.5.6. Open pit pumping

The Kuranah deposit site is situated in an area of longstanding permafrost throughout. The thickness of the permafrost body at the Kuranah site is more than 300 metres.

Water inflow to the pit was estimated during hydrological and hydrogeological observations performed at the Kuranah deposit area. (3). It is derived from atmospheric precipitation and underground water. In spite of the presence of permafrost, the inflow of underground water is expected from inter-permafrost water that is under pressure and thawed layers in the warm season. Ground water flow drained by the open pit is estimated to be 34 m³ per hour (3). Only atmospheric precipitation that precipitates directly on to the open pit area will contribute, as a special catch ditch 2600 meters in length is provided by the project along the north border of the pit for interception of surface water flow.

Within the open pit following water quantity will precipitates:

- in case of storm water (1 % probability) – 1200 m³/hour (28,000 m³/day);
- average precipitations in warm season – 21.6 m³/hour (500 m³/day);
- snow thawing – 46.8 m³/hour (1100 m³/day).

Taking ground water into account, following water income is expected for open pit:

- maximum – 1234 m³/hour (28,800 m³/day);
- average in warm season – 55.6 m³/hour (1300 m³/day);
- average during snow thawing – 80.8 m³/hour (1900 m³/day).

For drainage of the daily maximum, there are 6 pumps specified by the project. For drainage of the annual average water inflow, there is 1 pump provided.

Drainage water from the pit is collected in the clarifying pond, where suspended particles and mineral oils are removed, and after that it is discharged to the Yuzhnuy-2 Stream flowing into Arbagastar Stream.

5.5.7. Surface drainage system

For rainwater interception and transport away from the pit, there is a special catch ditch 2600 m in length provided along the north border of the pit. Water from the ditch is discharged to the land surface.

5.6. Concentration operations

5.6.1. General provisions

The potential output of the open pit is 2,400,000 tons of ore annually. Due to the complex relief and high capital investments into railway construction, the following procedure has been selected for ore processing:

- 2,400,000 tons of ore per annum are fed into the grinding-sorting factory, located near the open pit;
- after preliminary processing, 1,650,000 tons per annum are transported by motor transport to the process plant, located 4 km from Olekma railway station.

5.6.2. Grinding-sorting factory (GSF)

The grinding-sorting factory consists of a coarse breaking facility, secondary and fine crushing facility, grinding and separating facility, conveyor lines, five storehouses for different types of ore (-200, -60, -30, -10 mm) and a dry tails dump. The coarse breaking plant is located in a 2-storey building with a general area of about 400 m². The secondary and fine crushing plant, as well as the grinding and separating plant, are located in single-storey buildings with a general area of about 900 m².

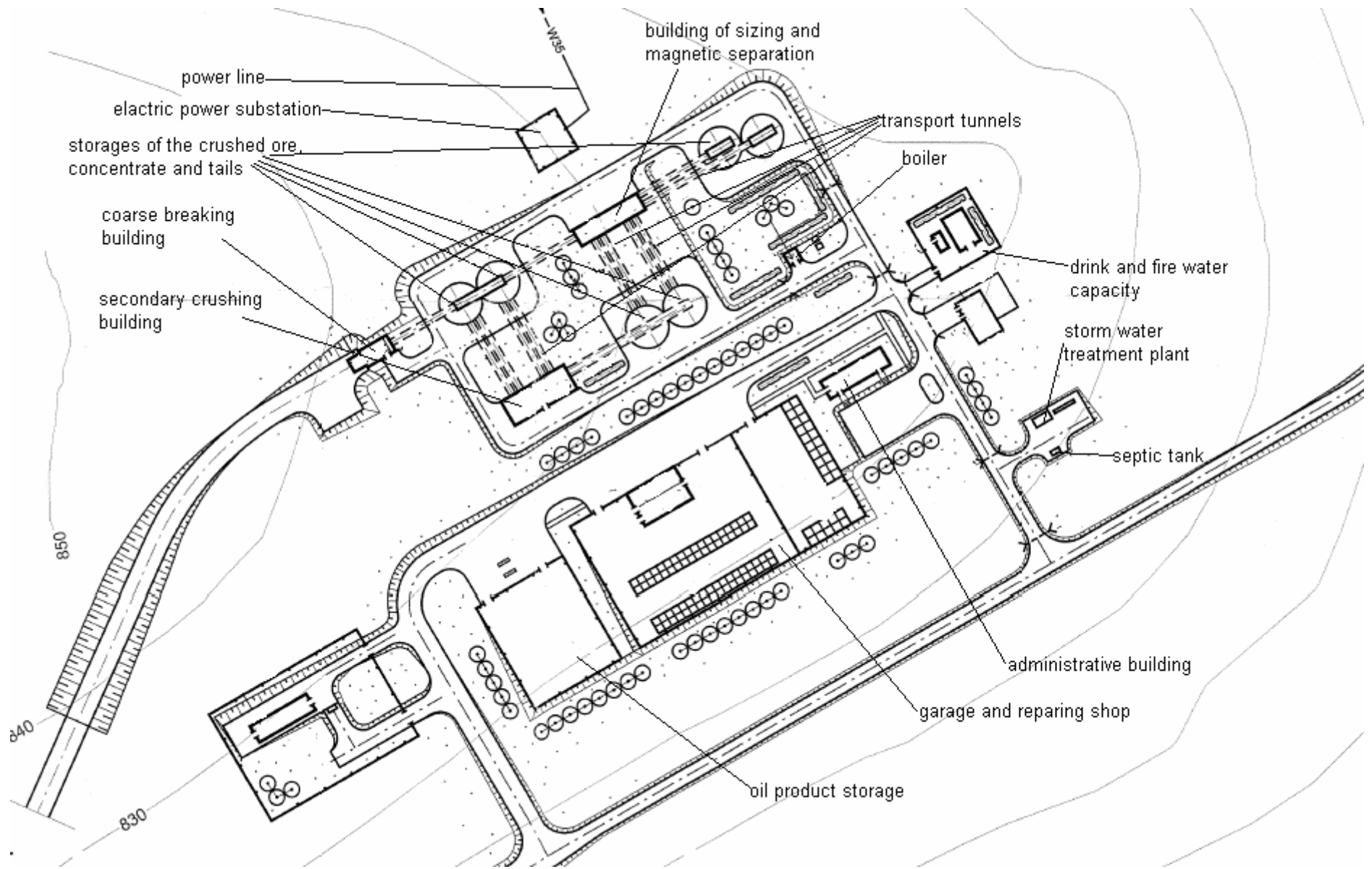
The flowchart for this preliminary ore processing includes the following operations:

- coarse breaking of ore to 220 mm size in a jaw breaker;
- secondary crushing of ore to 60 mm size in a cone crusher;
- grinding of ore to separate 10 mm size ore as a finished product (concentrate);
- fine crushing of ore to 30 mm size in a cone crusher;
- grinding of fine ore to -10 mm size to separate it as a concentrate;
- dry magnetic separation to extract tails in a drum-band separator. Dry magnetic separation is a process of extracting minerals on the basis of their different magnetic properties. Materials attracted to a magnet can be extracted by magnetic separation. Dry magnetic separation is used for preliminary separation, and works with relatively coarse material.

Dry tails from the primary processing are to be placed first in the storage area within the factory site, and then transported to the separate dump.

Besides the processing buildings, there are a garage and repair facility, oil product storage and other auxiliary components on the factory site. The plan of the grinding-sorting factory is shown on Figure 19.

Figure 19 Grinding-sorting factory and auxiliary components



5.6.3. Processing plant

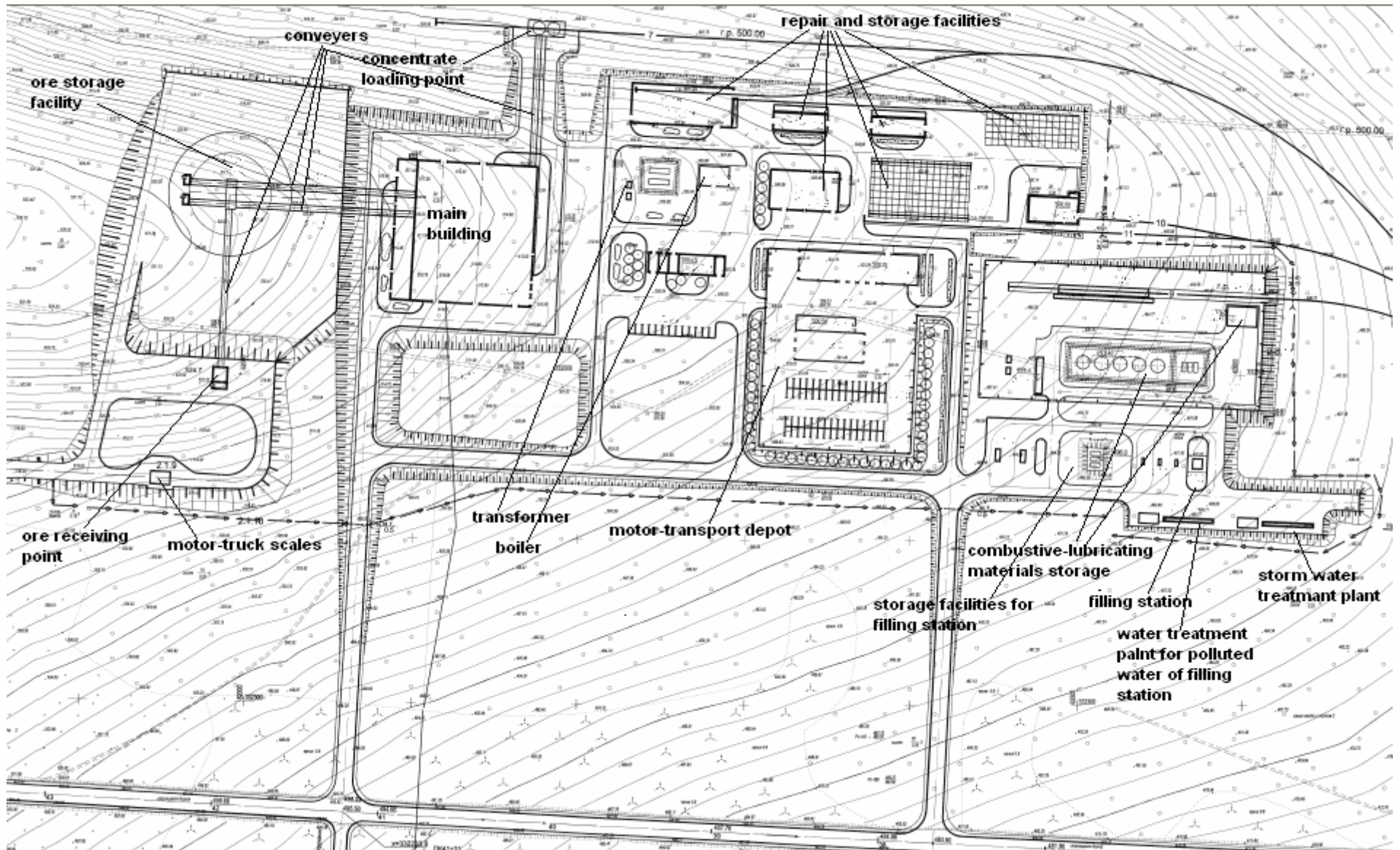
The processing plant site consists of a receiving point with a storage facility, the main processing building, a concentrate loading point, conveyors and pneumatic transportation unit. The receiving point with a storage facility is a 2-storey building constructed from ferroconcrete and metal-work, with a profiled shell plating. The main processing building with office rooms has from one to four storeys in different parts of building, covering a general area of about 7500 m². The concentrate loading point is a hangar with a metal frame, and includes a weighbridge on the railway. Conveyor galleries are located under cover with reinforced concrete underground sections and metal profiles on the overground sections.

Only physical processes are used to obtain concentrate, with no chemicals. The technology includes two main processes – fine grinding and magnetic separation. In contrast to the preliminary processing at the grinding-sorting factory, wet magnetic separation is used for this stage. The flowchart for the production of titanium-magnetite and ilmenite concentrate includes the following operations:

- reception and stocking of ore;
- wet grinding in a ball crusher;
- hydrocyclone separation, sand tails are directed to further size reduction;
- desliming of hydrocyclone discharge in magnetic deslimer with separation of -20 um slimes to tailings damp;
- magnetic separation of deslimed product with cleaning in separators;
- desliming of magnetic product – titanium-magnetite concentrate – in magnetic deslimer with separation of -20 mm slime to tails;
- filtering of titanium-magnetite concentrate by vacuum filter with further drainage at storage. Dehydrated titanium-magnetite concentrate is transported by conveyor belt to the concentrate loading point;
- hydrocyclone processing of non-magnetic product in hydrocyclone units with separation of sands with size 0.3 - 0.15 mm and discharge of size less 0.15 mm;
- separation of hydrocyclone sand tails with size 0.3 - 0.15 mm in spiral locks with double cleaning of product and tails;
- hydrocyclone processing of discharge with size less 0.15 mm in hydrocyclone units with separation of sands with size 0.15 - 0.074 mm and discharge less 0.074;
- concentration of hydrocyclone sand tails with size 0.15 - 0.074 mm;
- desliming of hydrocyclone discharge in magnetic deslimer with separation of less 0.20 mm slimes to tailings damp;
- concentration of hydrocyclone sand tails with size 0.074 - 0.020 mm with double cleaning of product and tails;
- desliming of preliminary ilmenite concentrate in magnetic deslimer. Slimes with size less 0.20 mm are directed to tailings damp;
- filtering of draft ilmenite concentrate in disk vacuum filter;
- drying of filtered concentrate in drum drier. Output gases from the driers are directed to a gas treatment unit, and trapped solid fractions are returned to the technological process;
- control of magnetic separation of dry concentrate. The magnetic product is extracted to the titanium-magnetite concentrate, and non-magnetic products are directed to the final stage of ilmenite concentrate;
- primary electric separation. The conducting product – finished ilmenite concentrate is directed to a bunker via conveyor, and further by pneumatic transport is delivered to the concentrate loading point for loading onto railway vehicles;
- two control electric separations of non-conducting products. Conducting product is returned to magnetic separation, non-conducting product is directed to tailing damps.

Several auxiliary facilities are located on the process plant site. The process plant and other facilities are shown on Figure 20.

Figure 20 Plan of the process plant



5.7. Tailings damp

A tailings damp is planned for wet tails disposal after wet magnetic separation in the process plant.

5.7.1. Construction and location

The tailings dump site is 900x1200 metres in area, and is located on the flat left bank of the River Kuranah, 300 metres from the river. The site is bounded on three sides by a dam wall, and the estimated capacity of the facility is 5.2 million m³; the facility will be filled by pouring tails in.

The tails volume from the concentration plant is 530 000 tons per annum. The ratio of solid to liquid in the pulp is 1:15 by mass. The mineralogical composition of 80% of the tails is quartz and feldspar. Also included are small quantities of amphiboles, garnet, biotite, ilmenite and titanium-magnetite. There are no dangerous or poisonous chemicals in the tails. The pulp temperature at the outlet from the concentration plant is +15-20 °C.

An engineering geology survey has not been conducted at the tailings dam site, and therefore precise specifications for the dam construction are to be completed at the next stage of the project design.

The tailings dump site is located on permafrost ground, which can become unstable during thawing in the warm season. Dam construction will be undertaken with permafrost in place. To achieve this, the base of the dam wall will be constructed in winter to ensure the ground under the dam is frozen. The subsequent layers will also be placed taking the permafrost conditions into account. The project designers consider that it is necessary to involve permafrost experts at the next stage of the project design.

It is assumed that there will not be seepage through the dam because it will be frozen.

Overburden and rocks from the quarry which is 6 km from the tailings dam site will be used for dam construction. The dam core will be formed from fine fractions from the grinding rejects. The maximum height of the dam is 23.3 m, and the width of the top of the dam wall is 10 m.

To increase the volume of recirculated water, precipitation drainage from the catchment area will be fed into the tailings dam with no outlet channel provided.

5.7.2. Tails transport system

A pressure and gravity flow system is used for tails hydro-transmission from the concentration plant to the tailings dam. The pulp is transported through pipeline 400 mm in diameter. The pipeline consists of two lines of length 603 m, a distributing pipeline of length 3581 m is run in one line. The pipeline is mounted on low ferroconcrete pillars without thermo-insulation. The pulp discharge to the facility is carried out via outlets mounted every 30 metres.

5.7.3. Water recycling system

A pressurized water recirculation system is fed from a mobile intake station with two pumps. The last one is towed by tractor during summer along a special bank inside the tailings dam which is built from open pit rocks.

In winter, the water surface at the intake location is covered by foamed polyurethane with a thickness not less than 20 cm.

Water is fed into the concentration plant via a steel pipeline 400 mm in diameter and 1122 m long. The pipeline is run along the ground surface on low ferroconcrete pillars. The pipeline is thermo-isolated by mineral cotton mats 5 cm in thickness.

Water discharge from the tailings dam into the local drainage network will not occur.

5.8. Infrastructure facilities

5.8.1. Introduction

The enterprise's infrastructure is located on two sites – the mine site and the process plant site. The infrastructure includes the following facilities:

- camp;
- transport network;
- heat, electricity and water supply and sewerage system;
- waste placement facilities;
- repair and storage facilities and others.

5.8.2. Auxiliary facilities of the process plant

The main auxiliary facilities are located on the process plant site and include a repair shop, storage facility, motor depot, boiler-house, storage for combustible-lubricating materials, drainage and domestic water treatment facilities, and locomotive depot. All these facilities, together with the process plant, comprise a single complex. A plan of the process plant site is shown on Figure 20.

The repair shop is for technical maintenance and repair of equipment. It includes a machine-shop, storage, mechanical assembly shop, wash room, tool house, electrical equipment repair shop, forging shop, welding shop and spare parts and materials storage.

The motor depot provides transportation services for the open pit and all other project areas, carriage of passengers and ore transportation from the grinding-sorting factory to the concentration plant. The stock of cars includes different vehicles: 36 heavy-duty BelAZ trucks, 52 KAMAZ tipper trucks, 10 service cars, 14 bulldozers, 2 cars for roadway maintenance and 10 cars for other purposes (shift team car, ambulance, etc.) Besides the motor depot at the plant complex, there is another service station and parking area at the mine site.

Storage for combustible-lubricating materials at the plant site includes 5 cylinder tanks with 400 m³ storage capacity each for diesel oil and 3 cylinder tanks with 75 m³ capacity for gasoline. Combustible-lubricating materials are delivered and kept in closed 200 litre barrels, with up to 500-600 barrels stored. Near the storage, the construction of a car filling station is planned. The grinding-sorting factory site has its own small storage area for 400 m³ of oil product and capacity for 10 tons of combustible-lubricating materials.

