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Ministry of agriculture of the republic of Kazakhstan

Committee of water resources

Consulting Center "NEDRA" LLP

ENVIRONMENTAL IMPACT ASSESSMENT (Pre-EIA)

FEASIBILITY STUDY "UST-KAMENOGORSK ENVIRONMENT REMEDIATION PROJECT"

(SUMMARY)

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Abbreviation

FS – Feasibility Study
EKO – East Kazakhstan Oblast
HM – Heavy Metals
RPC - Research & Production Center
UMP – Ulba Metallurgical Plant
UK HPP – Ust-Kamenogorsk Heat Power Plant
SHPP – Sogrinskiy Heat Power Plant
UK ME JSC KazZinc - Ust-Kamenogorsk Metallurgical Enterprise JSC KazZinc
OJSC AES Ust-Kamenogorsk Heat Power Plant
JSC UMP – Joint Stock Company “Ulba Metallurgical Plant”
OJSC UK TMP – Open Joint Stock Company Ust-Kamenogorsk Titanium-Magnesium Plant
MPC – maximum permissible concentration
MPD – maximum permissible discharge
$MPC_{fishing\ industry}$ - maximum permissible concentration in water bodies, used by industry
$MPC_{surface\ water}$ - maximum permissible concentration in water bodies used for drinking water supply
$MPC_{maximum\ single}$ - maximum single permissible concentration of pollutants
$MPC_{daily\ average}$ - maximum single permissible daily average concentration
EK HMC – East Kazakhstan Hydro-Meteorological Center
PCB - polychlorbiphenyl
BOD_5 - Biological Oxygen Demand
SRC USSR – State Reserves Committee of the United Soviet Socialist Republics
JSC “UKTMP” – Joint Stock Company “Ust-Kamenogorsk Titanium – Magnesium Plant
SRN –sanitary rules & norms
WRD – Working regulatory document
CIZ – central industrial zone
SRLI – safe reference levels of impact
GOST– State Industrial Standard
BF – buffer zone
SES – sanitary & epidemiological station
EK RTDEP – East Kazakhstan Regional Territorial Administration for Environment Protection
TA - Territorial Administration
IBRD – International Bank for Reconstruction and Development

INTRODUCTION

Ust-Kamenogorsk city is the regional center of East Kazakhstan Oblast (EKO). It is one of the major industrial centers in the Republic of Kazakhstan. Favorable location of the territory, which is expressed in the immediate proximity to the primary mineral resources (nonferrous ore and rare metals, gold, coal, construction materials), low-cost hydro-energy (Ust-Kamenogorsk and Bukhtarma HPP), have fostered rapid formation and development of the city's economic potential. Major enterprises of nonferrous metallurgy, nuclear –industrial, gold - and rare metal complexes, heat-power engineering, machinery industry and instrument making, transport, building industry, light and food industry, timber-processing, public utilities and agriculture are localized in the city of Ust-Kamenogorsk. Main marketable outputs of the above listed enterprises are as follows: lead, copper, zinc, gold, silver, tantalum, niobium, cadmium, stibium, selenium, indium, tellurium, uranium pellets, titanium, magnesium, sulfuric acid, mining equipment, paints, etc.

Distinctive feature of Ust-Kamenogorsk city infrastructure is a close spatial setting of the industrial and residential areas.

Superabundance with large industrial facilities, close setting of industrial zones and residential areas in this regional center, over fifty-year activity of the enterprises which is far from being perfect from the ecological viewpoint, led to the pollution with toxic components, and primarily with heavy metals (HM), of all environmental components: ambient air, surface and ground waters, soils, biota.

It should be noted that within the recent years the city enterprises put much efforts to improve the ecological situation in the city. Thus, some of the waste dumps were reclamated and new, much safer, wastes storages were constructed. However this does not mean that serious environmental problems of the city are solved. Ground waters within the certain areas remain to be highly contaminated, and, as well known, such contaminations are spreading with the water flows, that is why the area of ground waters contamination is still becoming larger. Thus, now is the critical moment when everyone realizes the necessity for rigid measures on the environmental protection and focused, in particular, on ground waters protection.

Initiator of FS development was the Committee of Water Resources under the RoK Ministry of Agriculture. The Feasibility Study "Ust-Kamenogorsk environment remediation" was developed by Wismut LLP, G.E.O.S. Freiberg Ingenieurgesellschaft mbH, Wisutec and VHIPIPromtechnologija, Moscow. This FS was aimed at developing a general strategy necessary for adaptation and determination of the following priority steps in terms of ground waters reclamation. With the help of hydrogeological modeling, various remediation measures were analyzed and worked out. As a result, an optimal option was selected allowing to solve the problem of the city water supply, to reduce pollutants migration within the aquifer and thus to prolong the life time of the water supply stations which ensure fresh water supply to the population.

This Feasibility Study is another proposal showing the ways to improve the environmental situation of the city. As early as in 1999 ecological and hydrogeological surveys were performed with the purpose to justify the method of polluted ground waters interception. Suggestions were developed under that project in order to improve the currently existing system of contaminated ground waters interception within the areas of certain industrial enterprises. However the analysis of results of ground waters interception within the chosen localities proves in many aspects the low efficiency of this method. Strictly speaking, local water supply facilities cannot cope with the regional contamination of ground waters.

One of the reasons of such ineffective polluted waters interception is the fact that most of the enterprises have not yet liquidated infiltration of waste water discharges which allows for their penetration into the aquifer.

In 2001 the study (BGR, 2001) was completed with the purpose to develop suggestions on the reduction of ground waters contamination by Ust-Kamenogorsk industrial waste storage dumps. Most of the developed recommendations haven’t been implemented yet. Spread of the pollution plum spread towards the ground waters flow is the reason of ceasing the exploitation of many water supply facilities in the city. In the nearest future the water supply problem will become very critical.