5.8.3. Camp

The camp site is located 700 metres from the concentration plant. The residential part of the camp consists of three detached apartment halls and four residence halls connected to each other by galleries. Besides these halls, the following facilities will be located at the camp site:

- canteen for 75 people with bakery and dairy shops;
- provision storage with freezers;
- office building;
- medical station;
- vegetable store;
- sauna and laundry service facility;
- sports centre;
- garage for 2 cars and parking for 8 cars, 1 bus, 2 shift team cars and ambulance car.

5.8.4. Transportation network

The transport network is presented on the General plan (Attachment 7) and includes the following:

- access railroad

External shipments will be carried out by railroad transport. An access railroad is planned to be constructed from Olekma station on the Baikal-Amur railroad line. The length of the railroad from the branch point to the internal site is 2.45 km and it includes one interim substation.

- internal railroads

An internal railroad network is planned for loading at the process plant site, with a total length of 3.26 km.

- main road between the open pit, process plant and Olekma station

Transportation of primary concentrate from the grinding-sorting facility to the process plant is carried out by KAMAZ tipper truck (20 tons of carrying capacity) along a new road. The route will be going along the left bank of the River Kuranah. The roadway width is 6 meters and total width is 10 meters. The height of the road mound (about 2.3 metres) will be based on the seasonal permafrost thaw depth. The road bed will be constructed from crushed stone and crosses 11 waterways. Along the road the installation of 67 culverts is planned for low relief areas and for watercourses. The construction of a bridge is planned at the 30th km of the road from the station. The route of the road is shown in Attachment 7.

- internal roads

The internal road network comprises the roads listed in Table 5.5:

Table 5.5. List of the internal roads

Route	Distance	Width, m	
		Roadway	Total width
From the open pit to the repair shop and storage facilities	1.3	11.5	23
From the main road to the grinding-sorting factory	0.7	11.5	23
From the main road to the tails dump of GSF	0.5	6.0	10
From the tails dump of GSF to the combustible materials store	0.9	4.5	6.5
From the open pit to the water pump station at the mine site	4.3	3.5	5.5
To the electrical substation	1.1	3.5	5.5
From the combustible materials store to the testing area	0.2	3.5	5.5

5.8.5. Heat supply

Heat for all sites is supplied from autonomous boiler-houses. They are located at:

- mine site – boiler house with 3.2MWt power. It has two boilers working on diesel oil, which is supplied from 3 metal tanks with a capacity of 25 m³ each. These tanks are placed near the boiler-house;

- process plant site – boiler house with 10.35MWt heat power. It has three boilers working on diesel oil, which is supplied from 2 metal tanks with a capacity of 100 m³ each;
- camp - boiler house with 2.1MWt power. It has two boilers working on diesel oil, which is supplied from 3 metal tanks with a capacity of 10 m³ each.

5.8.6. Water supply

Water for the operation will be supplied from underground water resources, derived from fissured areas of crystalline rocks. Based on previous surveys (reports on water supply investigations, GIDEK, 2005), two borehole water intakes are planned to be installed – one is for the process plant and camp and the other is for the mine site and grinding-sorting factory.

The water supply point for the process plant site and camp is located 4 km to the north of the site on the other side of the Baical-Amur railroad line in the floodplain of the Hany river. It consists of 2 boreholes with pump units, water disinfection facilities and control stations. Water from the pumps is fed to the reservoirs of second boost pump stations which are located near the camp. The total expected water consumption rate for the process plant and camp is 1556 m³ per day.

The water supply point for the mine site and grinding-sorting factory is planned 4 km to the south-east of the factory. It also consists of two boreholes with pump stations. The total expected water needs for the mine site and factory is 340 m³ per day.

5.8.7. Water discharge

Water discharge schemes are shown on Figure 21.

- Camp sewage water

Camp sewage water includes domestic and industrial sewage. Domestic sewage from residential houses, office and other buildings with a base-flow volume of 42.2 m³ per day (according to the general plan) are fed to the domestic sewage treatment facilities Biodisk-350.

The treatment scheme by Biodisk-350 is outlined below.

Sewage comes to the pumping station with a grate-container for collecting coarse admixtures. Further sewage comes to the zone of preliminary desilting and then to the bio-zone with treatment by microorganisms. The bio-zone has rotating disk-shaped bio-filters, which sink into the sewage for 40 % of its diameter. Microorganisms consolidate with filters, creating biofilm, which is enriched with oxygen as the filters rotate. The biofilm grows gradually, and if the biofilm thickness is more than 5 mm it flakes away and due to the water current comes to a secondary sedimentation tank, located on a lower level than the bio-zone. Periodically, excess biofilm from the secondary sedimentation tank is returned to the preliminary desilting zone. Sediment removal to the silt areas, and further to the composting areas, is carried out once every 3-6 months. Water from the secondary sedimentation tank goes to after-purification and to the ultraviolet irradiation installation. After treatment, the water is discharged into the tailings dam.

Industrial discharges from the camp (from the laundry, sauna, shower in the office building), with a base-flow volume of 40.4 m³ per hour, are fed into the tailings dam.

- Mine site sewage

Mine site sewage, with a flow volume of 3.75 m³ per day through the gravity-flow conduit, is fed into the septic tank. One to two times per year, the sediment is transported to the silt areas of the sewage treatment facilities of the process plant site.

- Discharges from the grinding-sorting factory

Discharge water is generated after washing of factory buildings and galleries and from storm water. Rainfall drainage, with a flow volume of 295 m³ per day (general plan), and wash water come into a collection pond. After desilting, the water passes to the storm water treatment

facility, which consists of a sediment catcher with oil-sorbing boom, pump station and treatment facility with filtering system. Filters are replaced regularly and sediment will be removed. The volume of sediment and further placement are not defined. Treated water is discharged into the stream Yuzhnui-1, flowing into Saikta Stream.

- Open pit dewatering

The total expected water inflow to the open pit (from underground water and precipitation) is 1300 m³ per day. After pumping out, the water is desilted at a collection pond with dimensions 140x30x4 metres, and then discharged into the stream Yuzhnui-2, flowing into Arbagastar Stream. Solid sediment is stored in the waste rock dump.

- Process plant sewage

Sewage from the process plant, with a flow volume of 40.05 m³ per day, comes to the sewage treatment facilities through a gravity-flow conduit.

- Rainfall drainage from the process plant

Rainfall drainage, with a flow volume of 370 m³ per day, is collected in the storage pond and after desilting is fed to the drainage treatment facility, which consists of a sediment catcher with oil-sorbing boom, pump station and treatment facility with filtering system. Filters are replaced regularly and the sediment is transported out to the sewage treatment facilities. The volume of sediment is not defined. Treated water is discharged into the tailings dam.

- Motor depot water discharge

Discharge from the washing room comes into the treatment facilities consisting of an underground sediment chamber and flotation-filtering station. The treated water is collected in a tank and reused for car washing. As required, collected slimes are removed.

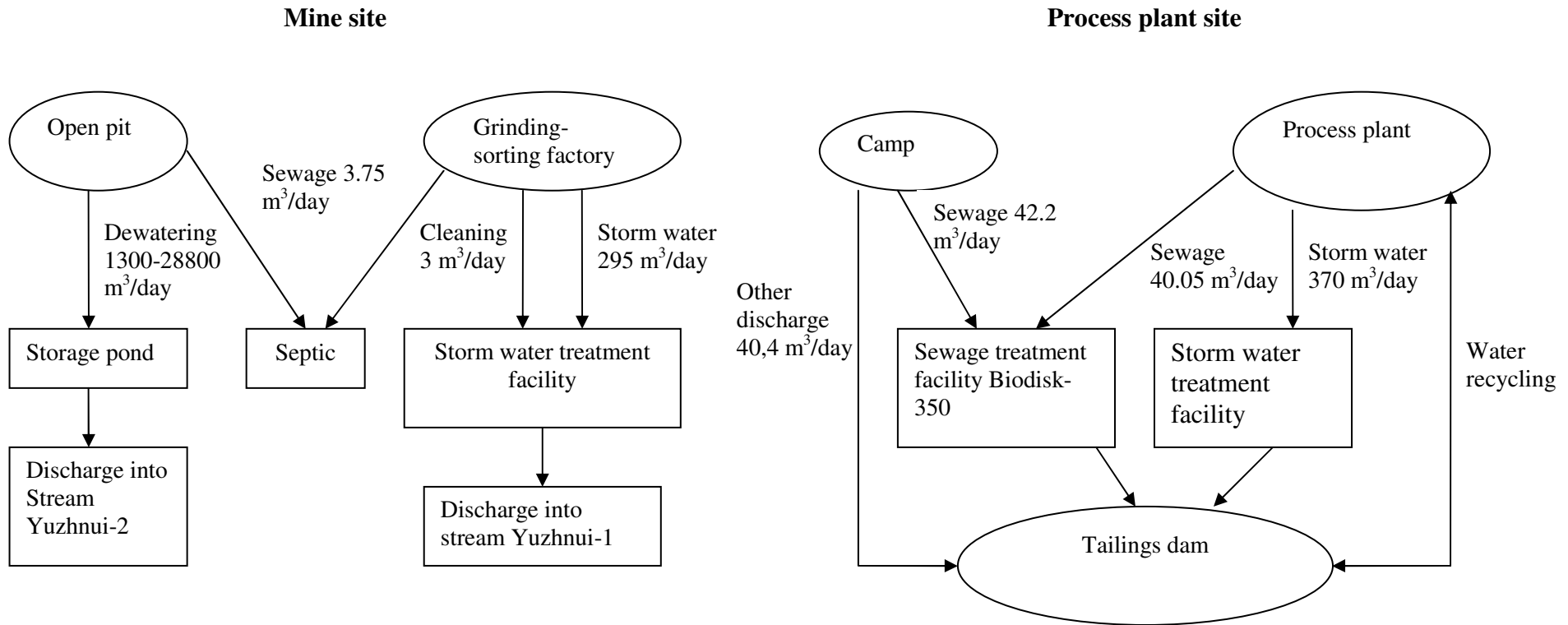
- Discharges from the combustible-lubricating storage and car filling station

Discharges, with a flow volume of 3178.36 m³ per annum, come into the treatment facilities consisting of a collection reservoir and treatment station. The treatment technology comprises the following:

- deposition of large solids and partial elimination of oils in the collection reservoir, which consists of three compartments;
- screening by a slotted strainer;
- fine filtering by a membrane filter with separation of the flow to slimes and treated water.

After treatment, the water is discharged to the storm water collecting system of the process plant. Slimes are moved to the 3rd compartment of the collection reservoir and, when required, are removed.

Figure 21 Water discharge schemes



5.8.8. Electric power supply

The project is located in the area of the company “Amurenergo” power networks. For power takeoff for the project, two electrical substations with capacities 220 and 35 kV will be built at the project location. One 220/35/6 kV substation with two power transformers will be built at the concentration plant and camp site. A second 35/6 kV substation with one power transformer will be built at the open pit and grinding-sorting factory site. The latter substation will be connected with the first substation at the concentration plant site by an overhead transmission line with a voltage of 35 kV. Route of the line will follow the main road.

5.8.9. Waste placement

- Domestic waste

Domestic wastes, collected at the open pit site, will be placed at a newly built landfill. Its location is shown on the general plan (Attachment 7), and construction details will be defined at the next stage of the project design. Domestic waste from the camp and process plant will be collected in the dustbins and then will be transported to the existing Olekma settlement landfill, as agreed by the existing contract between company Olekminskiy Rudnik and Administration of Olekma, which however does not define quantities and types of wastes.

- Waste rock and dry tails

Waste rock and dry tails from primary concentration, as well as solid sediment from the treatment of open pit water drainage, will be placed in the dumps. Data for the dumps are specified in section 5.4.5. A volume of 750,000 tons per annum of dry tails from the primary concentration process will be placed in a separate dry tails dump (see Figure 16).

- Other industrial waste

During the different industrial processes, different kinds of waste are generated. Depending on their hazard rating, they will be utilized, placed at the landfill, or transferred to 3rd party organizations. More detailed waste treatment processes will be specified in the Environmental management plan.

5.9. Employment

Approximately 400 people will be contracted on a temporary basis for the construction stage. It is expected that some of them will continue to work for the company during the operational stage on a permanent basis, when the project will employ 793 employees, taking a two-shift working schedule into account. In reality, additional people will be recruited for temporary work during the project life. It is assumed that most of the employees will come from Amur oblast (in particular the Tundinskiy district) and neighboring regions. The employment structure (for one shift) will be as defined in Table 5.6.

Table 5.6. Employment structure of Kuranah mining and processing operation

Type of employees	Number of one shift		
	1 st shift	2 nd shift	Total
Management	42	5	47
Specialists	27	5	32
Workers	216	130	346
Guard	6	5	11

6. ENVIRONMENTAL IMPACT ASSESSMENT

6.1. Introduction

Assessment of environmental impact has been carried out separately for the construction phase and the operational phase at the most significant sites of the project, which are listed below. In some cases, minor auxiliary sites have been united with the more significant ones, where they constitute one common industrial area. In terms of impact, the following areas are examined:

- open pit;
- grinding-sorting factory with auxiliary works;
- the road from the station Olekma to the mining area and the high voltage line;
- the process plant;
- the tailings damp;
- camp.

6.2. Environmental scoping

Following a review of baseline conditions, the project description and regulatory and other requirements, the following issues have been identified as requiring consideration in the EIA for this project:

- hydrogeological environment and permafrost conditions;
- land use;
- soils;
- vegetation;
- fauna;
- surface waterways;
- air quality;
- social-economical issues.

Assessment of social impact has been carried out jointly for the whole project and is presented at the end of this section.

The following issues were not considered significant in respect to this project, and will not be assessed during the environmental assessment process:

- geology – the project is based upon the exploitation of a known mineral resource. The project has no impact on any other known mineral resources.
- topography/landscape – physical changes take place on site, but there is no significant and sensible landscape features and no local population using this area to a high degree.
- archeology/cultural heritage – analysis of baseline conditions showed no issues.
- aquatic ecology – climatic conditions result in a poor aquatic population which does not need separate assessment.
- Acid rock drainage – is not expected based on the composition of the ore and waste rock.

6.3. Environmental impact assessment methodology

The **significance** of an impact is defined as a combination of the **consequence** of the impact occurring and the **probability** that the impact will occur. The criteria used to determine impact consequence are presented in Table 6.1.

Table 6.1: Criteria used to determine the consequence of the impact

Rating	Definition of Rating	Score
A. Spatial extent – the area in which the impact will be experienced		
None		0
Local	Confined to project or study area or part thereof (e.g. site)	1
Regional	The region, which may be defined in various ways, e.g. cadastral, catchment, topographic	2
(Inter) national	Nationally or beyond	3
B. Intensity – the magnitude or size of the impact		
None		0
Low	Natural and/or social functions and processes are negligibly altered	1
Medium	Natural and/or social functions and processes continue albeit in a modified way	2
High	Natural and/or social functions or processes are severely altered	3
C. Duration – the time frame for which the impact will be experienced		
None		0
Short-term	Up to 5 years	1
Medium-term	5 to 20 years	2
Long-term	More than 20 years	3

The combined score of these three criteria corresponds to a **consequence rating**, as shown in Table 6.2.

Table 6.2: Method used to determine the consequence score

Combined Score (A+B+C)	0 – 2	3 – 4	5	6	7	8 – 9
Consequence Rating	Not significant	Very low	Low	Medium	High	Very high

Once the consequence was derived, the probability of the impact occurring was considered, using the probability classifications presented in the table below.

Table 6.3. Probability classification

Probability – the likelihood of the impact occurring	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

The overall **significance** of impacts was determined by considering consequence and probability using the rating system prescribed in the table below.

Table 6.4. Impact significance ratings

<i>Significance Rating</i>	<i>Possible Impact Combinations</i>		
	<i>Consequence</i>		<i>Probability</i>
Insignificant	Very Low	&	Improbable
	Very Low	&	Possible
Very Low	Very Low	&	Probable
	Very Low	&	Definite
	Low	&	Improbable
	Low	&	Possible
Low	Low	&	Probable
	Low	&	Definite
	Medium	&	Improbable
	Medium	&	Possible
Medium	Medium	&	Probable
	Medium	&	Definite
	High	&	Improbable
	High	&	Possible
High	High	&	Probable
	High	&	Definite
	Very High	&	Improbable
	Very High	&	Possible
Very High	Very High	&	Probable
	Very High	&	Definite

Finally the impacts were also considered in terms of their status (positive or negative impact) and the confidence in the ascribed impact significance rating. The prescribed system for considering impacts status and confidence (in assessment) is laid out in the table below.

Table 6.5: Impact status and confidence classification

<i>Status of impact</i>	
Indication whether the impact is adverse (negative) or beneficial (positive).	+ ve (positive – a ‘benefit’)
	– ve (negative – a ‘cost’)
<i>Confidence of assessment</i>	
The degree of confidence in predictions based on available information, specialist judgment and/or knowledge.	Low
	Medium
	High

6.4. Construction stage

6.4.1. Road-building Olekma – Kuranakh and transmission facilities.

The route of the road lies from Olekma station to the mining area, through the process plant site along the left bank of the River Kuranah, as shown in Attachment 2. The length of the road is 41.16 km.

- Underground waters, permafrost.

There is not expected to be any impact on underground waters and permafrost during road-building.

- Land use

Land for the road construction will be withdrawn from forestry usage. The loss of the forest land will be permanent, however it is supposed that the road will be used by the local forestry agency after project closure.

- Soils

Topsoil will be destroyed on a minimum area of 40 hectares (the width of the ground required multiplied by the length of the road). The topsoil under the high voltage line supports will also be destroyed on an area of about 2.5 hectares. As described in the description of the baseline conditions, the fertile soil layer on the area is up to 10 cm thick, thus its removal and storage is not considered to be expedient. As the topsoil will not be saved the impact is long-term, intensive and local.

- Vegetation

Vegetation will be destroyed on a minimum area of 40 hectares. According to estimates made by project designer (VNIIPromtechnology), removal of approximately 16,000 trees will take place, and also grubbing of shrubs and small forest plants on an area of 22.7 hectares.

For the construction of the high voltage line, gaps will be cut in the vegetation on an area of 72 hectares, with the majority of this cutting being carried out along the 35 km line, running from the process plant site to the mine area.

- Fauna

Impact on animals during construction comprises primarily alienation from their current habitat. The anxiety factor will be assessed during assessment of the road impact whilst in operation. According to a specialist organization – “Far East Branch of the all-Russian Research Institute of hunting and fur-farming” (hereafter VNII), there will be complete withdrawal of hunting areas over an area of 200 hectares.

- Surface waters

The route of the road crosses 11 permanent waterways and 56 lows in relief, which have water during the rains or during snow thawing. Those watercourses (both permanent and temporary) flow into the River Kuranakh. Construction of the water conveyance structures (culverts under the road) will cause short-term discharge of water polluted by contaminants, mainly suspended solids, into the River Kuranakh. Because of the gradual construction of the water conveyance structures as the works progress along the road route, the impact will last for the whole construction period, that is about 1 year, but will be insignificant. The most significant impact will be caused by the construction of the bridge across the River Kuranakh, which will result in partial damage of the river channel and pollution of the river by suspended solids and probably oil products from construction machines.

- Air

During the road construction period, air pollution will occur because of emissions from the construction machinery, and dust generation caused by soil and surface damage. In addition, air pollution will occur due to burning of rooted out shrubs and small forest plants. The expected period of road construction is up to 1 year, meaning that the impact will be short-term.

Table 6.6. Summary of impacts during road construction

Environmental aspect	Impact	Spatial extent	Intensity	Duration	Consequence	Probability	Significance rating	Status of impact	Confidence of assessment
Hydrogeology and permafrost	-	-	-	-	-	-	-	-	medium
Land use	Loss of forest land	1	2	3	medium	definite	medium	-ve	high
Soils	Destruction of topsoil	1	3	3	high	definite	high	-ve	high
	Partial disturbance of topsoil	1	2	2	very low	definite	very low	-ve	medium
Vegetation	Destruction of growth	1	3	3	high	definite	high	-ve	high
Fauna	Destruction of habitats	1	2	3	medium	definite	medium	-ve	high
Surface water	Water contamination	1	1	1	very low	definite	very low	-ve	high
	Disturbance of the Kuranah river-bed	1	2	3	medium	definite	medium	-ve	medium
Air	Emissions from machinery and dust generation	1	1	1	very low	definite	very low	-ve	high

6.4.2. Open pit preparation

The open pit will be brought into operation with a small quantity of mining and capital work for the first year of operation (670 thousand m³ of overburden). Thus, a period of less than 1 year is considered to be preparatory.

- Underground waters, permafrost

While preparing the open pit a significant impact is not expected, either on permafrost or hydrogeological conditions. A change in the permafrost conditions (raising of the seasonal defrost level) will take place on the minor area allocated as the pit dump, which will be formed during the construction period.

- Land use

The open pit, as well as the other sites of the operation, is located on territories belonging to the state forestry lands. In Russia, forests are divided into groups according to their environmental value. The first, most valuable group, includes protective lines of woods along rivers. Woods in vast forests, which can be used for wood-taking, belong to the third group. The territory of the open pit, as well as the majority of the sites of the operation, is in forest belonging to the third group.

For open pit development, it is necessary to take 80 hectares of forest fund area. For the Kuranakh operation, the removal of forest will be temporary, since by the end of operations and after revegetation, the land will be returned to forestry, albeit leaving an area of about 35 hectares (left as the worked out area of the open pit) that will be removed irreversibly.

This territory is also used as grassland for deer and as a hunting area, part of which will also be no longer available for use. Construction of the open pit will lead to the loss of an 80 hectare area of grassland. However, hunting areas will be temporarily reduced over an area larger than the size of the open pit, because of the anxiety factor. Assessment of this impact is given below in the description of the impact on fauna.

- Soils

In general, overburden stripping operations will be carried out on an area of 80 hectares. Topsoil will not be stripped and stored for further use. Thereby, topsoil will be damaged over the whole area of about 80 hectares.

- Vegetation

Vegetation will be stripped and destroyed over an area of 80 hectares. Vegetation on the area where the open pit will be consists of partly disturbed forest land, with thicker vegetation within the boundaries of the future open pit and more sparse vegetation on the surrounding area. In spite of the fact that the vegetation of the area is not unique, two types of plants which are registered in The Red Book of Amur Oblast – *Rhododendron dauricum* L. And *Lilium pensylvanicum* Ker-Gawl) grow in large amounts, and three more types grow in the immediate neighbouring land and can be found on the damaged areas. Although no studies on the flora of the separate sites of the operation have been done, it is possible to state that the populations of these types of plants can be affected during the development of the open pit. Taking into consideration the fact that *Rhododendron dauricum* L. covers approximately 1% of the territory, it is considered that while stripping the open pit, less than 1 hectare of the area where this plant grows will be damaged. In addition, an impact on vegetation will occur due to dust during the construction works.

- Fauna

The impact on fauna during the construction stage will lie firstly in direct removal of habitat. The anxiety factor will be examined while assessing the impact of the operational stage of the project. According to the assessment of a specialist organization (9), the zone of complete

displacement of animals will cover 450 ha for the whole mine area (including grinding-sorting factory (GSF) area).

- Surface waters

According to the information available, during overburden removal, surface waters will not be affected because of the absence of watercourses on the area of the open pit. However this information has to be confirmed because of the absence of detailed hydrological examinations, which will be conducted in future, especially for ephemeral watercourses.

By the stage of the preparation works, water drains will be constructed along the upper pit edge, the drainage from which will be discharged to surface (on the land). It may be expected that the water from the drain will contain small amounts of suspended solids. This impact may last during the whole mining work.

- Air

During overburden removal, air quality will be affected by machinery emissions and dust generation. Since the overburden is characterized by high strength, overburden stripping will be carried out using drilling and blasting operations, which will result in emissions to air. The impact will be short-term and insignificant.

Table 6.7. Summary of impacts during open pit preparation

Environmental aspect	Impact	Spatial extent	Intensity	Duration	Consequence	Probability	Significance rating	Status of impact	Confidence of assessment
Hydrogeology and permafrost	Elevation of the seasonal thaw level under the overburden dumps	1	1	3	low	definite	low	-ve	high
Land use	Loss of forest land	1	3	3	high	definite	high	-ve	high
	Loss of pastures and hunting areas	1	3	2	medium	definite	medium	-ve	high
Soils	Destruction of topsoil	1	3	3	high	definite	high	-ve	high
	Partial disturbance of topsoil	1	2	2	very low	definite	very low	-ve	medium
Vegetation	Destruction of growth	1	3	2	medium	definite	medium	-ve	high
	Contamination by dust	1	2	1	very low	probable	very low	-ve	medium
Fauna	Destruction of habitats	1	3	2	medium	definite	medium	-ve	high
Surface water	Water contamination from the drain	1	1	2	very low	probable	very low	-ve	medium
Air	Emissions from machinery and dust generation	1	1	1	very low	definite	very low	-ve	high

6.4.3. Construction of grinding-sorting factory (GSF) and other facilities on the mine area

- Underground waters, permafrost

There will be no impact on underground waters or permafrost.

- Land use

The sites of the GSF and other works lie on state forestry land. As for the open pit territory, this forest belongs to the third group, and will be temporarily (until rehabilitation works) withdrawn from forestry land. The total area of removal will cover approximately 30 hectares. In addition, this area includes deer pastures and hunting areas. According to a specialist organization (9), complete displacement of hunting species will take place on the mine area (including the open pit), from the commencement of construction for a period of 10 years on an area of 450 hectares.

- Soils

The impact on soils during the construction of the grinding-sorting factory and other works will comprise destruction of the topsoil on an area of approximately 30 hectares (the area of construction). Apart from that, partial damage of topsoil may occur on near-by areas because of the storage of materials and possible access by construction equipment.

- Vegetation

During the construction of the GSF and other works, vegetation will be destroyed over an area of 30 hectares. Over this area, approximately 7200 trees will be felled, and bush and small forest removal will be carried out over an area of 20 hectares. On the GSF land, the vegetation has been partly destroyed by previous activity. On both the open pit area and on the area of the expected works some rare plants may grow which will be destroyed.

In addition, there will be an impact on vegetation that grows near-by because of the settlement of dust from the construction works, however this impact will be insignificant.

After completion of construction, revegetation will be carried out on the sites, with the creation of 24 hectares of grassland, planting of 60 trees and 200 bushes (honeysuckle, acacia), and also creation of a hedge.

- Fauna

The impact on fauna at the construction stage will comprise the removal of habitats. The anxiety factor will be examined during the impact assessment for the operational phase. According to assessment by a specialist organization, the area of complete fauna displacement will cover 450 hectares for the whole mine area (including the grinding-sorting factory). There will be no impact on water ecosystems because of the absence of watercourses near the GSF.

- Surface waters

During construction of the GSF and other works, there will be no impact on water resources because of the absence of the watercourses near the construction site.

- Air

An impact on air quality will occur due to emissions from the construction machinery as well as dust formation from the disturbed ground. The impact will be short-term and insignificant.

Table 6.8. Summary of impacts during the construction of the GSF and other facilities on the mine site

Environmental aspect	Impact	Spatial extent	Intensity	Duration	Consequence	Probability	Significance rating	Status of impact	Confidence of assessment
Land use	Loss of forest land	1	2	2	low	definite	low	-ve	high
	Loss of pastures and hunting lands	1	3	2	medium	definite	medium	-ve	high
Hydrogeology and permafrost	-	-	-	-	-	-	-	-	-
Soils	Destruction of topsoil	1	3	3	high	definite	high	-ve	high
	Partial disturbance of topsoil	1	2	1	very low	probable	very low	-ve	medium
Vegetation	Destruction of growth	1	3	2	medium	definite	definite	-ve	high
	Impact from dust	1	1	1	very low	probable	very low	-ve	medium
	Planting	1	1	3	low	definite	low	+ve	high
Fauna	Destruction of habitats	1	3	2	medium	definite	medium	-ve	high
Surface water	-	-	-	-	-	-	-	-	high
Air	Emissions from machinery and dust generation	1	1	1	very low	definite	very low	-ve	high

6.4.4. Construction of process plant and tailings dump

- Underground waters, permafrost

During construction of the process plant and auxiliary works, there will be no impact on the geological environment, underground waters and permafrost. The construction of the tailings dam will be realized with saving the permafrost

- Land use

The process plant site lies on state forestry land, mainly comprising forests of the third group (the least valuable group of forests according to the Russian classification). Part of the tailings dam site belongs to the first group of forests (protective belt of rivers). Some parts of the land will be temporarily (until rehabilitation operations) withdrawn from the forestry lands. The total area of removal will cover approximately 140 hectares. This site also crosses into the border of the hunting areas and pastures. According to assessment by a specialist organization (9), complete displacement of hunting species will occur on the area of the process plant and camp location, from the commencement of construction for a period of 12 years on an area of 300 hectares.

- Soils

During construction on the site of the process plant, topsoil will be completely destroyed on an area of approximately 140 hectares. An additional impact on soil may occur during building works due to the storage of building materials and access of construction machinery.

- Vegetation

Vegetation will be destroyed over an area of approximately 140 hectares. On the land of the tailings dam and process plant approximately 34 000 trees will be felled and small forest and bushes will be removed over an area of 25 hectares. Some rare plants may grow on the process plant land, and these will be destroyed.

In addition, an impact will occur on vegetation on near-by land due to dust settlement from the building works, however the impact will be insignificant.

After construction has been completed, 1.6 hectares of lawn, planting of 40 trees and 160 bushes (honeysuckles, acacia) as well as creation of hedge will occur within the area of the process plant, the warehouse and the garage.

- Fauna

At the construction stage, the impact on fauna consists mainly of loss of habitats. The anxiety factor will be examined during assessment of impacts for the operational phase of the project. According to a specialist organisation (9), complete displacement of hunting species will occur on the area of the process plant and the camp location from the commencement of construction for a period of 12 years, over an area of 300 hectares.

- Surface waters

The tailings dam site is located 300 metres from the River Kuronakh, this fact allows significant impact on the surface water to be avoided at the stage of the construction. The proposed tailings dam will cross an ephemeral tributary of the River Kuranah, but because of the low flow rate and ephemeral character of this tributary, the impact is not expected to be significant.

- Air

An impact on air quality will occur due to emissions from construction equipment as well as dust from the disturbed ground. The impact will be short-term and insignificant.

Table 6.9. Summary of impacts during construction of the process plant, tailings dam and other facilities on the plant site

Environmental aspect	Impact	Spatial extent	Intensity	Duration	Consequence	Probability	Significance rating	Status of impact	Confidence of assessment
Land use	Loss of forest land	1	2	2	low	definite	low	-ve	high
	Loss of pastures and hunting areas	1	3	2	medium	definite	medium	-ve	high
Hydrogeology and permafrost	Changing of permafrost conditions because of dam construction	1	2	2	low	definite	low	-ve	medium
Soils	Destruction of the topsoil	1	3	3	high	definite	high	-ve	high
	Partial disturbance of topsoil	1	2	1	very low	probable	very low	-ve	medium
Vegetation	Destruction of growth	1	3	2	medium	definite	medium	-ve	high
	Impact of dust	1	1	1	very low	probable	very low	-ve	medium
	Planting	1	1	3	low	definite	low	+ve	high
Fauna	Destruction of habitats	1	3	2	medium	definite	medium	-ve	high
Surface water	Destruction of the temporary watercourse	1	2	3	medium	definite	medium	-ve	high
Air	Emissions from machinery and dust	1	1	1	very low	definite	very low	-ve	high

6.4.5. Camp construction

- **Underground waters, permafrost**
During the construction of the camp, there will be no impact on underground waters and permafrost conditions.

- **Land use**
The camp, as well as the other project sites under construction, lies on state forestry lands of the 3rd group forests (the least valuable). The section of land for the camp will be temporarily withdrawn from forestry use and returned after rehabilitation. This site also crosses the border of the hunting areas and pastures.

- **Soils**
Soils on the site of the camp will not be stripped and kept during construction because of the small thickness of the topsoil (less than 10 cm). During construction, the topsoil will be destroyed over an area of approximately 4 hectares, and the soils on some near-by land may be damaged due to storage of materials and access of construction equipment.

- **Vegetation**
During the construction of the camp, vegetation will be destroyed on an area of approximately 5 hectares, and at that 800 trees and bushes on this area will be cut. The impact on vegetation due to dust will be extremely insignificant because of the small area of operation. After completion of construction, creation of 1.4 hectares of lawns, and planting of 60 trees and 120 bushes will be carried out.

- **Fauna (see impact on fauna during process plant construction)**

- **Surface waters**
There will be no impact on surface water.

- **Air**
There will be an impact on air quality because of emissions from construction equipment as well as dust from disturbed ground. The impact will be short-term and insignificant.

Table 6.10. Summary of impacts during camp construction

Environmental aspect	Impact	Spatial extent	Intensity	Duration	Consequence	Probability	Significance rating	Status of impact	Confidence of assessment
Land use	Loss of forest lands	1	2	2	low	definite	low	-ve	high
	Loss of pastures and hunting areas.	1	2	2	low	definite	low	-ve	high
Hydrogeology and permafrost	-	-	-	-	-	-	-	-	medium
Soils	Destruction of topsoil	1	3	3	high	definite	high	-ve	high
	Partial disturbance of topsoil	1	2	1	very low	probable	very low	-ve	medium
Vegetation	Destruction of growth	1	3	2	medium	definite	medium	-ve	high
	Planting	1	1	3	low	definite	low	+ve	high
Fauna	Destruction of habitats	1	3	2	medium	definite	medium	-ve	high
Surface water	-	-	-	-	-	-	-	-	high
Air	Emissions from machinery	1	1	1	very low	definite	very low	-ve	high

6.5. Operational phase

During the assessment of impacts for the operational phase of the project, it has been taken into account that additional change in land use, beyond that assessed for the construction phase, will not occur. Therefore, land use is not discussed during the impact assessment for the operational phase.

6.5.1. Mining operations

- Permafrost conditions, hydrogeology

A borehole drilled on the area of the open pit has defined the thickness of the permafrost as more than 300 metres. The base of the thickness of rock that has been frozen for many years is 610 m above sea level, which is 20 m lower than the bottom of the open pit (630 m). The depth of seasonal thaw is 2.3 – 2.6 m depending on the ground, thus it is reasonable to suggest that the permafrost will be damaged to a depth of about 2.5 m from the pit edge and below the base of the pit. As backfilling is carried out, the level of the permafrost will be restored.

Waste rock dump formation may influence the permafrost conditions. Thawing of the permafrost during the spring-summer period may lead to the deformation of the waste rock dump layers. Thus a layer with a thickness of 5-10 metres will be placed on the dump areas beforehand, in winter time, which will keep the rock at the base of the waste rock dump frozen. In spite of that, the probability exists that some of the surface layer on the dump area will thaw.

General loss of the drilling agent when drilling the boreholes at the site, which have exposed tectonic faults and high fissure zones, testifies to the absence of underground waters due to their complete drainage. The presence of permafrost will oppose the inflow from the large area.

According to GIDEK's assessment (3), the expected rate of water inflow to the open pit from underground waters will be 34 m³/hour or 800 m³/day. The calculations have been based on an area of 3.4 km² being drained, and the average drainage of 2.8 litres/s·km² (for the basin of Saikta Stream). During the assessment, the following assumptions were made:

- for the calculations, the general area of the basin has been used, some sections of which have been affected by permafrost;
- the possible increase in the thaw waters, caused by open pit development, has not been taken into consideration;

However, along the Yuzhny tectonic fault (streams Yuzhny-1, Yuzhny-2) at 640 m above sea level (10 m higher than the bottom of the open pit) there are rocks containing underground waters. In this respect, it is reasonable to suggest that in the south-east section of the open pit, underground waters which are located in the zones of fissuring, may drain into the pit at depths lower than 640 m (5). In spite of the fact that the south-eastern part of the open pit at this depth will be worked out towards the end of the project period (years 8-10), water drainage into the open pit may alter the hydrogeological conditions.

332.36 cubic meters of water per day will be taken from the water well for rock and road watering during summer time.

- Vegetation and soils

During open pit development, there will be an impact on vegetation and soils on near-by land due to dust. Dust settlement on vegetation may suppress its growth and dust settlement on soil may lead to its contamination.

- Fauna

Apart from the direct destruction of habitat which will take place during the construction phase, there will be a continued impact on fauna due to an anxiety factor. In terms of anxiety, usually the larger the animal is, the longer the radius of impact is from the operation. The radii of the impact of the mining operations on different species are given in Table 6.11, according to the reference letter, issued by a specialist organization (9).

Table 6.11. Radii of the impact on different species

Fauna groups and species	Radius of impact, km
Big hoofed animals (elk, Manchurian deer, reindeer)	2.0 – 3.0
Mask-deer	0.5 – 1.0
Wolverine, wolf, lynx	1.5 – 2.0
Bears	1.0 – 1.5
Sable	1.0 – 1.5
Japanese mink, stoat	0.4 – 0.6
Squirrel, hare	0.3 – 0.5
Wood-grouse, black grouse	1.5 – 2.0
Hazel grouse	0.5 – 0.8
Swans, geese	3.0 – 5.0
Ducks	0.3 – 0.5
Wood cock	0.2 – 0.4

According to the Russian method, the organization (9) has defined four zones of impact on fauna - zone of complete displacement, zone of high impact, zone of medium impact and zone of low impact. In addition to that, the operations have been united into three main sites:

- «open pit», including open pit with grinding-sorting factory and other structures, stockpile and testing area for explosive materials;
- «process plant», including process plant area, tailings dam, auxiliary works and the camp;
- «road» - highway from the process plant to the deposit area and high voltage line combined with it.