At present the ground waters occurring in the right bank of Ulba and Irtysh rivers are totally unsuitable for usage. Now the only way to establish control upon the environmental pollution is to take radical measures for the aquifer waters treatment.

This FS stipulates for the extensive suite of measures for ground waters rehabilitation. They include a liquidation of infiltration (leakages) from the technological systems of the industrial enterprises, providing a protective covering for the slurry ponds (sludge storages) and ash disposal site. Peculiar proposal of this Project is necessity to intercept the ground waters at the peripheral part of the Central Industrial Complex, to perform such ground waters treatment and their injection into the upper reach of the ground waters flow, although the Feasibility Study provides the review of other alternative options for ground waters rehabilitation. The FS project provides justifications for the key aspects of the estimations which enable to ensure the significant control upon the contamination spread within the aquifer. However the effect from ground water treatment depends upon the efficiency of covering or eliminating the ground waters contamination sources.

1. LEGAL AND ADMINISTRATIVE FRAMEWORK

1.1 BASIC LEGISLATIVE REQUIREMENTS APPLICABLE TO EIA PROJECTS

System of the environmental laws and environmental provisions pertaining to the environment and natural resources protection has been worked out in the Republic of Kazakhstan. Legal framework of the environment and natural resources protection, in the context of this project, encompasses the following issues:

- General environmental issues,
- Land use & protection,
- Subsurface use & protection,
- Water use & protection,
- Use, protection, safeguard and reproduction of woods and fauna,
- Ambient air protection.

The basic legislative documents pertaining to this EIA are summarized below.

The legislative base for general environmental issues includes those documents, which regulate powers of the state bodies and the local governmental authorities; the environmental rights and obligations of legal entities and physical persons; licensing of the activity associated with use of natural resources. The legislative base also covers the documents on ecological regulation; environmental monitoring; ecological expertise; legislative documents specifying ecological requirements put to economic and other activities; requirements to wastes disposal; ecological requirements on the environmental audit; specially protected territories and objects, the laws of economic mechanisms on the environmental protection.

Basic legislative documents covering the general environmental issues are as follows:

- Constitution of the Republic of Kazakhstan (adopted at the republican referendum on August 30, 1995) (amended and altered by RoK Laws dated 07.10.98 No. 284-1).

  Acting as fundamental law, Constitution specifies legal framework for ecological, social and economical stable development of the country. Clause 38 of RoK Constitution reads as follows: "Citizens of the Republic of Kazakhstan must protect the environment"

- Law of the Republic of Kazakhstan as of July 15, 1997 No. 160-I "On environment protection" (altered and amended by RoK Laws dated 24.12.98; as of 11.05.99 No. 381-1; as of 29.11.99. No. 488-1; as of 04.06.01 No. 205-II; as of 24.12.01. No. 276-II; as of 09.08.02 No. 346-II; as of 25.05.04 No. 553-II; as of 09.12.04. No. 8-III; as of 20.12.04. No. 13-III; as of 15.04.05. No. 45-III; as of 08.07.05. No. 71-III)

  This law is intended to ensure favorable natural environment for person's life and health. The law specifies legal, economical and social foundations of environment protection for the sake of present and future generations, it is aimed at prevention of the environment against harmful impact caused by economic activity, preservation of ecological balance and arrangement of rational nature use.

  It was established special body, which supervises the activity of ministries, administrations, enterprises, institutions and organizations in the field of environment protection (Ministry of environment protection of the Republic of Kazakhstan).

  The law reveals economical mechanism on environment protection and environmental management. It had been as well specified types of nature management and main conditions of their existence. Moreover, it was determined payment system for special nature management and procedure for nature protection funds formation.

The law regulates issues on standardization of environment quality, including kinds of standards, and approval procedure. Ecological requirements to economic and other activity and principles of ecological expertise have been laid down. It had been as well regulated the issues of control and supervision, regulation of disputes in the field of environment protection, responsibility for legislation violation and compensation for damage caused.

- Water Code of the Republic of Kazakhstan dated July 9, 2003 No. 481-II (amended and altered by RoK Law as of 20.12.04 No. 13-III).

The law explains conception of water fund, specifies the priority of water supply for drinking & domestic needs.

It was specified the competence of government and management bodies in the field of water relations regulation. It had been defined the procedure of work production in water bodies and water conservation zones. It was also regulated kinds of water use and conditions of their existence, including payment for the use of water resources.

Conditions for water bodies’ use for drinking, domestic needs, agriculture, industrial purposes, for the needs of hydro energy, transport, fishing industry and hunt, for fire fighting needs of reserved areas and special nature reserves had been differentiated.

It had also been spotlighted basic legal requirements to waters protection and prevention of their adverse impact, including protection of water against contamination and exhaustion, protection of underground waters and small rivers.

It was stipulated the procedure of state registration and planning of water use.

It had been specified responsibility for water legislation violation and procedure for water disputes regulation.

Clause 55 of this Law reads that placing of enterprises and other structures, which have impact upon water bodies’ condition, is undertaken in line with provisions and conditions of environment protection, subsurface protection, sanitation & epidemiological, industrial safety, reproduction and rational use of water bodies, considering ecological effect caused by the activity of the mentioned objects.

Clause 56 stipulates the requirements on reduction of contaminants emission into water bodies:

1. Use and protection of water resources are based on standardization of contaminants at discharge point, on total standardization of water management activity of overall organizations within the limits of relevant basin, channel or site.

2. Requirements to treatment and quality rate of discharged waters are determined according to directions of possible intended use of water body and justified by calculations, such requirements should also take into account real condition of water body, technical and economical potentialities and terms of the expected parameters achievement.

Clause 60. State monitoring of water bodies

1. State monitoring of water bodies is deemed as the constituent element of the system of state monitoring of environment and natural resources.