For the open pit and the grinding-sorting factory area, have been defined as shown in Table 6.12.

Table 6.12. Impact zones on fauna (in hectares)

Zone of complete displacement	High impact zone	Medium impact zone	Low impact zone
450	2350	2350	1400

Thus the mining operation impact will impact upon a total area of 6,550 hectares.

- Surface waters

An impact on surface waters will occur through pollution by discharge water and alteration of the hydrological regime.

Probably, by years 8-10 of the development of the deposit, underground waters connected with streams Yuzhny-1 and Yuzhny-2 will be affected. They are will be pumped out and this may cause alteration of the hydrological regime. Since there is currently no hydrological description of those streams, more detailed assessment is not possible at this stage. Hydrological descriptions will be obtained later as a result of specialist studies.

The daily water inflow to the open pit consists of underground water inflow and atmospheric precipitation. The atmospheric precipitation estimate includes precipitation falling directly on the area of the open pit only, since the installation of a drainage ditch along the north side of the open pit will collect water draining from the Arbagastsar mountainside. The quantity of precipitations and ground water were estimated (3) as following:

- in case of storm water (1 % probability) – 1200 m³/hour (28,000 m³/day);
- average precipitations in warm season – 21.6 m³/hour (500 m³/day);

- snow thawing – 46.8 m³/hour (1100 m³/day);
- ground water inflow is 34 m³/hour (800 m³/day).

Taking ground water into account, following water income is expected for open pit:

- maximum – 1234 m³/hour;
- average in warm season – 55.6 m³/hour;
- average during snow thawing – 80.8 m³/hour.

Water pumped from the pit will be discharged to Yuzhny-2 stream, which flows into Arbagastar Stream, which will probably cause alteration in the hydrological conditions of the watercourses. The absence of hydrological data on the Yuzhny-2 stream and the Arbagastar Stream prevents more exact predictions. The required data will be obtained in the future.

Pit waters, as estimated by VNIPI, will contain the following pollutants in the amount of:

- suspended solids – 2,250 mg/l;
- oil products – 40 mg/l;
- biochemical oxygen demand_{compl} – 30 mg/l;

Before the waters are discharged into the stream they will be desilted in the storage pond, after which the water will have the following characteristics (according to analogues):

- suspended solids – 450 mg/l;
- oil products – 8 mg/l;
- biochemical oxygen demand_{compl} – 6 mg/l.

According to study (1) the characteristics listed above for Yuzhny-2 Stream were as follows:

- oil products – 0.06 mg/l
- suspended solids – 1.1 mg/l
- biochemical oxygen demand₅ - 3.08 mg/l

Russian standards do not exist for the quality of discharged water and Table 6.13. therefore shows water quality characteristics with comparison with International standards.

Table 6.13. Comparison water quality with International standards

Parameters	Predicted concentrations, mg/l	Background characteristics of Yuzhny-2 stream, mg/l	International standards ¹² , mg/l
Suspended solids	450	1.1	50
Oil products	8	0.06	10
BOD _{comp}	6	3.08 (BOD ₅)	50

It can be seen from the table that the discharge water quality does not comply with international standards for suspended solids, and therefore it is necessary to carry out additional treatment measures. It is difficult to compare the figures with Russian standards, as Russian maximum admissible concentrations are determined not for discharge waters but for the receiving channel at the mixing point, however the hydrological characteristics of the receiving channel are not available.

Considering the amount of open pit waters and their quality in comparison with the background characteristics, it can be assumed that the impact on the water quality of Yuzhny-2 Stream and Arbagastar Stream will be significant.

It is important to note that whilst discharging pumped waters from the pit, the operation will, at the same time, extract water from the underground water supply point for dust suppression on mined rock and roads. To reduce the impact on watercourses the issue of using of mine water for dust will be investigated.

- Air

¹² General Environmental Guidelines, World Bank, 1998

The major factors causing air pollution are as follows:

- blasting;
- working of mining machinery;
- wind erosion from waste rock dumps;
- dust emissions from roads.

According to VNIPI estimates, there will be emissions in the following amounts:

Source	Emission , tonnes per year
Blasting works	122.39
Waste dump dust	59.1
Road dust	40.74

The amount of dust generated is estimated according to calculations using Russian methods, inclusive of dust control measures introduced by the project. Dust calculation results caused by the working of mining machinery are not available.

Dust emissions caused by blasting works will occur during the whole period of operation, as the waste rock and ore are very hard. Blasting works will be carried once per week, and the drilling machines involved in the operation will be equipped with filters. As the open pit deepens, the area affected by dust deposition will gradually reduce due to pit slope formation.

Dust deposition will occur alongside the roads due to the contact of wheels with the road surface, as well as rock dusting in the trucks. It is reasonable to assume that the majority of dust will fall within a distance of about 50 metres from the road.

Dust emissions from waste rock dumps will be caused by constant placement of mined rock. Mined rock displacement will cause dust generation itself and besides, the constant rock displacement will prevent the formation of a hard crust on the rock dump surface, assisting wind erosion.

Apart from dust emissions during open pit development, mining machinery exhaust fumes will be emitted too. Details of machines and fuel usage are given in Table 6.14.

Table 6.14. Machines and fuel usage

Machine Type	Number	Fuel Type	Working hours per unit / total	Amount of Fuel Required (tonnes per year)
Shovel EKG-5A	6	Electric power		6888,700 kwh
Drill ROC L8	4	Diesel fuel	6935/27740	1674
Dozer CAT-D9N	3	Diesel fuel	8750/26250	1001
Slurry pump truck	1	Diesel fuel	3744	40
Stemming machine	1	Diesel fuel	3744	20
Water distribution vehicle BelAZ-7547	2	Diesel fuel	Not available	347
Electric pump	6	Electric power		816 000 kwh
Truck BelAZ-75473 (transportation to grinding and sorting factory and transportation of waste to the dump)	5	Diesel fuel	8160/40800	2807

Total emissions from the mining machinery, working on the open pit (tonnes per year):

NO ₂	- 23.766;
NO	- 6.691;
Benzol	- 4.153;
Xylene	- 4.493;
Carbon black	- 5.588;
H ₂ S	- 43.139;
SO ₂	- 7.01;
Carbohydrates	- 2.32;
CO	- 0.021;
Dust (apart from blasting works)	- 35.677.

Table 6.15. Summary of impacts during mine operation

Environmental aspect	Impact	Spatial extent	Intensity	Duration	Consequence	Probability	Significance rating	Status of impact	Confidence of assessment
Hydrogeology and permafrost	Loss of waste rock dump stability because of the thawing of upper layers of frozen ground	1	2	3	medium	possible	low	-ve	medium
	Disturbance of permafrost conditions by open pit	1	2	2	low	possible	very low	-ve	medium
	Changing of the hydrogeological regime during first years of development	1	1	1 ¹³	very low	probable	very low	-ve	high
	Disturbance of the hydrological regime of Saikta Stream because of water abstraction	1	2	2	low	probable	low	-ve	medium
	Changing of the hydrogeological regime during last years of development	1	2	3	medium	possible	low	-ve	medium
Soils	Contamination by dust	1	2	2	low	probable	low	-ve	high
Vegetation	Contamination by dust	1	2	2	low	probable	low	-ve	medium
Fauna	Destruction of habitats	1	3	3	high	definite	high	-ve	high
	Disturbance of animals	1	2	2	medium	definite	medium	-ve	high
Surface water	Changing of the hydrological regime because of mine water pumping	1	2	2	low	probable	low	-ve	medium
	Changing of the hydrological regime because of the mine water discharge	1	2	2	low	definite	low	-ve	medium
	Contamination by mine water	2	2	2	medium	definite	medium	-ve	medium
Air	Emissions from machines and dust emissions	1	1	1	very low	definite	very low	-ve	medium

¹³ if it is backfill during development

6.5.2. Grinding-sorting factory and auxiliary works

- Underground water and permafrost conditions

The water requirements for the grinding-sorting factory and auxiliary works are 340 cubic metres per day, which will be taken from a water supply point located in the valley of Saikta Stream. Research carried out in 2005 (GIDEK report) showed that the whole production rate of the water supply point is 1200 cubic metres per day. Taking into account the fact that, during summer time, 332.36 m³ per day of water will also be taken from the hole to spray on mined rock for dust suppression, the total abstraction will be more than half of the water, affecting the underground water.

Operation of the grinding-sorting factory may cause changes to the frozen ground conditions, where there can be some thawing during winter time as well.

- Soils and vegetation

Soils and vegetation will be insignificantly affected by dust.

- Fauna

See the assessment of impact on fauna after the open pit is been worked.

- Surface waters

The waste water from the grinding-sorting factory will be made up from used water for cleaning the buildings and storm water.

A volume of 3.0 m³ per day of used water for cleaning is sent to a storage pond and then, discharged to land.

A volume of 26293.5 m³ per year of storm water is sent to the treatment plant, and after treatment, is discharged into the stream Yuzhny-1, which is located to the south of the pit, and flows into Saikta Stream. The VNIPI predicts that, after treatment, the storm waters will contain 3 mg/l suspended solids and 0.05 mg/l oil products. This amount is acceptable according to the Russian maximum admissible concentrations for fishery water bodies, and is much less than the International standards. Any other data on storm water is not available.

- Air

Air pollution at the grinding-sorting factory and auxiliary works can be caused by the following:

- handling section;
- crushing and separation section;
- garage with the maintenance and repair works shop;
- boiler;
- combustion-lubricating materials warehouse.

In accordance with calculation of VNIPI, the handling section causes the emission of 83.52 tonnes of dust per year, and a loading machine and a dozer's exhaust fumes too.

Dust is caused by the crushing and separation section of the grinding-sorting factory. According to VNIPI estimates, the amount of dust issued will total 22.77 tonnes per year taking into account that an air treatment plant will be used. Air treatment is carried out in cyclones fixed in crushing and separation vessels and in the conveyor loading sections. The effectiveness of dust control is 85 %.

The boiler causes the emission of the following substances (VNIPI calculations according to Russian methods):

Table 6.16. Emission from the boiler

Substance	Emission amount, tonnes per year
CO	5.192
NO ₂	3.944
NO	0.64
Carbon black	0.978
SO ₂	5.518
Benzopyrene	1.66x10 ⁻⁵
paraffin hydrocarbon	0.001
Hydrogen sulphide	0.000004

There is no emissions control equipment for the boiler.

The garage with the maintenance and repair works shop will cause the emission of about 2 tonnes per year of different pollutants. Only the mechanical section has treatment equipment. According to the estimates, the combustible-lubricating materials warehouse will emit about 27 kg of paraffin hydrocarbon and some insignificant amount of hydrogen sulfide.

According to the Russian Standard (SanPiN 2.2.1/2.1.1.1200-03), determining the size of buffer (protection) zone for operations of different profiles, the protection zone of the grinding-sorting factory ground totals 300 m. The estimates of the spread of pollutants show that there will be no exceedence of MAC on any of the protection zone boundaries for no one component. As shown in Chapter 2, the Russian air quality standards are higher than the International ones, and the impact of the crushing and separation section on air quality can be assessed as not significant.

Table 6.17. Summary of the impacts of the GSF and other facilities

Environmental aspect	Impact	Spatial extent	Intensity	Duration	Consequence	Probability	Significance rating	Status of impact	Confidence of assessment
Hydrogeology and permafrost	Disturbance of permafrost conditions	1	1	2	very low	probable	very low	-ve	medium
	Disturbance of hydrological regime of Saikta Stream due to the water abstraction (pumping)	1	2	2	low	probable	low	-ve	medium
Soils	Contamination by dust	1	1	2	very low	probable	very low	-ve	high
Vegetation	Contamination by dust	1	1	2	very low	probable	very low	-ve	medium
Fauna	Destruction of habitats	1	3	3	high	definite	high	-ve	high
	Disturbance of animals	2	2	2	medium	definite	medium	-ve	high
Surface water	Contamination by discharged water	1	0	2	very low	definite	very low	-ve	medium
Air	Dust emission from GSF and emission from other components	1	1	2	very low	definite	very low	-ve	high

6.5.3. Transportation from the grinding-sorting factory to the process plant

Primary processed ore will be transported from the grinding-sorting factory to the process plant by BelAZ trucks. The new road is currently under construction.

- hydrogeology and permafrost conditions

The existence of the roadbed will influence the frozen ground conditions, protecting the upper layer of ground from thawing during the spring-summer period. The total roadbed height is taken according to the depth of seasonal thaw, and will be about 2.3m, which will cause the seasonal ground thaw level to rise by approximately 2 metres.

- Soils

Dust fall and pollutants from machine exhaust fumes will affect the soils, which may result in a decrease in soil quality. It can be assumed that, for a width of about 2 metres on the both sides of the road, the soil will be completely destroyed because of pollution by dust and vehicle exhausts. This will total about 16 ha alongside the road.

- Vegetation

Dust fall and pollutants from machine exhaust fumes will affect the vegetation, which may cause inhibition of plant growth and some individual plant destruction (especially grass flora). Besides, use of the road will cause physical damage of tree and bush flora growing alongside the roadbed. The impact will take place during the whole period of road use.

- Fauna

According to reference (9) the impact zones on fauna due to the road will be as shown in Table 6.18.

Table 6.18. Impact zones on fauna due to the road (in hectares).

Complete displacement zone	High impact zone	Medium impact zone	Low impact zone
200	1620	1550	-

Taking into account that the degree of impact is progressively reducing, the low impact zone has not been assessed.

In addition, the road blocks access to the river Kuranah for animals, and twenty-four-hour traffic will make it difficult for them to cross the road.

- Surface waters

The road from the grinding-sorting factory to the process plant is built along the River Kuronakh. Along its length, the road crosses 11 permanent water courses and 56 lows in relief which become temporary waterlines during the spring and storm rains, all of which are tributaries to the River Kuronakh. Road dust and vehicle exhaust fumes will partially fall onto the surface of the river and its tributaries, and will also be washed from the ground surface by rains. The total amount of pollutants emitted into the air is shown in the description of the impact on air, but can also be an indirect factor in the impact of the road on water bodies.

There will be no additional impact on the hydrological regime above that described for the period of construction.

No poisonous or dangerous substances will be transported on the road, with the exception of the transportation of petrochemicals to the on-site storage area on the mine site from the main storage area located on the process plant site. Transportation is carried out by petrol tankers, so if

an accident occurs, it may produce some significant impact on the River Kuronakh and waterways located downstream.

- Air

Vehicle exhaust fumes and roadbed dust will produce an impact on air quality. The estimates made by VNIPI according to Russian standards, has shown the following amounts of pollutants issued:

Table 6.19. Air emission from the road

Pollutant	Amount tonnes per year
CO	81.809
Carbohydrates	25.50
NO ₂	196.87
NO	31.99
Carbon black	6.08
SO ₂	10.588
Dust	90.897

It is expected that the amount of pollutants issued will be significant, but the majority of them will fall alongside the road.

Table 6.20. Summary of the impacts of the road pit-plant-Olekma

Environmental aspect	Impact	Spatial extent	Intensity	Duration	Consequence	Probability	Significance rating	Status of impact	Confidence of assessment
Hydrogeology and permafrost	Raising of the seasonal ground thaw level	1	1	3	low	definite	low	-ve	high
Soils	Dust contamination	1	2	2	low	definite	low	-ve	high
	Destruction of the soil close to the roadway	1	3	3	high	probable	high	-ve	high
Vegetation	Dust contamination	1	1	2	very low	definite	very low	-ve	high
	Physical damage	1	2	2	low	probable	low	-ve	high
Fauna	Destruction of habitats	1	3	2	medium	definite	medium	-ve	high
	Disturbance of animals	1	2	2	low	definite	low	-ve	high
Surface water	Contamination by dust and emission from transport	1	1	2	very low	definite	very low	-ve	medium
	Contamination by oil products in case of accident with oil product transport	2	3	1	medium	improbable	low	-ve	medium
Air	Contamination by dust and exhausts	1	1	2	very low	definite	very low	-ve	high

6.5.4. Process plant and auxiliary works

- Hydrogeology and permafrost

Operation of the process plant may cause some thermal effects on the ground, which might lead to the occurrence of a thawed layer during the cold season and enlargement of the seasonal thaw layer during the warm season.

Underground spring water will be used for the process plant and the camp water supply. The spring is located 5 kilometres away from the process plant site. The process plant and the camp water demand is 1556 m³ per day, which totals about 10 % of the water supply source and the water abstraction will produce no impact on underground waters.

- Soils and Vegetation

There will be an insignificant impact on soils and vegetation. It will mostly be caused by dust fall that may lead to suppression of plant growth and a decrease in soil productivity.

- Fauna

Impact zones on fauna have been determined in report (9) for the process plant site and the camp, as shown in Table 6.21.:

Table 6.21. Impact zones on fauna for the process plant site, (hectares)

Complete displacement zone	High impact zone	Medium impact zone	Low impact zone
300	900	700	850

Thus impact zones on fauna will total 2750 ha.

- surface waters

The project does not involve the discharge of process plant effluent into surface watercourses.

- air

At the process plant, the following will produce the main impact on the air:

- ore pre-treatment section – causes dust emissions of 38.3 tonnes per year and is not equipped with control measures (according to VNIPI calculation);
- concentrate drying section – the drying furnace is equipped with a dust-arrester installation, and wastes are issued through the chimney. Apart from 4 tonnes per year of dust, the section emits carbon monoxide, nitrogen oxide, carbon black, and sulphur dioxide, totaling about 80 tonnes per year, and 7 kg per year of carbohydrates from the diesel fuel tank;
- separation section and finished-products storage area – these cause 4.5 tonnes per year of dust emission;
- rail transportation – locomotive exhaust fumes containing carbon monoxide, nitrogen oxide, carbon black, and sulphur dioxide, totaling 8.5 tonnes per year;
- the boiler - is not equipped with control measures and causes emissions of carbon monoxide, nitrogen oxide, carbon black, and sulphur dioxide and benzopyrene, totaling 48.5 tonnes per year;
- combustible-lubricating materials warehouse and filling station – cause the emission of carbohydrates, benzene, toluene, xylene, ethylbenzene and hydrogen sulfide, totaling 248 kg per year;

- service shops – are equipped with treatment plants for the control of dust, iron oxide, manganese and its compounds, fluorides and cause emission of about 20 substances and compounds.

- garage and warehouses – are not equipped with control measures and cause emissions of carbon monoxide, nitrogen oxide, carbon black, sulphur dioxide and carbohydrates totaling about 2 tonnes per year.

Thus, it follows that the ore pre-treatment section causes emissions of a significant amount of dust, and some control measures will be taken in this connection. Dust control measures are described in Environmental Management Plan.

According to the Russian Standard (SanPiN 2.2.1/2.1.1.1200-03), determining the size of protection zone for operations of different profiles, the protection zone of the process plant ground totals 300 m. The estimates of pollutants spreading show that there will be no exceedence of Russian maximum concentration limits on any of the sanitary protection zone boundaries, for no one component. The impact of the process plant section on air quality can be assessed as not significant.

Table 6.22. Summary of impacts of the process plant and auxiliary works

Environmental aspect	Impact	Spatial extent	Intensity	Duration	Consequence	Probability	Significance rating	Status of impact	Confidence of assessment
Hydrogeology and permafrost	Change to the ground seasonal thaw level in the cold season	1	2	2	low	probable	low	-ve	medium
Soils	Contamination by dust	1	2	2	low	probable	low	-ve	high
Vegetation	Contamination by dust	1	1	2	very low	probable	very low	-ve	high
Fauna	Loss of habitats	1	3	2	medium	definite	medium	-ve	high
	Disturbance of animals	1	2	2	low	definite	low	-ve	high
Surface water	-	-	-	-	-	-	-	-	high
Air	Air contamination	1	2	2	low	definite	low	-ve	high

6.5.5. Tailings dump

- Hydrogeology and permafrost

Tailings dam operational experience in a similar natural environment to the project site shows that during the initial period of tailings deposition, thawing of permafrost grounds takes place in the tailings dam basin to a depth of 4.5 meters. With tailings accumulation, the upper level of permafrost ground will be restored.

Dam construction will be undertaken with permafrost in place. To achieve this, the base of the dam wall will be constructed in winter to ensure the ground under the dam is frozen. The subsequent layers will also be placed taking the permafrost conditions into account. Permafrost ground experts will be consulted in the next stage of project design.

Loss of dam stability is possible in the event that the frozen condition changes, and could result in dam collapse. The probability of this is very low, but dam collapse can cause significant contamination of the River Kuronakh and its waterways downstream of the tailings dam.

- Soils and Vegetation

During the period of tailings dam operation there will be no impact on soils and vegetation.

- Fauna

See the description of process plant site impact. It can be assumed that there will be no negative impact caused by the tailings dam above that described for the process plant site.

- Surface waters

The project does not involve water discharge from the tailings dump into surface water bodies, and routine operation will cause no damage to surface waters. However, in the case of tailings dam wall collapse because of frozen ground thawing there will be a significant impact on a large area of the River Kuranah downstream from the tailings dam.

- air

The emission of dust from the tailings beaches will impact on air quality. According to the project, the beaches in the tailings dam basin will be of a minimum size (20-25 metres), so as to strengthen the dam.

Table 6.23. Summary of the impacts of the tailings dam

Environmental aspect	Impact	Spatial extent	Intensity	Duration	Consequence	Probability	Significance rating	Status of impact	Confidence of assessment
Hydrogeology and permafrost	Degradation of the permafrost under the tailings dam	1	3	1	very low	definite	very low	-ve	high
Soils	-	-	-	-	-	-	-	-	medium
Vegetation	-	-	-	-	-	-	-	-	high
Fauna	Destruction of habitats	1	3	2	medium	definite	medium	-ve	high
Surface water	Contamination of the River Kuranah in the event of dam collapse	3	3	1	high	possible	medium	-ve	medium
Air	Dust from beaches	1	2	2	low	definite	low	-ve	high

6.5.6. The camp

- Hydrology and permafrost

During the camp use change in permafrost conditions under the buildings can occur because of the presence of constant sources of heat (sauna, living buildings, boiler and others).

- soils and vegetation

There will be no additional impact on soils and vegetation above that described for the period of construction.

- fauna

See the description of process plant impact.

- surface waters

All the camp water discharges, after being treated, will be discharged into the tailings dam, and there will be no impact on surface water bodies.

- air

Air emissions from the camp will be generated by the following:

- boiler;
- indoor and outdoor car parks;
- canteen.

In total, the camp is the source of 12 substances, with a total volume of 12 tonnes per year.

Table 6.24. Summary of impacts of the camp

Environmental aspect	Impact	Spatial extent	Intensity	Duration	Consequence	Probability	Significance rating	Status of impact	Confidence of assessment
Hydrogeology and permafrost	Change in permafrost conditions under the buildings	1	1	2	low	probable	low	-ve	medium
Soils	-	-	-	-	-	-	-	-	medium
Vegetation	-	-	-	-	-	-	-	-	medium
Fauna	Destruction of habitats	1	3	2	medium	definite	medium	-ve	high
	Disturbance of animals	1	2	2	low	definite	low	-ve	high
Surface water	-	-	-	-	-	-	-	-	high
Air	Air contamination	1	2	2	low	definite	low	-ve	high

6.6. Socio-economic impacts

The main potential kinds of influence during the operational phase of the project are:

- possible detrimental effect on income from hunting;
- possible detrimental effect caused by the loss of pasture lands;
- positive impact on the economy of the Tyndinsky district and Amur oblast as a result of tax payments;
- positive impact on the employment of residents in the Tyndinsky region;
- positive impact on the infrastructure of Olekma settlement through the construction of additional facilities.

Hunting rights on the area near the Kuranah deposit belong to the Nyukzha collective farm, where representatives of native people of the North are employed. The area and border of the Nyukzha collective farm hunting area are defined by the Amursky Region Administration Resolution of 04.11.96 № 530. According to this resolution, the total hunting ground of 2,200,000 ha has been given to the collective farm for a period of 10 years, that is, until 4 November 2006. Thus, development of the deposit will impact only upon some small parts of the land, amounting to about 0.6% of the whole hunting ground territory given to this farm (12,600 ha out of 2,200,000 ha). However, taking into account that hunting is one of the major sources of income for residents, compensation has been calculated, amounting to 1849434.87 rubles (about \$70 000) that will be paid out by Olekminsky mining company.

The pasture area near the deposit is also used by the Nyukzha collective farm, defined by the Amursky Region Administration Resolution of 25.05.1984 № 233. According to this resolution, the total pasture area of 1 933 070 ha has been given to the collective farm for a period of 25 years, that is, until 2009. Thus, development of the deposit will impact only upon some small parts of the land – amounting to about 0.03 % of the whole pasture territory. The Committee on Land Resources of the Tyndinsky region has calculated compensation for the pasture land loss, which totals 3 057 400 rubles (about US \$ 110 000), which will be paid out by Olekminsky mining company.

Despite the comparatively insignificant impact, one should take into account that deer farming and hunting is the only source of income for representatives of native people. That is why the Olekminsky mining company initiated cooperation with representatives of native people. Delivery of meat and some clothing by generic communities for Kuranah mine needs can make the basis of such cooperation.

The proposed deposit development will bring some significant, however short-term, economic profit to the Amur oblast and Tyndinsky district. It is expected that salary and tax payments will directly influence the local economy. Besides, it is well-known that such direct payments bring additional profit, being made in the process of internal currency in local economy (so called multiple influences). It is difficult to forecast (and even to measure) the scale of such influence, but according to research, the real amount that the local economy gains through local purchases is approximately 2.5-3.0 times the direct payments. Despite the fact that it is difficult to estimate the definite rate of economic profit in a quantitative manner, it is expected that this profit will be significant. The possible negative influence caused by violation of hunting and agricultural activities will be insignificant.

Olekma settlement, the nearest to the operation, will be subject to the strongest impact. As the assessment of the influence of production on the components of the natural environment has shown, local people will not experience any negative impacts because of environment pollution. On the other hand, positive impacts will be caused by the following:

- Direct employment of the settlement residents.
- Support of social projects which generally involves repair works and servicing, provision of technical equipment and building works.

- The indirect impact caused by the operations of Olekma railway station used for transportation, which employs more than 50% of the able-bodied settlement residents (according to the administration of Tyndinsky region).

6.7. Conclusion

The environmental impact assessment has shown that on the whole, construction and operation of the Kuranakhsy deposit will cause no significant consequences to the natural and social environment.

Definite positive impacts will occur in the socio-economic area. In addition, cooperation with representatives of native people of the North may also produce some positive socio-economic effect on this group of people.

A summary of the assessment of impacts on the components of the environment is given in Table 6.9.

The main impact during the construction phase will be on soil cover and vegetation, which will be destroyed on an area of not less than 500 ha. Vegetation cover will be partially restored during the rehabilitation period. Because of the low capacity of the topsoil, it will not be removed and kept for re- use later for rehabilitation, thus loss of soils will be irreversible.

The main impact at the production phase will be on the following:

- fauna because of irreversible loss of animal natural habitat in the pit area;
- dust pollution of the components of the environment.

The assessment of impact has shown that there is some information that is unavailable, because no research work has been carried out on the issues, including the following:

- hydrological characteristics of small waterways on the mining works lands;
- hydrological and frozen ground conditions after the deposit has been worked out in the event of flooding of the void;
- engineering-geological conditions of the tailings dam site.

The impact assessment has shown that there is the need for a system of management to be developed on the following issues:

- frozen ground conditions;
- environmental monitoring;
- water management optimization and further hydrological characteristics research;
- dust control;
- waste management.

Table 6.25. Summary table on the environmental impact assessment of the Kuranah mining and processing operation

Environmental aspect	Source of impact	Impact	Significance rating	Status	Confidence of assessment
Construction phase					
Hydrogeology and permafrost	Open pit	Raising of the seasonal thaw level of ground under the overburden dumps	low	-ve	high
	GSF and other facilities on the mine site	-	-	-	medium
	Road	-	-	-	medium
	Process plant and other facilities on the plant site	-	-	-	medium
	Tailings dam	Changing of the permafrost conditions because of tailings dam construction	low	-ve	medium
	Camp	-	-	-ve	medium
Land use	Open pit	Loss of forest land	high	-ve	high
		Loss of pastures and hunting areas	medium	-ve	high
	Road	Loss of forest land	high	-ve	high
	For all other project components	Loss of forest land	low	-ve	high
		Loss of pastures and hunting areas	medium	-ve	high
Soils	For all project components	Destruction of top soil	high	-ve	high
		Partial top soil destruction	very low	-ve	medium
Vegetation	Open pit	Destruction of growth	medium	-ve	high
		Impact of dust deposition	very low	-ve	medium
	GSF and other facilities on the mine site	Destruction of growth	medium	-ve	high
		Impact of dust deposition	very low	-ve	medium
		Planting	low	+ve	high
	Road	Destruction of growth	high	-ve	high
	Process plant and other facilities	Destruction of growth	medium	-ve	high
		Impact of dust deposition	very low	-ve	medium
		Planting	low	+ve	high

	Tailings damp	Destruction of growth	medium	-ve	high
		Impact of dust deposition	very low	-ve	medium
		Planting	low	+ve	high
	Camp	Destruction of growth	medium	-ve	high
		Planting	low	+ve	high
Fauna	Open pit	Destruction of habitats	medium	-ve	high
	GSF and other facilities on mine site	Destruction of habitats	medium	-ve	high
	Road	Destruction of habitats	medium	-ve	high
	Process plant and other facilities	Destruction of habitats	medium	-ve	high
	Tailings dam	Destruction of habitats	medium	-ve	high
	Camp	Destruction of habitats	medium	-ve	high
Surface water	Open pit	Water contamination because of the discharge from the drainage ditch	very low	-ve	medium
	GSF and other facilities on the mine site	-	-	-ve	high
	Road	Water contamination	very low	-ve	high
		Disturbance of the Kuranah river-bed	medium	-ve	medium
	Process plant and other facilities	Destruction of the temporary watercourse	medium	-ve	high
	Tailings dam				
Camp	-	-	-	high	
Air	Open pit	Emissions from machinery and dust generation	very low	-ve	high
	For all other project components	Emissions from machinery and dust generation	very low	-ve	high
Operational phase					
Hydrogeology and permafrost	Open pit	Loss of stability because of thawing of the upper layers of permafrost grounds	low	-ve	medium
		Disturbance of permafrost conditions by open pit	very low	-ve	medium
		Hydrogeological regime changing during first years of development	very low	-ve	high
		Disturbance of hydrological regime of Saikta Stream because of the water abstraction in summer time	low	-ve	medium
		Hydrogeological regime changing during last	low	-ve	medium

		years of development			
	GSF and other project components on mine site	Disturbance of permafrost conditions	very low	-ve	medium
		Disturbance of hydrological regime of Saikta stream because of water abstraction	low	-ve	medium
	Road	Raise of seasonal level of ground thaw	low	-ve	high
	Process plant and other facilities	Changing of seasonal thaw and presence of a thawed layer in the cold season	low	-ve	medium
	Tailings dam	Degradation of permafrost under the tailings dam	low	-ve	high
	Camp	Changing of permafrost conditions under buildings	low	-ve	medium
Soils	Open pit	Contamination by dust	low	-ve	high
	GSF and other facilities on mine site	Contamination by dust	very low	-ve	high
	Road	Contamination by dust	low	-ve	high
		Destruction of soil close to the roadway	high	-ve	high
	Process plant and other facilities	Contamination by dust	low	-ve	high
	Tailings dam	-	-	-	medium
	Camp	-	-	medium	
Vegetation	Open pit	Contamination by dust	low	-ve	medium
	GSF and other facilities on mine site	Contamination by dust	very low	-ve	medium
	Road	Contamination by dust	very low	-ve	high
		Physical damage	low	-ve	high
	Process plant and other facilities	Contamination by dust	very low	-ve	high
	Tailings dam	-	-	-	high
	Camp	-	-	high	
Fauna	Open pit	Destruction of habitats	high	-ve	high
		Disturbance of animals	medium	-ve	high
	GSF and other facilities on mine site	Destruction of habitats	high	-ve	high
		Disturbance of animals	medium	-ve	high
	Road	Destruction of habitats	medium	-ve	high
		Disturbance of animals	low	-ve	high
	Process plant and other facilities	Destruction of habitats	medium	-ve	high
		Disturbance of animals	low	-ve	high
	Tailings dam	Destruction of habitats	medium	-ve	high

	Camp	Destruction of habitats	medium	-ve	high
		Disturbance of animals	low	-ve	high
Surface water	Open pit	Changing of hydrological regime because of mine water pumping	low	-ve	medium
		Changing of hydrological regime because of mine water discharge	low	-ve	medium
		Contamination by discharged mine water	medium	-ve	medium
	GSF and other facilities on mine site	Contamination by discharged water	very low	-ve	medium
	Road	Contamination by dust and emissions from vehicles	very low	-ve	medium
		Contamination by oil products in the event of an accident with transport	medium	-ve	medium
	Process plant and other facilities	-	-	-	high
	Tailings dam	Contamination of River Kuranah in the event of dam collapse	very low	-ve	medium
	Camp	-	-	-	high
Air	Open pit	Emissions from machinery and blasting operation and dust generation	very low	-ve	medium
	GSF and other facilities on mine site	Dust emission from GSF and emission from other project components	very low	-ve	high
	Road	Contamination by dust and emissions of vehicles	very low	-ve	high
	Process plant and other facilities	Air contamination	low	-ve	high
	Tailings dam	Dust generation from beaches	low	-ve	high
	Camp	Air contamination	low	-ve	high

6.8. Operation closing and phasing-out

Russian standards concerning operation closure and rehabilitation are general, and definite technical requirements are given only for closure of mine workings and soil covering rehabilitation. The Russian legal system regulates building and construction demolition issues to a minor extent, to be more exact, there are no direct regulations concerning the necessity to completely disassemble and remove (or bury) buildings and structures.

The main World Bank guidelines containing regulations for the area of rehabilitation for the mineral resource industry is “Base metal and iron ore mining”. In addition, there is “Mining and milling – open pit” guideline.

According to these documents, a Plan of operation closure and rehabilitation must be developed. Such a plan should contain rehabilitation measures for tailings dams, waste rock dumps, open pits, ponds, mill and camp sites. Such a plan has been developed on behalf of the company “Aricom” by the independent consultant E.Y.Vershinina in March 2006, and is presented as part of this document in Section 8.

According to the Plan, the key points concerning the closure of the operation and rehabilitation of the land are as follows:

- open pit rehabilitation;
- waste rock dump rehabilitation;
- demolition of operation buildings, structures and ancillary facilities, located on the project sites;
- tailings dam rehabilitation;
- camp demolition;
- resolution on access and section-connecting roads, railways and power lines;
- solving socioeconomic issues;
- financial aspects of rehabilitation.

The Plan involves carrying out post-closure environmental monitoring, which is a standard International procedure; and also it is considered by the Olekminsky mine company to be a safety provision measure.

The post-closure monitoring program will be developed on the basis of the operational phase monitoring program, and will continue on from it. The post-closure monitoring will consider operational phase monitoring results and any new factors that might have arisen by the time of operation closure. The main outline of post-closure monitoring is presented in the Plan.

7. ENVIRONMENTAL, HEALTH AND SAFETY MANAGEMENT PLAN

7.1. Introduction

This Plan describes the main commitments of company Olekminskiy Rudnik for the Kuranah mining and processing project in terms of mitigation measures to protect the environment, safety provisions and proposals on public consultation. On the basis of this plan, detailed procedures and instructions will be developed for employees on every component outlined. The Plan has been developed based on the issues identified during the environmental impact assessment process.

7.2. Management and responsibilities

All questions related to environmental protection will be the responsibility of the environmental services department of the project. The department is headed by a chief specialist on environmental protection and safety, who has appropriate qualifications and work experience in mining. The head of the department reports directly to the chief engineer.

The environmental services department also includes a specialist on health and safety, and an environmental engineer. Responsibilities of the environmental services department's members are outlined in Table 7.1.

Table 7.1. Responsibilities of the environmental services department's members

Position	Subordination /reporting	Qualification requirements	Responsibilities
Chief specialist on environmental protection and safety	Chief engineer	High technical education, additional environmental education, experience in environmental protection in mining	<ul style="list-style-type: none"> • Implementation of this plan and its updates, including implementation of the proposed measures; • Review and analysis of monitoring results and preparation of reports to chief engineer; • Obtaining all necessary permits; • Planning of training programs for personnel in accordance with Russian requirements on labour protection and international standards and control of carrying them out
Environmental engineer	Chief specialist on environmental protection and safety	High technical or environmental education, work experience in the field of environmental protection, experience in performing environmental monitoring	<ul style="list-style-type: none"> • Environmental monitoring and sampling; • Preparation of environmental monitoring report; • Help in carrying out training programs; • Control over fulfilling the environmental protection requirements for workers and

			contractual organizations
Health and safety specialist	Chief specialist on environmental protection and safety	High technical education, specialized education on health and safety.	<ul style="list-style-type: none"> • Instructions on health and safety; • Control over carrying out the safety requirements. • development and implementation of emergency response plans

7.3. Waste management

7.3.1. Introduction

The Kuranah mining and processing project will produce a large quantity of different kinds of wastes. The main parts of the waste will be waste rock, dry tails from primary separation and tailings from the process plant. The most dangerous wastes are the waste mercury lamps.