2. State monitoring of water bodies represents system of regular observations over hydrological, hydrogeological, hydrogeochemical, sanitary & chemical, microbiological, parasitological, radiological and toxicological parameters of water bodies’ condition, collection, processing and transmission of the acquired information with a view to timely identify negative processes, assessment and forecast of their development, working out of recommendations on harmful effects prevention and determination of efficiency rate of water related activities.

3. State monitoring of water objects is undertaken by the authorized body in the field of use and protection of water fund jointly with central executive body of the Republic of Kazakhstan in the field of environment protection, authorized body in the field of sanitary & epidemiological welfare of population, authorized body on subsurface use and protection

Clause 112. Protection of water bodies

1. Water bodies should be protected against:

- natural and man-caused contamination with harmful hazardous chemical and toxic agents and their compounds, thermal, bacterial, radiation pollution;

- choking with hard, insoluble objects, wastes of industrial, domestic and other origin;
- exhaustion.

2. Water bodies should be safeguarded in order to prevent:

- violation of ecological sustainability of natural systems;
- damage to life and health of population;
- reduction of fish reserves and other shellfish;
- worsening of water supply conditions;
- reduction of water bodies' ability to natural reproduction and purification;
- worsening of hydrological and hydrogeological water bodies' condition;
- other unfavorable events, which have adverse impact on physical, chemical and biological properties of water bodies.

3. Protection of water bodies is undertaken by:

- specifying general requirements on water bodies protection to all water users;
- specifying special requirements to certain kinds of economic activity;
- improvement and employment of water protective measures by implementing new equipment and environmentally, epidemiologically safe technology;
- conduction of state and other forms of control over use and protection of water bodies.

4. Central and local executive bodies of oblasts (city of the republican level, capital) in accordance with RoK legislation take measures, consistent with principles of stable development, on protection of water bodies, prevention of their pollution, chocking and exhaustion, as well as on mitigation of consequences.

5. Individuals and legal entities whose activity has impact upon water bodies' condition, are obliged to conduct organizational, technological, timber reclamative, agronomical, hydro-technical, sanitary – epidemiological and other measures, which ensure protection of water bodies against pollution, chocking and exhaustion.

Clause 113. Protection of water bodies against pollution
1. Pollution of water bodies means discharge or inflow, by any way, into the water bodies of objects or contaminants, which aggravate qualitative condition and complicate usage of water bodies.
2. Water bodies are protected against all kinds of pollution, including diffusive pollution (pollution through ground surface and air).
3. With the purpose to protect water bodies against pollution it is prohibited to:

- use toxic chemicals, fertilizers at water catchment area for water bodies. Disinfecting, disinsective and disinfestation activities at water catchment area and in the sanitary protection zone are held upon agreement with the authorized body in the field of sanitary – epidemiological welfare of population;
- discharge and dispose radioactive and toxic substances into water bodies;
- discharge into water bodies wastewaters from industrial, food objects, which don't have treatment facilities and don't ensure effective treatment in accordance with standards;
- employ the equipment and technology in water bodies and water facilities, jeopardizing population health and environment.

Clause 120. Specifics of underground water bodies protection
1. Individuals and legal entities, whose production activity might have adverse impact on underground waters condition, are obliged to undertake ***monitoring of underground waters*** and timely take measures on prevention of pollution and exhaustion of water resources as well as adverse impact of waters.
2. ***It is prohibited to dispose radioactive and chemical wastes, dumps, cemeteries, burial grounds for animal refuse and other objects influencing on underground water conditions*** at water catchment areas for underground waters, which are used or might be used for drinking and domestic sanitary water supply**.**
3. It is prohibited to irrigate lands with wastewaters, if it has impact or might have impact upon underground water condition.
4. Those individuals and legal entities, who maintain water intake facilities for underground waters, are required to organize protective sanitary zones and monitoring of underground waters.

5.During disposal, design, construction, commissioning of water intake facilities associated with underground water use, it is required to stipulate measures oriented to prevention of adverse impact on surface water bodies and environment.
6. During geological survey of subsurface, exploration and production of minerals, construction and maintenance of underground structures, which are not associated with mining operations, subsurface users are required to take measures for underground waters pollution and exhaustion prevention.

- Water Code of the Republic of Kazakhstan (June 20, 2003, No. 442-II).

The law specifies lands' character, land use principles and procedure, land withdrawal procedure for state and public needs, use of land plots for survey works. It was defined competence of government authorities in the field of regulation of land relations, rights, obligations and protection of landowners and land users' rights.

The law revealed legal requirements to allocation, provision and use of lands for agricultural needs, lands for populated area, lands for industry, transport, communication, defense and other purposes, lands for nature-conservative, health improvement, recreation and historical –cultural purpose, lands of forest resources and reserves, water bodies, etc.

It was envisaged legislative procedure, which stipulates compensation for damages to landowners, land users and losses of agricultural and forestry-based production.

The law specified goals and objectives of land protection, including standards for maximum permissible concentrations of chemical agents in soil; formulated principles for land cadastre and land development and adapted responsibility for land legislation violation and procedure for land disputes regulation.

- Law of the Republic of Kazakhstan dated March 11, 2002 No. 302-II On ambient air protection (amended by RoK Law as of 20.12.04 No. 13-III).

The law specifies measures on ambient air protection. Amidst these measures one can find standards for maximum permissible concentration of contaminants in ambient air levels of harmful physical impact on air, as well as standards for maximum permissible emissions of contaminants released into ambient air.

Issues regarding regulation of contaminants' emissions released into atmosphere by stationary contamination sources, motor-vehicles, airplanes, other mobile facilities, as well as regulation of harmful physical impact upon atmosphere, had been settled.

It had been specified conditions of disposal, design, construction and commissioning of plants, structures and other objects influencing on ambient air.