7.3.2. Solid domestic wastes

Domestic wastes will be produced at the mine site, and the sites of the process plant and camp.

Domestic wastes at the mine site will be collected in containers (two containers, 0.75 m³ capacity each) which, once full of waste, will be transported to the landfill on the mine site. The annual quantity of domestic waste generated at the mine site is 2.5 tonnes. Besides domestic wastes, some industrial wastes are supposed to be placed in the same landfill. The State sanitary service will give its opinion on the possibility of combined disposal of domestic and industrial wastes on the basis of special analysis.

Domestic wastes produced in the camp and process plant are collected in containers (6 containers on the camp site and 4 on the process plant site, with a capacity of 0.75 m³ each) and transported to the landfill in Olekma settlement on the basis of a contract, signed with Olekma's administration.

During the temporary storage of wastes, the possibility of its decay must be excluded, which is why the containers will not be kept for more than 3 days in the cold season (temperature less than -5°C), and one day in the case of higher temperatures. Metal containers are used for the waste collection, with ablution of them every 10 days.

7.3.3. Waste rock

Waste rock from the open pit is disposed to the dump, located in the void of the open pit (internal dump), and beside the open pit (external dump). The volume of the internal dump is 25,200,000 m³, and the external dump is 23,519,200 m³. The area of the external waste rock dumps is 90 ha. The waste rock does not contain any toxic elements and is not a potential source of acid drainage.

During construction of the base of the dump, a thickness of 5-10 metres of waste rock will be placed in winter to maintain the permafrost and provide dump stability.

Waste rock dumps are a source of dust generation, and the management of dust will be described in the appropriate section of this Plan. The mining engineer is responsible for the dump management.

7.3.4. Dry tails from primary concentration

Dry tails generated by the grinding-sorting factory will be disposed of in a separate dump. The quantity of dry tails is 750 000 tonnes per year. The dry tails do not contain toxic elements and are not a source of acid drainage. The particle size of the dry tails is less than 10 mm, which can cause elevated levels of dust generation. The management of dust will be described in the appropriate section of this Plan.

7.3.5. Tailings from the process plant

The quantity of tailings from the process plant is 530 thousand tonnes per year. They are disposed of in the tailings dump, located close to the process plant. A description of the tailings dump is presented in the “Project description” section. As the tailings dump construction is not defined yet, details on its management will be developed later on the basis of the adopted project design. It is expected that the main focus during the design definition and provision of safety will be the question of maintaining the permafrost, because its loss can cause dam deformation.

7.3.6. Other industrial wastes

The main and auxiliary units of the operation are sources of wastes which are diverse in composition and quantity. In accordance with the Russian classification, all wastes are divided into 5 classes from the 1st (the most hazardous) to the 5th (not hazardous). A list of the types and quantities of wastes produced, as well as their place of disposal, is given in Table 7.2.

The main task at this stage is to define methods of waste utilization (re-use and recycling), for wastes which will not be disposed of to the landfills of the mine site and the settlement. A search of specialist organizations will be organized in Amur oblast and neighbouring regions (first of all Chita oblast and Yakutia), which can utilize certain types of wastes. Research will be undertaken through the Administrations of Tundinskiy district and Amur oblast and through the Internet. Waste utilization will be organized on the basis of a contract between the companies. Waste removal will be made by the company Olekminskiy Rudnik or by the contractual organization, depending on the contract conditions. Special sites will be defined and fitted out for waste collection. Most of the waste will be collected and temporarily kept on the area of the repair shop on the process plant site, because this section is the source most of the wastes types.

Table 7.2. List of the produced wastes

Source of waste products	Waste description	Danger class	Units	Average qty per annum	Treatment and/or placement
Mine site and grinding-sorting factory					
Explosive materials storage area	Cardboard boxes	5	Pcs.	28000	Burning or using for heating
	Wooden boxes	5	Pcs.	1150	
Grinding-sorting factory	Rubber scraps	5	tonnes	0.5	Mine site landfill
	Scrap metal from repaired and written-off equipment	5	tonnes	3	Export out for re-use
Treatment facilities for open pit water	Dredge products	5	tonnes	782	To the waste rock dump
	Oil products	3	tonnes	13.9	Mine site landfill
Garage and repair	Exhausted motor oils	3	tonnes	195	Export out for re-use

shop, storage facilities	Exhausted transmission oils	3	tonnes	19.5	Export out for re-use
	Exhausted hydraulic oils	3	tonnes	47	Export out for re-use
	Exhausted filters	3	tonnes	0.8	Mine site landfill
	Worn-out tyres with metal cord	4	tonnes	293.5	Mine site landfill
	Cleaning materials	4	tonnes	0.15	Mine site landfill
	Battery acid	2	tonnes	0.4	Export out for re-use
	Exhausted battery without acid	3	Pcs.	40	Export out for re-use
	Metal barrels (solid oils, lubricating oils)	4	tonnes	0.5	Export out for re-use
	Scrap metal from vehicle repair	5	tonnes	3	Export out for re-use
	Welding electrode ends	5	tonnes	1	Export out for re-use
	Flue cinders	4	tonnes	0.2	Mine site landfill
	Abrasive materials scrap	5	tonnes	0.3	Mine site landfill
	Grit	5	tonnes	0.7	Mine site landfill
	Worn-out brake pads	5	tonnes	2.7	Export out for re-use
	Sweepings and rubbish	4	tonnes	4.6	Mine site landfill
Combustible-lubricating materials store	Soils polluted by oils	4	tonnes	1.5	Mine site landfill
Septic tank	Septic tank waste	4	tonnes	-	To the treatment facilities of the process plant
Treatment facilities for stormwater	Solid sediment	5	tonnes	0.2	Mine site landfill
	Oils	3	tonnes	0.01	Mine site landfill
Treatment facilities for black-oily water drainage	Solid sediment	4	tonnes	250	Mine site landfill
	Oils	3	tonnes	1.02	Export out for re-use
Indoor and outdoor lighting	Fluorescent and mercury lamps	1	Pcs.	1220	Export out for re-use
	Sodium lamps	5	Pcs.	190	Mine site landfill
Process plant and camp site					
Process plant	Sweepings and rubbish	4	tonnes	41.0	Mine site landfill
Motor depot	Exhausted motor oils	3	tonnes	55.5	Export out for re-use
	Exhausted transmission oils	3	tonnes	7.0	Export out for re-use
	Exhausted hydraulic oils	3	tonnes	6.9	Export out for re-use
	Exhausted filters	3	tonnes	0.3	Solid waste landfill of Olekma settlement
	Worn-out tyres with metal cord	4	tonnes	34.7	Solid waste landfill of Olekma settlement
	Cleaning materials	4	tonnes	0.7	Solid waste landfill of Olekma settlement
	Battery acid	2	tonnes	0.3	Export out for re-use
	Exhausted battery without acid	3	Pcs.	40	Export out for re-use
	Metal barrels (solid oils, lubricating oils)	4	tonnes	0.3	Export out for re-use
	Ferrous metals scrap from	5	tonnes	20.0	Export out for re-use

	vehicle repair				
	Non-ferrous metals scrap from vehicle repair	5	tonnes	20.0	Export out for re-use
	Welding electrode ends	5	tonnes	2.0	Export out for re-use
	Flue cinders	4	tonnes	0.5	Solid waste landfill of Olekma settlement
	Abrasive materials scrap	5	tonnes	1.0	Solid waste landfill of Olekma settlement
	Grit	4	tonnes	2.3	Solid waste landfill of Olekma settlement
	Worn-out brake pads	5	tonnes	0.6	Export out for re-use
	Sweepings and solid waste	4	tonnes	12.0	Solid waste landfill of Olekma settlement
Repair shop and storage facilities	Welding electrode ends	5	tonnes	1.3	Solid waste landfill of Olekma settlement
	Flue cinders	4	tonnes	0.4	Solid waste landfill of Olekma settlement
	Abrasive materials scrap	5	tonnes	0.2	Solid waste landfill of Olekma settlement
	Grit	4	tonnes	0.5	Solid waste landfill of Olekma settlement
	Cleaning material	4	tonnes	2.0	Solid waste landfill of Olekma settlement
	Sweepings and solid waste	4	tonnes	25.0	Solid waste landfill of Olekma settlement
	Packaging materials	5	tonnes	10.8	Burning
	Polyethylene waste	5	tonnes	3.6	Solid waste landfill of Olekma settlement
	Machinery oil	3	m ³	0.66	Export out for re-use
Combustible-lubricating materials store	Soils polluted by oils	4	tonnes	0.2	Solid waste landfill of Olekma settlement
	Metal barrels	4	tonnes	Not defined	Export out for re-use
Treatment facilities for stormwater	Solid sediment	4	tonnes	0.22	Processing at the sludge beds with further composting
	Mineral oils	3	tonnes	0.01	Solid waste landfill of Olekma settlement
Treatment facilities for domestic water	Solid sediment (silts)	4	m ³	17.9	Processing at the sludge beds with further composting
Treatment facilities for black-oily drainage from storage near railways	Solid sediment	4	tonnes	32.0	Export to the tailings dump
	Mineral oils	3	tonnes	0.13	Export out for re-use
Check-point	Sweepings and rubbish	4	tonnes	0.5	Solid waste landfill of Olekma settlement
Railways and roads	Sweepings and rubbish	4	tonnes	2.5	Solid waste landfill of Olekma settlement
	Soils polluted by oils	4	tonnes	7.0	Solid waste landfill of Olekma settlement
Camp site	Solid waste from	4	tonnes	93.6	Solid waste landfill of

	residential buildings				Olekma settlement
	Food waste from canteen	5	tonnes	16.2	Solid waste landfill of Olekma settlement
	Waste from medical station	4	tonnes	0.1	Solid waste landfill of Olekma settlement
	Sweepings	4	tonnes	71.0	Solid waste landfill of Olekma settlement
Indoor and outdoor lighting	Fluorescent and mercury lamps	1	Pcs.	3610	Export out for re-use
	Sodium lamps	5	Pcs.	240	Solid waste landfill of Olekma settlement
Process plant power supply system	Isolators	5	tonnes	0.04	Solid waste landfill of Olekma settlement
	Exhausted dielectric oils	3	Litres	60	Export out for re-use
	Soils polluted by oils	4	tonnes	0.1	Solid waste landfill of Olekma settlement
	Ungraded aluminium scrap	5	tonnes	1.5	Export out for re-use

7.4. Dust control

7.4.1. Introduction

The Kuranah mining and processing project is the source of a significant quantity of dust, and the low precipitation reinforces this problem. In spite of the fact that the nearest settlement is 5 km from the process plant site and 40 km from the open pit, and impact on the local residents isn't expected to have place in the event of intensive dust emissions, elevated concentrations can have a negative impact on personnel health during work and rest. Dust contamination of surrounding soils and plants can cause their degradation. Dust control measures are therefore an important part of the Environmental management plan.

Dust sources were defined in the VNIPI project, and the main ones are as follows:

- open pit;
- waste rock dumps;
- primary concentration dry tails dump;
- grinding-sorting factory;
- road from open pit to process plant;
- process plant;
- tailings dump.

7.4.2. Measures

Measures described bellow will be implemented to provide the dust suppression and minimize the impact of dusting on the physical environment and human health.

Table 7.3. Dust control measures

Dust source (place and process)	Features	Control measures	Frequency	Responsibility
Open pit and waste rock dumps				
Open pit - roads	Continuous dust emissions	Road sprinkling	As required	Mining engineer
Open pit – loading	Continuous dust	Sprinkling of ore and	As required	

and transport	emissions	waste rock before loading and transport		
Waste rock dumps	Dust emissions from large area	Rehabilitation of completed dumps	Just after completion of the dump	
Grinding-sorting factory				
Dry tails dump	Continuous dust emissions	Sprinkling of the surface	As required	Chief specialist on environmental protection and safety
Loading section	Areal source	Sprinkling of ore after unloading	As required	
Crushing and separation buildings	Emission through the pipe	Regular checking of the efficiency of the cyclones	Once per day	
Process plant				
Ore receiving area	-	Sprinkling of ore being stored	As required	Chief specialist on environmental protection and safety
Other components				
Road between Olekma-process plant-open pit	Dust emissions from road	Road sprinkling	Once per day if needed	Chief specialist on environmental protection and safety
Tailings dump	Dust emissions from beach	Keeping beaches of width not more than 20-25 m	Constantly	
		Revegetation	As soon as possible	

7.5. Water management

7.5.1. Water supply optimization

The environmental impact assessment on water resources showed that use of water resources on the mine site was not efficient enough.

The mine site does not need high quality water (for sprinkling, cleaning and other uses), and according to the project design requires a constant 4.2 m³ per day and 336.56 m³ per day in summer time. A water supply of good quality is proposed for this purpose, including:

- sprinkling of the rock mass (288.24 m³ per day (project design));
- road sprinkling (44.12 m³ per day (project design));
- cleaning of the grinding-sorting factory (3 m³ per day (project design));

Besides, the project design does not consider water needed for dust control on other sites which are the source of the dust emission, including:

- primary concentration dry tails dump;
- loading section of the grinding-sorting factory;
- road between open pit-process plant-Olekma.

At the same time, the project plans to discharge mine and storm water. As long as pumped mine water is treated through the clarifying pond prior to being discharged, it can be

used as a supply of recycled water. For this purpose, the pond will be provided with a pump station, which will fill sprinklers.

It is important to note that almost the whole volume of pit water is due to precipitation, and so in the case of dry weather, the water inflow into open pit will be only 800 m³ per day, and additional water can be needed.

7.5.2. Discharge water quality

During periods of precipitation, the need to discharge water remains. The impact assessment showed that the planned quality of water for discharge is not in compliance with World Bank requirements for suspended matter, and additional measures on water treatment will be considered at the next stage of the project design.

Water monitoring is described below.

7.5.3. Measures for surface water pollution prevention

The main commitments for surface water pollution prevention are:

- Waste disposal control;
- Erosion control, especially rivers and streams banks destruction during the construction phase;
- Inspection of oil product transport;
- Prevention of oil product seepages;
- Control of prevention of seepage from pipelines.

7.6. Emergency response

7.6.1. Introduction

The Company has a responsibility both to minimise the risk of emergencies and to ensure effective planning for response to emergencies. In spite of the fact that Russian legislation concerns mainly the prediction of potential emergencies and does not focus much on actions in an emergency situation, Olekminskiy Rudnik will develop detailed emergency response plans for potential events prior to the operational phase of the project on the basis of detailed design, which will be undertaken later. A framework for the content of these plans is presented in this section.

The distance separating the operational units of the Kuranah mining and processing project will be taken into account in the emergency response plans.

7.6.2. Components of an emergency response plan

The main parts of the emergency response plan are:

- Definition of emergency situations;
- Development of emergency scenarios and assessment of the risk of their occurrence;
- Identified group of risk;
- Record of the quantity and location of hazardous substances;
- Material safety data sheets detailing the properties of each hazardous substance;
- Detailed plan of action for each type of emergency;
- Reporting procedures.

7.6.3. Emergency response centre

An emergency response centre will be located at the process plant site, where the person in charge of emergency response will be on duty twenty four hours per day. All Emergency Response Plans and essential information will be held in the centre. Copies of the plans for the mine site will be kept in the office on the mine site.

In addition to the emergency response plans, the following documents will be available in the emergency centre:

- Lists of functions of key people.
- Notification lists with telephone numbers.
- Shut down procedures and type and location of alarm systems.
- Locations of hazardous material storage areas/ emergency safety equipment.
- Emergency power source/location capacity.
- Operating manuals.
- List of personnel with alternate skills for use in emergencies.
- Emergency equipment and resources.

The emergency response centre will have special equipment:

- Fire fighting equipment, including a special vehicle.
- Local or regional weather forecasting service.
- Breathing apparatus.
- Protective equipment.
- Adequate emergency equipment for spill containment or collection such as additional supplies of booms and absorbent material.

7.6.4. Emergency training

The following training and drills will be designed and then implemented:

- Evacuation procedure for personnel from every operational unit.
- Procedures for reporting emergencies (for the specialist on health and safety and persons in charge).
- Operation and knowledge of alarm systems and communications system.
- Location and use of fire-fighting and protective equipment.

7.7. Health and safety management

7.7.1. General statements

The Olekminsky mining company considers labour protection and industrial safety issues to be one of the most important and necessary components of efficient organizational management.

The Russian mining industry has its own history as far as labour protection and industrial safety issues are concerned. The Russian system of standards and regulations written in various standards documents, can be compared with similar systems in other countries – they make it possible to establish a solid basis for labour protection and industrial safety management. However, inefficient practical implementation and lack of appropriate control for the execution of particular regulations has led to the fact that some types of work do not meet International standard requirements in some particular aspects.

Olekminsky mining company considers that the establishment of a protection and industrial safety system is necessary for the development of the Kuranah project to satisfy the demands of Russian standards and International standards, irrespective of how strict the inspections by the controlling unit are.

At the present stage, it is necessary to define particular principals determining the establishment of such a system of management:

1) The system will satisfy the demands of Russian standards and International principals.

In international practice, there exists basic organizational management, with a system of continuous assessment, control and management of work progress on site. Russian requirements, however, are mostly based on reports detailing how the assessment, control, and management scheme are carried out by controlling units and public officials. The system for the Kuranah project will include both approaches.

2) The system will satisfy basic international standards of labour protection and industrial safety (including OHSAS 18001).

Thus, the system will include:

- Labour protection and industrial safety standards, adopted by the administration, strict fulfilment of the established standards.
- Obligation to constantly raise safety standards according to national and international standard changes.
- Constant staff and contractor training for them to become better aware of labour protection and safety, which is especially important as the general labour safety culture is not very well developed in Russia.

The system of labour protection and industrial safety management will be managed by a health and safety specialist, with the assistance of foreign and Russian experts. Health and safety general management will be carried out by the Health and Safety Specialist, who reports to the Chief Specialist on environmental protection and safety. A person-in-charge of Health and Safety is appointed on each section of the operation.

Health and Safety management will be carried out using a risk assessment method and essential measures of engineering and procedural control. The procedure for the performance of higher risk works, such as explosive materials treatment and usage, will be developed on the basis this Plan.

All employees will complete general and specific courses in labour protection and industrial safety.

Inspection of records of on-site work to relevant standards will be carried out in the course of regular administrative and annual external reviews.

One of the main areas of focus in the Health and Safety Plan will be fire safety.

For the sake of fire safety, and building and construction fire security, the project involves the following measures:

- Treatment of metal and wooden constructions with a fire-resistant coating;
- Establishment of fire hydrants;
- Finishing of building interiors with materials which are non-toxic when heated;
- Location technical equipment will be defined with taking possibility of quick and safe evacuation in case of fire into account;
- Availability of primary fire-extinguishing means;
- Availability of necessary access to buildings;
- Automatic fire-alarm system in all buildings;
- Installation of an emergency lighting network, indicating emergency exits, position of fire extinguishers, hydrants and other fire protection equipment;

The operation's fire prevention will be carried out by operation's fire service.

7.7.2. Health and Safety management system

To provide effective occupational health and safety management, an appropriate Health and Safety Management System (HSMS) will be implemented by Olekminskiy Rudnik. The Chief specialist for environmental protection and safety will develop the occupational health and safety management system, with input from international and local experts. Occupational

health and safety on site will be managed by the health and safety specialist who will report to the Chief specialist for environmental protection and safety.

The HSMS will include the following main parts:

- risks identification; risks identification for working places will take into account:
 - situations, events, circumstances, which potentially can course injury or illness of workers;
 - causes of potential illnesses connected with work;
 - data about previous injuries, illnesses or accidents;

During risks identification, the following items will be considered:

- planning of working places;
- process technologies;
- work organization;
- equipment assembling;

On prior estimation, the main dangers for the Kuranah project could be:

- accidents during loading works;
- blasting operations in the open pit;
- transport accidents;
- electrical equipment work;
- risk assessment and control;

All risks associated with each risk will be estimated and assigned a priority rating. One of the main causes of increased risk for Russian mining projects is alcohol and drugs. This problem will be under especially intensive control.

For all risks, risk decreasing measures will be developed.

- First-aid

In case of injury, the employer will seek immediate first aid from a suitably qualified person. Medical centres with the necessary equipment for first-aid will be located on every operational site (open pit, grinding-sorting factory, process plant and camp). The Company will have a special medical car which can, if necessary, transport an injured person to the medical centre, located in camp and having permanent medical establishment.

- training;

Training on health and safety will have the following content:

- instruction on fire safety and general safety measures;
- routine regular instruction of workers on accident prevention for every working place;
- administering first-aid;
- ambient conditions in the workplaces

The standards for ambient conditions in the workplace are listed in Table 7.4¹⁴

Table 7.4. Standards for ambient conditions in the workplace

Conditions	Working place	Level
Noise (8 h)	Processing sections	85 dB (A)
	Offices and other rooms	50 dB (A)
Illumination (minimum level)	Machine storage, garage, warehouse	50 lux
	Industrial buildings	200 lux
Temperature	Industrial buildings,	27.5 °C

¹⁴ Levels adopted in accordance with Environmental and Social Guidelines for Occupational Health and Safety, IFC, 2003.

	indoor		
	Outdoor in the cold season warm-up periods should be provided for temperatures:	> - 20 °C > - 32 °C > - 43 °C	10-minutes every 4 hours two 10-minute periods every 4 hours non emergency work should cease

Monitoring of the working place air is described in the section on monitoring.

7.8. Environmental monitoring

7.8.1. Introduction

The environmental monitoring plan is developed for the Kuranah mining and processing project with the purpose of:

- Providing compliance of the operational activity with Russian and International requirements in the field of environmental protection;
- Providing information on the adequacy of the mitigation measures and monitor the effectiveness of their implementation;
- Providing unbiased and relevant information for presentation to control bodies, public and financial organizations;
- Obtaining data for the calculation of environmental pollution payments.

The environmental services department of the company Olekminskiy Rudnik will be responsible for environmental monitoring. Environmental monitoring results will be reviewed by the Chief specialist on environmental protection and safety once every three months.

An annual report on environmental monitoring will be presented to the operation management, as well as the public through the web-sites of the companies “Olekminskiy Rudnik” and “Aricom”.

The environmental monitoring program includes following components:

- Meteorological and climate characteristics;
- Monitoring of pollution sources;
- Hydrogeological monitoring;
- Surface water quality;
- Ambient air quality;
- Workplace zone air quality;
- Radiological monitoring.

7.8.2. Meteorological and climate characteristics

In accordance with Russian standard SNIIP 1.02.07-87, projects located in complicated conditions should be accompanied by meteorological monitoring at every stage from design until closure of the development. The following measurements will be included in the meteorological monitoring:

- atmospheric pressure;
- wind speed and direction;
- air temperature;
- humidity;
- soil temperature on sites with and without vegetation;
- precipitation and snow cover;
- ice phenomena;
- atmospheric phenomena.

The meteorological station will be located near the tailings dump, but out of the zone of its influence.

7.8.3. Surface water monitoring

Surface water quality monitoring will be commenced before construction starts and will be continued after the rehabilitation works have been completed. The monitoring schedule for the pre-construction phase, the construction phase and the operational phase of the project will be as presented in Table 7.5. Parameters for post-closure monitoring will be defined on the basis of monitoring during operation. After regular measurement over three years on the sites out of the impact zone, background concentrations will be defined for comparison with future concentrations of the parameters and agreed with state control bodies.

The Kuranah mining and processing operation has two points of discharge to the surface water environment – discharge of mine water from the open pit to the stream Yuzhnui-2 and discharge of stormwater from the grinding-sorting factory site to the stream Yuzhnui-1.

Table 7.5. Monitoring schedule for surface water quality

Parameter	Sampling point	Frequency	Responsible person	Action in case of exceedence
pH	Two discharge points – one to stream Yuzhnuy-2 (mine water) and one to stream Yuzhnui-1 (stormwater)	Once per week	Chief specialist on environmental protection and safety	Checking the effectiveness of the stormwater treatment plant, design of measures for additional treatment of mine water
Suspended solids				
BOD ₅				
Oil products				
Zn				
Ni				
Fe				
Hg				
Cu				
Mn				
Cl ⁻				
F ⁻				
NO ₃ ²⁻				
NO ₂ ⁻				
Na ⁺				
K ⁺				
NH ₄ ⁺				
Ca ⁺				
Mg ⁺				
pH	<ul style="list-style-type: none"> • streams Yuzhnui-1 and Yuzhnui-2 before and after discharge points; • River Kuranah after confluence with Saikta stream; • River Kuranah before and after tailings dump site 	Once per week	Chief specialist on environmental protection and safety	Find out the reason, report to chief engineer with proposals about a solution to the problem
Suspended solids				
BOD ₅				
Oil products				
Cl ⁻				
F ⁻				
NO ₃ ²⁻				
NO ₂ ⁻				
Na ⁺				
K ⁺				
NH ₄ ⁺				

Ca ⁺				
Mg ⁺				
Zn				
Ni				
Fe				
Hg				
Cu				
Mn				

7.8.4. Air quality monitoring

Air quality monitoring will be undertaken for point sources and ambient air. The operation has the following point sources of air emissions:

- crushing and separation buildings of the grinding-sorting factory;
- repairing shops;
- boilers;
- warehouses of combustible-lubricating materials on the site of GSF and process plant;
- concentrates drying section on the process plant site;
- loading and concentrate warehouse sections;
- filling station;
- garages;
- canteen and closed car parking on the camp site.

Regular control will be undertaken for machinery's engines for compliance with technical standards for exhausts.

Ambient air quality monitoring will be commenced before construction and continue until after rehabilitation.

The parameters listed in Table 7.6. will be measured for point sources and ambient air.

Table 7.6. Measured parameters for point sources and ambient air

Parameter	Sampling point	Measurement frequency	Responsible person	Action in case of exceedence
Volume of discharged gas	For all sources	Once per month	Power engineering specialist	Checking regime of fuel combustion
Dust	For boilers	Once per month		
NO ₂				
SO ₂				
Hydrocarbon				
Dust	GSF crushing and separation buildings, loading sections, process plant concentrates warehouse	Once per month	Chief specialist on environmental protection and safety	Find out cause and take action
NO ₂	All other sources	Once per month		
SO ₂				
Hydrocarbons				
Dust				

CO				
soot				
H ₂ S				
Benzopyrene				
CO	For cars	In accordance with schedule of regular maintenance	Head of garage	Engine repair
Hydrocarbons				
Dust	On the boundary of buffer zone (sanitary protection zone) of open pit (500 m) and GSF (300 m) on mine site	Once per week	Chief specialist on environmental protection and safety	To initiate additional measures for dust suppression
NO, NO ₂				
SO ₂				
Dust	On the boundary of buffer zone (sanitary protection zone) of process plant site (300 m) and in camp	Once per week		To initiate additional measures for dust suppression
NO, NO ₂				In case of systematic exceedence, implement treatment facility
SO ₂				
Hydrocarbons				
Soot				
CO				
Dust	Olekma settlement	Once per week		See above
NO, NO ₂				
SO ₂				

7.8.5. Hydrogeological monitoring

A network of specially constructed wells will be installed for hydrogeological monitoring. The wells will be located (according to the project design):

- along the contour of the open pit;
- at the source of watercourses, beginning on the mine site;
- along the tailings dump wall;
- at background sites (which are not impacted by the operation).

The exact location of the wells will be defined as a result of reconnaissance in July-August 2006, taking possible pollution migration into account.

Water sampling is performed from perched groundwater and from the first water-bearing stratum after borehole washing and recovery of the water level. Samples are analyzed for the parameters listed in Table 7.7¹⁵:

Table 7.7. Parameters for hydrogeological monitoring

Parameter	Sampling location	Frequency	Responsible person	Actions in case of exceedence
pH	Will be defined later	Once per month	Chief specialist on environmental protection and safety	Find out cause and take action
Cl ⁻				
SO ₄ ²⁻				
F ⁻				
NO ₃ ²⁻				

¹⁵ parameters were chosen based on Russian requirements and results of EIA

NO ₂ ⁻				
Na ⁺				
K ⁺				
NH ₄ ⁺				
HCO ₃ ⁻ , Ca ⁺ , Mg ⁺				
Fe				
Hardness				
Permanganate oxidation				
Phenol				
Oil products				
Ni				
F				
V				
Mn				
Cu				
Zn				
Hg				

7.8.6. Workplace zone air quality

Workplace zones on the project site are as follows:

- open pit;
- grinding and sorting factory buildings;
- process plant buildings;
- repair shops, garages, combustible-lubricating materials storages, filling station, boilers.

Measured parameters for the air of working zones are listed in Table 7.8.

Table 7.8. Measured parameters for the air of working zones

Parameter	Sampling point	Frequency	Responsible person	MAC ¹⁶ , mg/m ³	Actions in case of exceedence
Dust	<ul style="list-style-type: none"> • open pit; • grinding and sorting factory buildings; • process plant buildings 	Once per week	Health and safety specialist	4	Find out cause and take action
NO, NO ₂	<ul style="list-style-type: none"> • repair shops; • garages, • combustible-lubricating materials storages, • filling station • boilers 			5	
SO ₂				10	
Hydrocarbons				300	
CO				20	

7.8.7. Radiological monitoring

Radiological monitoring will be performed for extracted ore on the ore storage area of the grinding and sorting factory. The specific activity of Ra²²⁶, Th²³², K⁴⁰ and Cs¹³⁷ will be

¹⁶ Russian standard for air of working zones GN 2.2.5.1313-03, average concentrations per working shift

measured regularly as the ore comes into the factory. A sanitary certificate on the basis of this monitoring is a requirement for selling the concentrate.

7.9. Public consultation plan

7.9.1. Introduction

An initial Public consultation plan was developed in March 2006; it is shown in Attachment 6. In accordance with this plan, more investigations into social-economical conditions took place, and a public meeting on the project proposals was held in April 2006. The results of the consultation have been taken into account in the EIA report.

7.9.2. Further consultations

The EIA report will be presented for public consideration, as will the Environmental Management plan. Documents will be put in the offices of the Administrations of Olekma and Tundinskiy district and on the web-sites of the companies Olekminskiy Rudnik (OR), Aricom and the Administration of Amur oblast. In addition to the documents, company contact details will be provided, and information given that all remarks and comments will be accepted and considered by the company.

Work on the public consultation process and information disclosure will be performed by the company OR. In the case of public interest in the project after consideration of the EIA materials, another public meeting or other events with public meetings can be organized.

The Company OR carries out all measures connected with taking account of public opinion:

- prepares documents and other materials for publication;
- carries out measures for information disclosure;
- effectively reacts to questions and proposals from interested parties;
- makes suggestions on additions and alterations to this Plan.

In case of the need to discuss detailed technical questions with interested parties, appropriate specialists from the company OR, or from its managing company, can be asked to participate.

Official inquiries from the state authority and municipalities is will be dealt with by the management of OR.

The company Aricom publishes on its web-site materials and information provided by OR as part of the work on public consultation.

During project operation, OR will publish in the mass media and its sites, the following information:

- updated Environmental Management Plan;
- environmental monitoring results;
- the company's social projects and the results of their implementation.

7.9.3. Grievance mechanism

During the public consultation process, expressions of displeasure or complaints from interested parties and different questions are possible. every effort will be made to solve possible conflicts effectively and in a timely manner. The following mechanism is offered for timely and effective reaction to conflict situations:

- all complaints by public representatives are registered in a special journal by the person responsible for interaction with the public;
- within three days after the complaint has been received, the author of the complaint (person or organization) will be informed in writing that the complaint is under consideration,

except for the case when the complaint was received by phone and the declarant did not leave contact details (an appropriate record will be made in the journal);

- during the three days, the responsible person will present proposals for solving the problem to the company management. The Company management gives all the necessary instructions. Within three weeks after the complaint was received, the author will be informed about the results of the complaint consideration and about the complaint resolution measures;

- in the event of receiving a complaint from the state authority, the company will respond to the complaint within three weeks without prior notification, unless a different deadline for a response is defined by the state authority.

In the event that the public of the municipalities require clarification of questions, an additional public hearing or meetings with separate groups can be organized.

8. CLOSURE AND REHABILITATION PLAN

8.1. Introduction

The mining industry is characterized by the presence of enterprises with a short operational life. This factor results in the need for planning of closure and rehabilitation activities for the project at the very beginning of the project design.

The Kuranah titanium-magnetite deposit site is located in the north-west of Amur oblast, at the east of the Russian Federation. The site is 480 kilometers from the district centre of Tynda, and 840 kilometres from the regional centre of Blagoveschensk. The settlement nearest to the deposit site is Olekma, which is 48 km to the north of the deposit site.

The planned life of the mine is 10 years, including site development and closure. The enterprise will conduct ore processing and concentration to obtain titanium-magnetite and ilmenite concentrate, with an annual production of 2,400,000 tonnes of ore. Mining will be developed by open-pit method.

This plan is provided to ensure the following:

- project complies with Russian law regarding enterprise closure and rehabilitation activities;
- conditions of maximum possible beneficial use and stable deposit site area after enterprise closure;
- safety for visitors to the site area after enterprise closure;
- reduction of possible negative impacts to the environment;
- prevention of negative social consequences after the enterprise closure;
- sufficient financial support for all planned activities for enterprise closure and rehabilitation.

The area which will be disturbed currently belongs to state forest lands, and will be used temporarily for the term of working the deposit. This area is also used by local people as a deer pasture, but they use it primarily as a forest land. The distance of the sites from settlements and the existing land use defined the direction of the proposed rehabilitation works, and it is planned to return the occupied lands to local forestry after closure of the project.

8.2. Russian requirements for enterprise closure and rehabilitation

The requirements for mine closure and rehabilitation of mining and processing enterprises are specified by the following legal texts:

- Federal law “About subsoil”;
- Federal law “About industrial safety of dangerous operations”;
- Land Code of the Russian Federation;
- Instruction “About order of work on liquidation of dangerous operations and conservation of subsoil”;
- State standard GOST 17.5.1.02-85 “Nature protection. Lands. Classification of disturbed areas for rehabilitation”.
- State standard GOST 17.4.3.02-85 “Nature protection. Soils. Requirements for topsoil protection during earthwork”.
- State standard GOST 17.5.3.04-83 “Nature protection. Lands. General requirements for land rehabilitation”.

Social and economical consequences caused by enterprise closure are not covered by Russian legislation, with the exception of a redundancy payment for discharging employees which is one-time payment of the sum about three regular salaries.

According to Russian legal requirements, land users must carry out activities for disturbed land reclamation and rehabilitation of fertile soil layer.

As applied to the mining industry, the following regulations of the Federal Law “About subsoil” are valid. According to the latter, the land user must provide the following:

- Bringing the land sites and other natural areas into line with conditions suitable for further use;
- Liquidation of the mines which will not be used in future.

Land rehabilitation is carried out in accordance with a separate project, which also will obtain all the necessary approvals from the proper authorities, and will be subject to the same approval process as that outlined in the Introduction section.

The existing documents contain only general requirements, detailed technical parameters are given only for mine liquidation and topsoil rehabilitation. To a lesser degree, Russian legislation defines issues of liquidation of buildings and facilities; more precisely – they do not contain any directives for the necessity to fully dismantle and remove (or bury) buildings and facilities.

This document represents an initial framework closure plan for planning purposes, and is intended to be developed into a full technical project at a later date.

8.3. WB requirements for enterprise closure and rehabilitation

There are two guidelines within the Equator Principles which are applicable to rehabilitation issues in mining. In 1998, the WB published a code of guidelines “Pollution Prevention and Abatement Handbook” (PPAH). Several of the mentioned documents provide general provisions, others are related to certain industries or activities. As for the Kuranah deposit site, the basic guideline including requirements for site rehabilitation is “Base metal and iron ore mining”. Besides the PPAH documents, another guideline for mining operations exists – “Mining and milling – open pit”.

In accordance with “Base metal and iron ore mining” a Plan for enterprise closure and rehabilitation should be developed, covering reclamation of tailings deposits, waste rock deposits, any open pit areas, sedimentation basins, and abandoned mine, mill, and camp sites. Mine reclamation plans should incorporate the following:

- Return of the land to conditions capable of supporting prior land use, equivalent uses or other acceptable uses;
- Elimination of significant adverse effects on adjacent water resources;
- Use of waste rock for backfill and of topsoil (or other acceptable materials) for reclamation to the extent feasible;
- Contouring of slopes to minimize erosion and runoff;
- Planting of native species of vegetation and of other species that are environmentally acceptable to prevent erosion and to encourage a self-sustaining, productive ecosystem on the reclaimed land;
- Post-closure management of acid mine drainage (AMD) and tailings; reduction of AMD formation by sealing of pyrite-containing waste from oxidation and percolating water;
- Budget and schedule for pre- and post-closure reclamation activities;
- Sealing or securing of all shaft openings and mine adits on closure of the mine.

Money should be reserved over the life of the mine to cover the costs associated with mine closure. The mine reclamation activities and their financing should be discussed and agreed on as early as possible.

The document “Mining and milling – open pit” includes requirements for the project proponent to develop and implement a mine closure activities plan, which should also provide for reclamation of the major mine components. In general this document includes the same requirements as included in the document “Base metal and iron ore mining”.