The law exposed legal matters on state registration of adverse impact upon ambient air, monitoring and control in the field of ambient air protection, responsibility for legislation violation and procedure for settling the disputes on ambient air protection.

- Law of the Republic of Kazakhstan dated March 18, 1997 No. 85-I "On ecological expertise" (amended by RoK Law as of 24.12.98 No. 334-1; as of 11.05.99 No. 381-1; as of 02.07.03 No. 454-II; as of 20.12.04 No. 13-III)

The law regulates social relation in ecological expertise sphere, aiming to prevent negative impact of managerial, economic and other activity upon the environment, life and health of Kazakhstani population. The intention of ecological expertise is to prevent negative effects, which might occur as a result of implementation of the expected managerial, economic and other activity.

The law considers expertise as the obligatory, objective, independent EIA process, transparent for publicity. Any projects should undergo state ecological expertise. Law on ecological expertise outlines EIA concept (integrated ecological –social and economical impact assessment of the expected activity upon the environment, population health for the entire period of activity). According to this law, conduction of EIA is deemed as obligatory procedure during projects development.

Initiators of ecological expertise are required to notify mass media on such expertise. If required, this should be done by the body, who undertakes ecological expertise.

Clause 16 Environmental Impact Assessment should include as follows:

- determination of impact kinds and levels of the expected activity upon the environment, inclusive of ecological risk;
- forecasting of environmental change, and their socio-economic effects, should the expected activity be undertaken;

- working out of measures ensuring environment protection while the expected activity is performed;
- development of all regulatory requirements in this field.
- According to results of environmental impact assessment, customer should prepare and submit, as part of exported materials, statement on ecological effects, which might occur as a result of the expected or performed economic activity, the mentioned statement will serve as the basis enabling to prepare decisions for its implementation.

In the Republic of Kazakhstan process of State ecological expertise, in addition to abovementioned law, is regulated by the following normative acts:

1. **Instruction on state ecological expertise of pre-project and project materials** (approved by the order of RoK Ministry of Environment Protection dated February 16, 2005 No. 57-П) [Section 6. item 12. paragraphs 1, 2, 3, 4.].

2. **Instruction on environmental impact assessment of the expected economic and other activity while developing pre-planned, pre-project and project documentation** (Approved by the order of RoK Ministry of Environment Protection dated February 28, 2004 No. 68-п "On approval of the Instruction on environmental impact assessment of the expected economic and other activity while developing pre-planned, pre-project and project documentation ") [Chapter 1. item 3. paragraph 3, 4., chapter 4. item 22, 23., chapter 5. item 35.].

For convenience, we provide graphical scheme of pre-project and project documentation preparation for undergoing State ecological expertise, which is produced in strict compliance with the aforesaid regulatory acts and existing practice. (Figure 1.1)

- Law of the Republic of Kazakhstan dated July 16, 2001 No. 242-II "On architectural, town planning and construction activity in the Republic of Kazakhstan" (amended by RoK Laws as of 20.12.04 No. 13-III; as of 12.04.05 No. 38-III; as of 13.04.05 . No. 40-III).

The law ensures favorable environment and life activity while undertaking construction operations.

- Law of the Republic of Kazakhstan dated January 27, 1996 No. 2828 "On subsurface and subsurface use" (amended by RoK Laws dated 11.05.99, No. 381-I; as of 11.08.99, No. 467- I; as of 16.05.03, No. 416-II; as of 01.12.04, No. 2-III; as of 20.12.04 , No. 13-III).

The law specifies general ecological requirements to subsurface users while undertaking operations, it also determines rights and obligations of Subsurface users and conditions for performing operations on subsurface use. Pursuant to this decree, withdrawal of subsurface plots representing special ecological, scientific, cultural or other value it not allowed.

- Law of the Republic of Kazakhstan dated April 23, 1998 No. 219-I "On radiation safety of population" (amended by RoK Law as of 20.12.04 No. 13-III)

The law reads that while selecting land lots for construction of buildings and structures, it is required to perform survey and assessment of radiation situation aiming to protect population and staff against impact of natural radionuclide.

- Law of the Republic of Kazakhstan dated July 5, 1996 No. 19-1 On emergency situations of natural and man-caused character (amended by RoK Laws as of 09.12.98. No. 307-1; as of 12.03.99. No. 347-1; as of 19.05.2000. No. 51-II).

Protection of population, environment and economic agents against emergency situations and effects caused by them, it is one of the priority area where state policy is conducted.

This law regulates social relations within the territory of the Republic of Kazakhstan, on prevention and liquidation of emergency situations of natural and man-caused character.

The law specifies rights and obligations of population in the field of emergency situation of natural and man-caused character.

It was defined power of state bodies and local government authorities in the field of emergency situation.

The law framed measures on emergency situation prevention, specified objectives of scientific research.

Declaration by the government of the Republic of Kazakhstan or local executive bodies on emergency situation of natural and man-caused character acts as the basis enabling to implement actions on emergency situations liquidation.

The law describes mechanism on liquidation of emergency situation of natural and man-caused character.

The law specifies aims and objects of expertise, procedure stipulating financing of the activities on emergency situations prevention and liquidation, objectives of control and supervision, responsibility for violation of legislation in the field of emergency situations.

- Law of the Republic of Kazakhstan as of July 8, 1994 No. 110-XIII On sanitary – epidemiological welfare of population as of 04.12.02 No. 361-13 RoK.

  The law envisages rights and obligations of individuals and legal entities in the field of sanitary-epidemiological welfare, organization and conduction of sanitary –anti-epidemiological activities.

- Law of the Republic of Kazakhstan as of May 19, 1997 No. 111-1 On protection of health of Kazakhstani citizens (amended and altered by RoK Laws as of 1.07.98 No. 259-1; as of 17.12.98. No. 325-1; as of 7.04.99 No. 374-1; as of 22.11.99 No. 484-1, as of 21.03.02 No. 308 II).

  This law specifies legal, economical and social bases for protection of health of Kazakhstani citizens, regulates participation of state bodies, individuals and legal entities, irregardless of form of ownership, in realization of citizens' constitutional right for health protection.

- Governmental regulation of the Republic of Kazakhstan dated June 27, 2001 No. 885 "On approval of the Provision for organization and conduction of Unified system of state monitoring of the environment and natural resources" (amended by Governmental regulation of RoK as of 01.07.05. No. 675).

  The following monitoring systems are distinguished depending on objects of monitoring:

  - monitoring of ambient air;
  - monitoring of surface water resources;
  - monitoring of land resources;
  - monitoring of fauna and flora (reproduction and use);
  - monitoring of subsurface (as related to pollution).

  Unified system of state monitoring of the environment and natural resources encompasses as follows:

  1) collection, storage, processing of initial data on environmental condition and use of natural resources according to complex of parameters, stipulated by state and industrial monitoring programs, maintenance of cadastres and informational data banks pertaining to monitoring of environmental components and nature management;

  2) preparation and transmission of regulated data and data processing results , including the forecasts, references, reports and other forms of information to be submitted to governmental authorities, republican and regional state bodies relating to monitoring of the environment and natural resources;

  3) development of recommendations stipulating the activities on liquidation or mitigation of the effects of adverse impact upon the environment, protection and rational use of natural resources;

  4) information support to perform state statistics, ecological expertise, environmental audit, control in the field of environment and use of natural resources.

- Governmental regulation of the Republic of Kazakhstan dated 12.03.04 No. 311 approved the list of specially authorized bodies, empowered with the functions of environment protection, nature use management and state control, and Provisions for arrangement of measures to be carried out by the mentioned bodies.

  The following organizations pertain to specially authorized bodies, empowered with the functions of environment protection, nature use management and state control in ecology sphere:

1) **RoK Ministry of Environment Protection**, as the central executive body of the Republic of Kazakhstan in the field of environment protection, which coordinates the activity of other central executive bodies, empowered with the functions of environment protection and nature use management;

2) **RoK Agency for land resource management,** performs functions - use and protection of land resources;

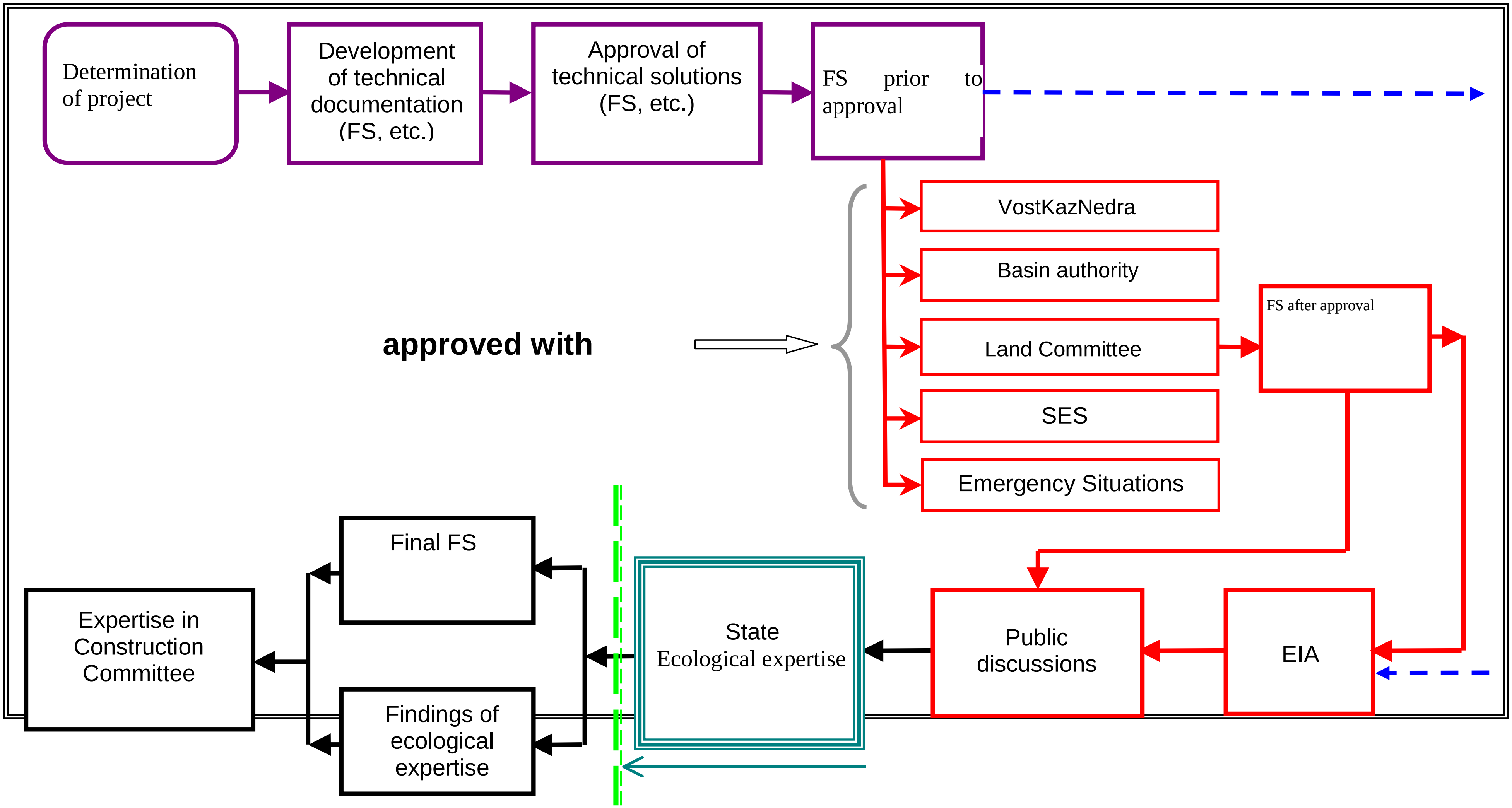
3) **RoK Ministry of agriculture**, undertakes control-supervision functions in the field of protection, reproduction, use of forest and water resources, resources of flora and fauna, water, specially protected natural territories;