8.4. Key aspects

The Kuranah project spatially consists of two major sites. The first one is located 40 km to the south of Olekma settlement and railroad station, and includes the open pit, grinding-

sorting factory, and a number of auxiliary facilities. The other site is located 35 km to the north of the open pit (4-5 km to the south of Olekma railroad station accordingly) and includes the ore processing plant and camp with auxiliary facilities. The two sites and Olekma railroad station will be connected by road. The railroad station is also connected with the process plant by a railway. All plans are available in the “Project description” Chapter.

Activities for mine closure and reclamation will consider the following key aspects:

- Open pit reclamation;
- Waste rock dump reclamation;
- Liquidation of factory buildings and auxiliary facilities located at the project sites;
- Dry tails and tailings damp reclamation;
- Camp liquidation;
- Methods for access and internal roads reclamation, railways and power line liquidation;
- Solutions for social and economic issues;
- Post closure monitoring;
- Financial provision.

8.4.1. Open pit

Extraction of ore will be performed using strip mining technology to mine five-metre high benches. The length of the open pit at the surface is 2500 metres, the width is 450 metres, and the depth of the pit in different parts is from 50 to 300 metres. The open pit has four sections for reference: South, West, Central and East, which will be worked in the given sequence. During the working of the sections, worked-out areas will be used for internal dump placement.

Towards the end of the open pit mining, the East section will not be filled, leaving a void with a surface area of 33.85 hectares and depth up to 300 metres. The open pit plan, with proposed dump locations, is shown on Figure 18.

8.4.2. Waste rock dumps

As the open pit is mined, the waste rock dumps will be partially placed in the worked-out area of the pit. The area under external waste rock dumps at mine closure will be 90 hectares, with total volume of waste rock of 19,900,000 m³. Waste rock dump locations at the end of open pit mining are shown in Figure 18. Besides the waste rock dumps located near the open pit, a dry tails dump from primary concentration will be placed near the grinding-sorting factory. Its area is 15 hectares with a total volume of about 6M tonnes.

8.4.3. Project buildings and auxiliary facilities

8.4.3.1. Buildings and facilities at the mine site

The buildings and facilities located at the mine site and grinding-sorting factory are detailed in Table 8.1

Table 8.1. Buildings and facilities located at the mine site

Project component	Building area, m² (length for linear objects, m)	Construction and building materials
Explosive materials storage	2800	Metal-worked shipping containers on ferroconcrete footing
Testing area for explosive materials	1400	Yard with blindage made from ferroconcrete
Grinding-sorting factory		
Coarse breaking building	375	2-storey building with pile foundation and solid grillage, ferroconcrete constructions. Partitions are made of ferroconcrete, bricks and gypsum fibre materials.
Secondary and fine crushing building	890.6	1-storey building with metal frame covered by “sandwich” type insulation veneer. Foundation is made of solid ferroconcrete. Partitions are of ferroconcrete, bricks and gypsum fibre materials.
Grating and separating building	600	
Conveyor galleries (12 pcs),	3000 (680)	Foundation is of solid ferroconcrete. Building is with metal frame covered by “sandwich” type insulation veneer. Partitions are made of ferroconcrete and bricks.
Auxiliary building with service rooms	540	1-storey building with metal frame covered by “sandwich” type insulation veneer. Partitions are made of gypsum fibre and gypsum carton materials.
Other facilities		
Garage and repair shop	2500	1-storey building 9.6 meters high (height of BelAZ heavy truck)
Open parking	900	-
Service store for oils	3000	2 reservoirs with total capacity 400 m ³ ; 1-storey industry building with pump station; constructions with metal frames and insulating veneer.
Boiler-house	100	1-storey building; metal frame covered by insulating veneer.
Septic tank	40	-
Fire-prevention tanks with pump station	360	5 tanks with total capacity 100m ³
Rainfall drainage treatment facilities		-
Electric sub-station 35/6 kV	-	-
Water intake borehole (2 pcs.) with transformer 6/0.4 kV	20	-
Solid waste landfill	400	Construction is not defined yet.

8.4.3.2. Buildings and facilities at the process plant site

The buildings and facilities located at the process plant site are detailed in Table 8.2.

Table 8.2. The buildings and facilities located at the process plant site

Project component	Building area, m ² (length for linear objects, m)	Construction and building materials
Processing plant		
Ore receiving point	135	2-storey building; partly of ferroconcrete construction, partly of metal-work construction with profiled plate shell. Pile foundation with solid grillage.
Floor storage for ore	117.8	
Main processing building with office rooms	7500	1- and 4-storey building. Pile foundation with solid grillage. Metal frame covered by “sandwich” type insulation veneer. Floors made of ferroconcrete, walls and partitions made of ferroconcrete, bricks and gypsum fibre (carton) materials.
Concentrate loading point with weighbridge	220	Metal frame covered by “sandwich” type insulation veneer.
Conveyor galleries (4 pcs.) with length 400 metres each	1600	Metal frame covered by “sandwich” type insulation veneer. Foundation made of solid ferroconcrete. Partitions made of ferroconcrete, bricks.
Motor-truck weighbridge	30	1-storey building with vehicle access. Metal frame with profiled plate shell. Concrete floor.
Other facilities		
Repair shop and storage facility	6800	Several 1-storey buildings. Metal frame with insulation veneer. Partitions made of bricks and gypsum fibre materials.
Motor depot building	1400	1-storey building with 2-storey part. Metal frame with insulation veneer. Partitions made of bricks and gypsum fibre materials.
Carport	800	1-storey building with metal frame covered by plates.
Washing point with treatment facilities	350	1-storey building. Metal frame with profiled plate shell.
Parking	2100	-
Boiler-house	250	1-storey building; metal frame with insulation veneer; 2 fuel tanks with capacity 100 m ³ each.
Combustible-lubricating storage facility	2200	- 5 tanks for diesel oil (V=400 m ³) and 3 tanks for gasoline (V=75 m ³); - service building with pump station; - storage for packaged combustible-lubricating materials.
Electric sub-station 220/35 κB	-	-
Rainfall drainage treatment facilities		-
Domestic water treatment facilities for process plant and camp		1-storey building; metal frame covered by “sandwich” type insulation veneer. Partitions made of profiled plates.

8.4.4. Process plant tailings facility

The tailings facility includes the tailings dam, the tailings transportation system, and the water recycling system. The tailings dam site, with a size of 800x1200 metres, is located on the flat left bank of the River Kuranah, 300 m from the river. The site will be enclosed by dams on three sides, and the proposed capacity of the dam is 5.2M m³; the dam will be filled by pouring tailings in. The tailings production from the process plant is 530,000 tonnes per annum. The ratio of solid to liquid in the tailings pulp is 1:15 by mass. 80% of the tailings is comprised of quartz and feldspar. Also, small quantities of amphiboles, garnet, biotite, ilmenite and titanium-magnetite are included. The tailings do not contain poisonous or dangerous chemical compounds.

The total length of the tailings dam wall is 2670 metres, the maximum height is 23.3 metres, and the width of the dam at the top is 10 metres. Considering the presence of permafrost, a “frozen type dam” will be built.

The main pipeline for pulp transportation consists of two lines 603 m in length. Distribution pipeline 3581 m in length is run in one line. The pipeline is mounted on low pillars without thermo-insulation. Water is fed to the process plant through a steel pipeline 400 mm in diameter and with a maximum length of 1122 metres. The pipeline is mounted above the ground surface on low pillars.

8.4.5. Camp

The camp is located 700 metres from the process plant site. The buildings and facilities located at the camp area are detailed in Table 8.3.

Table 8.3. The buildings and facilities located at the camp area

Project component	Building area, m² (length for linear objects, m)	Construction and building materials
Residential buildings (7 pcs.), total building area	3600	2-storey buildings on a pile foundation with solid grillage, wooden construction
Canteen	1200	1-storey building with solid ferroconcrete floor; metal frame with panel shell; internal partitions made of gypsum fibre materials
Office building	900	2-storey building with metal frame with panel shell; floors made of solid ferroconcrete; partitions made of bricks and gypsum fibre materials.
Medical station	300	1-storey wooden buildings; internal partitions made of wooden beams and gypsum fibre materials.
Gym	340	
Bath-house and laundry	700	1-storey building; metal frame with panel shell; partitions made of bricks and gypsum fibre materials; roof made of profiled metal plates.
Galleries between residential buildings	200 (50)	1-storey facilities; wooden construction.
Provision storage with freezers	140	1-storey building; metal frame with panel shell; partitions made of bricks and gypsum fibre materials; roof made of profiled metal plates.

Vegetable store	400	1-storey building excavated into the ground; walls and foundation from ferroconcrete; internal walls from bricks.
Boiler-house	100	3 fuel tanks with capacity 10 m ³ each
Garage	500	1-storey building; metal frame with panel shell
Hangar with tanks for water storage	600	12 tanks with capacity 100 m ³ each
Pump station	360	-

8.4.6. Access and internal roads and railways, power lines

The project railways consist of an access railway from railway station Olekma to the process plant and internal auxiliary railways. The total length of project railways is about 6000 metres.

The motor road network includes an access road with a total length of 40 km, from Olekma station to the process plant and further to the deposit site, and internal inter-site roads with a total length of 10 km.

The following power lines and transformers are proposed for the project area:

Table 8.4. Power lines and transformers proposed for the project area

Object	Features
Power transformers 6/0.4 kV	27 pcs
220 kV power line from existing 220 kV line to sub-station at the process plant site	Length of the line is 1 km; metal pylons with ferroconcrete footing
35 kV power line from sub-station at the process plant site to the mine site	Length of the line is 37 km; 142 metal pylons with ferroconcrete footing.
6 kV power line within the mine site	Length of the line is 19 km; wooden pylons

8.4.7. Social and economic issues

It is expected that the project will employ 793 employees taking a two-shift schedule of work into account. In reality, additional people will be recruited for temporary work during the project life. All these people will no longer be employed after project closure.

8.5. Plan for mine closure and rehabilitation

It is assumed that after project closure, some equipment and materials will be sold, which will partly compensate the costs of project closure and rehabilitation. Profit from those sales will be evaluated later, according to the situation at the time of project closure. At present, it is possible to propose that the following items would be sold:

- Primary equipment of the grinding-sorting factory and process plant;
- Boiler-houses equipment;
- Electric sub-stations equipment;
- Pumping equipment;
- Furniture and home appliances, laundry equipment, gym equipment.

After the valuable equipment is removed from the site, the following works will be performed: dismantling of buildings and facilities, technical reclamation of the project area,

removal off site of dismantled equipment and waste. Activities for certain project components are listed below.

8.5.1. Open pit

The walls of the void, will be recontoured to provide walls that are stable in the long-term.

To prevent people and animals falling into the open pit, a special bund of waste rock is formed along the open pit border. The road entrance to the pit is blocked with waste rock. After project closure and dismantling of buildings and facilities, inert construction materials will be buried in the open pit. Building refuse is covered by waste rock from the Central section dump with simultaneous contouring of the dump. Building refuse is inert and will not do any harm to underground water.

8.5.2. Waste rock dumps

Reclamation activities for waste rock dumps include the following:

- Dump formation with maximum possible surface area;
- Contouring and terracing of the dumps;
- Reclamation leveling.

Waste rock dumps will be revegetated with species, typical of the region (herbs, bushes, trees).

8.5.3. Buildings and facilities

All power supply lines will be disconnected before buildings are dismantled, and heat and water supplies will be cut off. Before this, all pipelines, plumbing and sewage system and equipment using mineral oils will be washed and then dismantled and removed to the open pit for burial.

Buildings and facilities are dismantled down to the foundations, building refuse is buried in the open pit. Piles and concrete foundations are left on the site and covered by a 0.5 metre layer of ground from the waste rock dumps.

After buildings and facilities are dismantled, a rough leveling with further fine leveling will be performed, including filling ground pits with waste rock.

8.5.4. Process plant tailings dam

After closure of the process plant, excess water from the tailings dam will be discharged to the River Kuranah. Discharge will be performed when the river is not covered by ice. The discharge schedule is specified by the project closure plan according to agreement with local environment protection authorities. The estimated water discharge volume is 2.3 M m^3 , which will be discharged over 3 months. The quality of discharged water is unknown.

The tailings transportation system and water recycling system are dismantled and removed to the open pit for burial after water discharge.

After tailings sedimentation and surface shrinkage, the tailings dump surface is covered by a 0.5 metre high layer of ground with further leveling and revegetation with local species.

8.5.5. Access and inter-site roads, railways and power lines

High-voltage power lines are taken down, wires and metal pylons are removed from the project site, and wooden pylons of the 6 kV power line are buried in the open pit.

Railways are dismantled, rails are removed from the project site, and sleepers will be burned. A decision for the reclamation of the main motor road (from Olekma station to the

deposit site) will be made later, in accordance with local forestry interests. The road could be kept as is for fire-prevention purposes.

8.5.6. Camp

Camp buildings and facilities will be the last to be dismantled. Superstructure parts of buildings and facilities are dismantled, piles and concrete foundations are left on the site and covered by a 0.5 metre thick layer of ground. Wooden constructions of floors and galleries are burned on the site, in compliance with fire-prevention requirements. Some of the remaining building refuse will be placed in the ground pit which is left after the vegetable store is dismantled and covered by a ground. The rest of the refuse will be transported to the open pit for burial.

8.5.7. Lands reclamation

As far as disturbed lands will be used as forest lands, they partly will be overgrown by local species of trees and bushes. Planting is proposed at the following locations:

- At the tailings dam site (including dam wall) – 100 hectares;
- At the camp site – 2 hectares (except for areas occupied by concrete foundations);
- At the waste rock dumps – 90 hectares;

Land areas released from the buildings and facilities of the grinding-sorting factory and process plant will be sowed with seeds of local herb species. The total sowing area is about 50 hectares. Local species which do not need fertile soils for growth will be used for reclamation - mountain pine (*Pinus pumila*), which practically does not need soil and in natural conditions grows on rocks; Dahurian larch and others.

8.5.8. Resolving social issues

It is expected that most of the employees will come from Amur oblast. Some possibility of job placement exists for residents of nearby settlements, some of them already work for the company. After project closure, those people will be unemployed, but acquired experience and knowledge will allow them to obtain employment at other mining enterprises. The expected number of unemployed will be about 800 – 1000 people. Solving social issues is possible in the following ways:

- Placement of redundant workers at other mining enterprises of Peter Hambro Mining company, where vacancies exist;
- Retraining of redundant workers for further job placement at other mining enterprises of Peter Hambro Mining company;
- Retraining of redundant workers at their will for further independent job search.

Resolving social issues will be defined in more detail later, taking into account the situation during the project operational phase.

8.5.9. Post-closure monitoring

Russian legislation does not make provision for post-closure monitoring after enterprise closure, and it is not standard practice in Russia. Nevertheless, the company Olekminsky rudnik, following best international practice, considers post-closure monitoring activities as necessary measures to ensure health and safety of people. Moreover, carrying out such monitoring gives the opportunity to demonstrate to local authorities and public the ecological stability and safety of the project site during reclamation work and after project closure.

The program of this monitoring will be developed on the basis of the monitoring program during the operational phase of the project, and will be its continuation. Post-closure

monitoring should consider monitoring data acquired during the project operation, and conditions that could arise after mine closure.

Monitoring during reclamation work will include:

- Monitoring surface water;
- Monitoring of air quality.

Taking into account that poisonous and toxic chemicals will not be used in the technological process at the Kuranah project, post-closure monitoring could be simplified. It is proposed that the main post-closure monitoring activities will be as follows:

- Monitoring of surface water quality;
- Monitoring of the condition of planted vegetation.

8.6. Financial resources for mine closure and area reclamation activities

The costs of closure activities are determined on the basis of similar projects, with a precision of 50 %, and will be specified more exactly nearer to the time of closure. Costs for primary objects that make a major contribution to the total cost of activities are shown only. To simplify calculations, some objects are grouped. Costs for solving social issues are not specified at the moment because of the uncertainty associated with these expenses. A summary of costs is given in Table 8.5. In accordance with information provided by Aricom money for the closure and area reclamation will be provided at the expense of profit at last year of enterprise working (agreed with Aricom's financiers).

Table 8.5. Costs of activities for the Kuranah project closure and area reclamation

Facility	Quantity /area	Summary description of closure	Unit cost (US\$)	Cost estimate (US\$)
Mine site				
Open pit	34 ha	Formation of the walls	0.3 /m ²	102 000
Formation of bund around the open pit	3000 metres		20 /m	60 000
Waste rock dumps	90 ha	Formation and surface leveling	0.3/m ²	270 000
Combustible materials store	2800 m ²		30/m ²	84 000
Sub-total				516 000
Grinding-sorting factory and other objects at the deposit site				
Grinding-sorting factory buildings	2500 m ²	Dismantling and removal off-site	80/m ²	200 000
Conveyors	680 m	Dismantling and removal off-site	50/m	34000
Dry tails dump from the primary concentration	15 ha	Formation and surface leveling	0.3/m ²	45 000
Boiler-house	100 m ²	Dismantling and removal off-site	50/m ²	5000
Garage, repair shop and storage facilities	5500 m ²	Dismantling and removal off-site	30/m ²	165 000
Septic and treatment facilities for stormwater drainage	2000 m ²	Dismantling and removal off-site	30/m ²	60 000
Tanks for water storage	5 units	Dismantling and removal off-site	2000/ Unit	10 000
Electric sub-station 35/6 kV	100 m ²	Dismantling and removal off-site	80/m ²	8000
Mine site landfill	400 m ²	Covering by layer of ground	1/m ²	400
Sub-total				527 400

Process plant site				
Major industry buildings	7800 m ²		80/m ²	624 000
Conveyors	400 m	Dismantling and removal off-site	50/m	20 000
Repair shops and storage facilities, motor depot, washing room, carport	11 000 m ²	Dismantling and removal off-site	30/m ²	330 000
Boiler-house	250 m ²	Dismantling and removal off-site	50/m ²	12 500
Treatment facilities	2000 m ²		30/m ²	60 000
Sub-total				1 046 500
Camp				
Residential, office and service buildings	7200 m ²	Dismantling and partial removal off-site, covering over with soil layer	25/m ²	180 000
Garage and storage facilities	1100 m ²		30/m ²	33 000
Boiler-house	100	Dismantling and removal off-site	50/m ²	5 000
Hangar with tanks for water storage	12 tanks	Dismantling and removal off-site	2000	24 000
Sub-total				242 000
Other objects				
High-voltage power lines 220 kV and 35kV	149 pylons, 38 km	Dismantling and removal off-site	2000 /km	76 000
Railways	6000 m	Dismantling and removal off-site	10/m	60 000
Inter-site roads	10 km /8.8 ha	Breaking of road edges	80/km	800
Sub-total				136 800
Biological reclamation				
Tailings dam site, camp site and waste rock dumps	192 ha	Planting of trees and bushes	1500/ha	288 000
Grinding-sorting factory and process plant areas	50 ha	Herb sowing	1000/ha	50 000
Post-closure monitoring				
Monitoring	4 years		20 000/Year	80 000
Total				2 886 300