4) **RoK Ministry of energy and mineral resources**, undertakes functions in the field of subsurface use and protection;

5) **RoK Ministry of internal affairs**, empowered with the functions - control over contaminants' emissions released into atmosphere from motor vehicles; fight against poachers, illegal chopping of trees and bushes, violating hunting and fishing rules; investigation of ecological crimes;

6) Local executive bodies undertake their functions within their competence, specified by RoK legislation.

FIGURE 1 SCHEME OF PRE-PROJECT AND PROJECT DOCUMENTATION PREPARATION TO STATE ECOLOGICAL EXPERTISE



Note: Processes are colored:

- Development of *technical documentation*
- State ecological expertise
- *Handover of preliminary FS materials for EIA development commencement*
- *Preparation of documents to ecological expertise*
- *State technical expertise*

2. SUPPLEMENTAL INFORMATION USED FOR EIA PROJECT DEVELOPMENT

To perform the environmental elements impact assessment, the following supplemental information was used:

- LLP “EcoService” - ambient air, radiation pollution, surface waters,
- VostKazNedra – geology, groundwaters,
- Institute of Geological Sciences (Altay Branch) - conditions of soils,
- SIC of fishery industry – current state of Ulba & Irtysh rivers biocenose
- Department of environmental programs of the City Administration – flora & fauna of Ust-Kamenogorsk city

Hydrogeology and hydrology data acquired by WISMUT LLP were employed to a considerable extent for the development of the Feasibility Study.

Information about the city industrial enterprises (UMP, KazZinc, UK HPP, SHPP, TMP, Vodocanal, etc.), volumes of disposed waste, discharged sewage and emitted pollutions was obtained during the visits of EIA project developers to the mentioned enterprises.

In addition to that, fieldworks were performed in the middle of March 2005 followed by the laboratory analytical studies. The following operations were carried out during the fieldworks:

- Visual observations and photographing of groundwater pollution sources,
- Radiological surveys of the residential part of the city as well as the peripheral part of the industrial complex.
- Surface waters sampling and analyses from Ulba & Irtysh rivers
- Snow water sampling.

Laboratory analyses were conducted in the certified LOTOS laboratory (Ust-Kamenogorsk). List of analytes to be assessed was substantiated by the presence of these components in the sources of the environmental pollution.

3. ENVIRONMENTAL CONDITIONS OF UST-KAMENOGORSK AREA

The city of Ust-Kamenogorsk is the regional center of East Kazakhstan Oblast (EKO) and one of the biggest industrial centers of Republic of Kazakhstan. Favorable location of the city in immediate proximity to the natural resources (deposits of nonferrous and rare metals, gold, coal, construction materials, etc.), availability of inexpensive hydro-power facilities (Ust-Kamenogorsk and Bukhtarminskaya Hydroelectric Power Plants) contributed to the fast growth and development of economic potential of the city. The city is famous of having large enterprises of nonferrous metallurgy, nuclear power, gold- and rare metal plants, heat power plants, mechanical engineering and instrument-manufacturing works, facilities of transportation, construction industry, enterprises of light industry, food and timber works, utilities and agriculture production as well as many other enterprises belonging to other industries. Major marketable products of the said industrial complexes are lead, copper, zinc, gold, silver, tantalum, niobium, cadmium, antimony, selenium, indium, tellurium, uranium fuel pellets, titanium, magnesium, sulfuric acid, mining equipment, paints, etc.

Close location of the industrial complexes and residential zones is the specific feature of the city infrastructure.

Superabundant industrial infrastructure of Ust-Kamenogorsk, close proximity of the industrial complexes to the districts of residential housing in this regional center, as well as semi-centennial activity of the industrial enterprises, being far from perfect in terms of the environmental aspects, led to pollution with toxic components, including first of all the pollution of all the environment elements with heavy metals (HM) which impacted the atmospheric air, surface and ground waters, soils and biota of the city area.

3.1. GENERAL NATURAL AND CLIMATE CONDITIONS

Geographical location of the city

Ust-Kamenogorsk is located in the north-east of Kazakhstan, stretching at foothills of Rundy Altay mountains at the confluence of Irtysh and Ulba rivers. Pursuant to the current general city plan, the city covers an area of 23300 hectares. Shape of the city territory is determined by the valley of Irtysh and Ulba rivers. Major part of Ust-Kamenogorsk facilities are situated on the right-banks of these rivers, occupying the territory from Novaya Sogra village in the north-east up to the Airport site in the north-west. The valley of Irtysh river lying within the city area is of SE-NW direction. Major part of the city is of the same direction. The line along Irtysh river bank stretching near Ablaketka village was the southern border of the surveyed area, and the line linking Opytnoye Pole village and Titanium-Magnesium Plant (TMP) served as the northern border of the survey area. Geographical coordinates of the center point of the survey area were 49°59′ North and 82°37′ East.

Distance between Ust-Kamenogorsk and such nearest and biggest towns in East Kazakhstan Oblast as Semipalatinsk, Ridder and Zyryanovsk is 200, 120 and 150 km respectively. Ust-Kamenogorsk is linked with the said towns by railway and motor roads.

Relief and hydrography

It is a very important ecological factor that Ust-Kamenogorsk is situated in the plain area formed of the valleys of Irtysh and Ulba rivers. The city is surrounded by the mountain ridges of up to 800 m height from the north, east, south and south-west. The plain valley remains open from the north-west only and less open - from the south-east. This factor considerably reduces a possibility of quick dispersal of toxic pollutants emitted by the city enterprises.

Ust-Kamenogorsk is situated on the border of Kazakh low hills and Rudny Altay mountains. Located west of Ust-Kamenogorsk city, Kazakh low hills are characterized by a hilly relief of low and middle height (up to 1600 m). Rudny Altay mountains, consisting of several mountain ridges, are characterized as the relief of low and middle mountains belonging to West Altay chain.

Ust-Kamenogorsk is located in the place of Irtysh and Ulba rivers outflow from the mountains, the city's elevation marks are ranging within 280-340 m. Maximum elevation marks for the major part of the city area are limited to 300 m. Slopes of the right-bank of Ulba river and the left-bank of Irtysh river are characterized by the relief of hills and ridges. The valleys of Irtysh and Ulba rivers are characterized as a smooth terrain, covered with terrace benches, flow channels, former river beds.

Irtysh and Ulba rivers are the major water bodies, which water flows are generated in adjacent lands. Water flow of the rivers is replenished by virtue of the surface and ground waters drain. Major water replenishment is provided by snow thawing. Irtysh river flow is regulated by Bukhtarminsky and Ust-Kamenogorsk water storage reservoirs which ensure a long-lasting river flow control. Flows of Ulba river and small brooks are of uncontrollable nature.

Irtysh river is one of the biggest rivers in Eurasia. The river length is 4248 km, and area of the river basin is 1643 thousand km^2. Irtysh is a typical lowland river which forms a wide and clearly defined valley. The main river channel is 170-380m wide, total width of the river bed together with the channels and islands reaches up to 3-3,5 km, being 3m and sometimes 5m deep. An average flow rate of Irtysh river section, located upstream of the city, is around 400 m^3/sec.

Within the region of Ust-Kamenogorsk city, the hydrological regime of Irtysh river is mainly determined by the operational regime of Ust-Kamenogorsk Hydroelectric Power Plant. Air inversion phenomenon, occurring above the water surface of Irtysh river, forms the atmospheric barrier which favorably affects the city ecology, because such barrier prevents a distribution to the left-bank of Irtysh river of the toxic substances, emitted by the enterprises of the North industrial zone.

The part of Ulba river running within Ust-Kamenogorsk city is 24 km long, crossing the city area starting from Ulba-Perevalochnaya Hydro-station and ending at the place of Ulba river inflow into Irtysh river. Tributary of Ulba river, crossing the survey area, is Makhovka river, being supplied with waters from brooks of Bezymyanniy, Ovechiy Kluch and other small brooks, inflowing into Makhovka river from the right and left river banks. Terrace complexes are developed in the river valley. Width of the flood-lands near the city is changing from 150-200m in the east up to 4 km in the west. Terrain of the river valley is changeable due to impact of intensive floods. Most part of the residential housing and industrial facilities of the city are located on the first terrace above the flood-plain, composed of alluvial boulder bed, pebbles, overlaid with a 2-3 m thick layer of sand and loam. The second terrace above the flood-plain is formed of diluvial-proluvial loesslike loams, sandy loams with inter-layers of sand and less often – with gravel, crushed rock and gruss.

Spring floods in Ulba river are of quite remarkable character. The river waters are supplied from various water sources.

Within Ust-Kamenogorsk city waters of Ulba river are polluted with toxic discharges from the city enterprises. In this connection pollution of Ulba river waters is changing from average pollution level upstream of the bypass road bridge up to a strong pollution level - downstream of the bypass road bridge.

Surface waters of Ulba and Irtysh rivers are hydraulically connected with the ground waters of alluvial Quaternary horizon, such ground waters being accumulated mainly due to waters infiltration from the rivers. Therefore groundwater pollution is mostly caused by the polluted river waters. Major pollution impact is brought by Ulba river, which water flow is not regulated and is strongly affected by seasonal water level fluctuations. Waters of Ulba river are more polluted than waters of Irtysh river.

Climate

Climate in Ust-Kamenogorsk city area is sharply continental. The coldest month is January, when the average air temperature is - 16,10C. The lowest observed temperature was -490C. Summer is usually hot, with average air temperature of +20,60C. Average annual quantity of precipitation is about 500 mm.

Stable snow cover is usually formed in the second decade of November and sometimes – in the third decade of October. Average monthly thickness of the snow cover is 20 cm. Depth of ground frost penetration is 90 cm on average. Ground surface is usually cleared of snow cover in the first decade of April. Spring floods in Irtysh river are usually in the first decade of April.

Average wind speed is 2,5-3,5 m/sec, and speed of strong winds reaches up to 15 m/sec. As per the long-observed wind rose, the prevailing winds in Ust-Kamenogorsk area are of north-west and south-east directions (along the watercourse of Irtysh river). Windy days comprise up to 50-70% of a year period.

Ust-Kamenogorsk area belongs to the regions with insufficient precipitation. Minimum monthly precipitation is observed in winter months (20-22 mm in January – February period). Maximum precipitation is observed June and July (56-65 mm).

Changes of air temperature in Ust-Kamenogorsk area depend on specific features of atmospheric air circulation and radiation factors. These factors determine considerable daily changes and day-to-day variations of the air temperature. Amplitude of monthly average change of air temperature in summer and winter seasons is 370C. Absolute extreme air temperature values reach up to 490C.

Inversions of air temperature are of special interest from viewpoint of environmental studies. Such air temperature inversions hinder from turbulent air exchange and contribute to aerosol concentration in the near-surface air layer.

Number of foggy days and daily foggy weather duration are very important factors affecting the environmental conditions in Ust-Kamenogorsk. Owing to construction of Hydroelectric Power Plant in Irtysh river, number of foggy days considerably increased from 35-40 up to 65-70. Both air pollution level and number of various air polluting substances are changing in foggy days. The most prevailing air pollutant is sulfur dioxide gas dissolved in drops of fog, resulting in formation of sulfuric acid aerosol, which is a typical phenomenon for Ust-Kamenogorsk area. Furthermore, such sulfuric acid aerosol contained in drops of fog is of higher toxicity than sulfur dioxide gas emitted by the industrial enterprises. Lowering of polluted fog drops downward from the upper and most polluted air layers down to the near-surface air layer and onto the ground surface leads to strong deterioration of environmental conditions, which is similar to acid rain impact. Close relationship was identified between a number of foggy days and the ambient air pollution level, and the factor of such correlation is assessed as equal to 0,9.

Specific features of the geologic structure

Paleozoic rock and Neogene patches are overlaid by Quaternary sediments, which are formed of various complexes being different in terms of lithology, genesis and age. Quaternary sediments in the valleys of Irtysh and Ulba rivers are composed of alluvial and diluvial sediments in a form of deep erosion trench in the Paleozoic basement. Total thickness of Quaternary sediments reaches up to 20-120 m.

Lower part (40-60 m thick) of Quaternary sediments is formed of sand-gravel-pebble sediments with clay inter-layers. Age of these sediments is Lower Quaternary. This formation is overlaid by alluvial sand-gravel horizon of Middle Quaternary, characterized by less content of clay and practical absence of clay inter-layers. Thickness of Middle Quaternary horizon is 40-60 m. Lower- Middle Quaternary strata form a single grey-color alluvial complex, being the main aquifer in Ust-Kamenogorsk alluvial basin.

The alluvial complex is overlaid with Middle-Upper Quaternary diluvial & proluvial sediments, which thickness is varying from several meters near the river bottomlands up to 30-40 m strata occurring in the flanges of the valley. These sediments play a role of the sedimentary cover that protects sediments of alluvial aquifer from infiltration of toxic pollution from the ground surface resulted from the activities of the industrial enterprises and the city population. It is believed that just minimum 4 m thickness of the loamy covering layers may provide the effective protection for underlying layers from their pollution. However, the protection efficiency depends not only on the covering layer thickness but depends to a greater degree on the presence of sandy inter-layers within the covering loamy layers. So, despite good thickness of loamy layers occurring in the region of North industrial zone (8 m thick and more), efficiency of the covering layers protection is low because of a big number of sandy inter-layers which are worsening the protective properties, so that this horizon may not prevent pollution penetrating from the industrial sites into ground waters of the alluvial complex.

Infrastructure of Ust-Kamenogorsk city

At present Ust-Kamenogorsk city is one of the biggest industrial centers of nonferrous metallurgy in Kazakhstan. Nonferrous metallurgy and mechanical engineering, which are the most developed industries in this region, have been growing in close cooperation with local facilities of the electric power industry.

The administrative register of the legal entities operating in Ust-Kamenogorsk includes 6072 commercial enterprises. There are 143 joint-stock companies, 2335 limited liability partnerships, 48 agricultural farms, 1333 trade companies in the city. 78,7 thousand people are engaged in the operation of the large-scale and moderate-size enterprises of Ust-Kamenogorsk, including 31,4 thousand people involved in the industrial production, 5,8 thousand people engaged in the construction activity, 16,1 thousand people involved in the fields of education and public health services, 9,7 thousand people – in trading activity, 10,3 thousand people - transport and communication services, etc. about 17,7 thousand people are engaged in the business of small and medium-size enterprises.

Ust-Kamenogorsk is characterized by a big number of technogenic pollution sources, such as the industrial enterprises, transport facilities, agricultural farms, gas stations, food industry enterprises and the sector of private houses. Major environmental impact is caused by the industrial enterprises and transport facilities of the city.

As for the industrial enterprises, the major pollution sources in Ust-Kamenogorsk are such enterprises as JSC “KazZinc”, OJSC Ust-Kamenogorsk Heat Power Plant, JSC UMP, OJSC UK TMC (Fig. 3.1). Ust-Kamenogorsk is one of the cities characterized by the most adversely impacted environment and the highest concentration of industrial enterprises causing considerable pollution of the city environment, as well as a number of enterprises located in the immediate proximity to the city. Summary of the city environmental features is provided below.

FIG 3.1

3.2. AMBIENT AIR CONDITIONS

Under conditions of insufficient ambient air ventilation in the city (days with calm weather comprise 48% on average), a big number of constant pollution sources and transport facilities in the city bring to the unquestionable fact of critical situation with air pollution is Ust-Kamenogorsk.

Monitoring of Ust-Kamenogorsk ambient air pollution is carried out by East Kazakhstan Hydro-Meteorological Center through involving 5 stationary observation stations and 1 mobile observation station, as well as using the industry-controlled monitoring stations established at the industrial enterprises.

There are about 170 enterprises in the city that create over 3 thousand constant pollution sources bringing an adverse impact on both biocenoses and the city population. The city enterprises are divided into several categories in terms of their potential environmental hazard, air pollutants quantities and composition. Six enterprises are placed into the 1st hazard group, including such industrial giants as Ust-Kamenogorsk JSC "KazZinc" (76,8% of air pollution) , Ust-Kamenogorsk Heat Power Plant (12,21% of air pollution), Ust-Kamenogorsk Heating Network (4,91% of air pollution), Sogrunsky Heat Power Plant (4,01% of air pollution) (Fig. 3.2). Contribution of small enterprises into the city air pollution is not big, but taken altogether, such small enterprises also cause certain impact on the city environment.

Motor transport causes an essential impact to the near-surface air layer of the city, contributing 30% of the total air pollution.

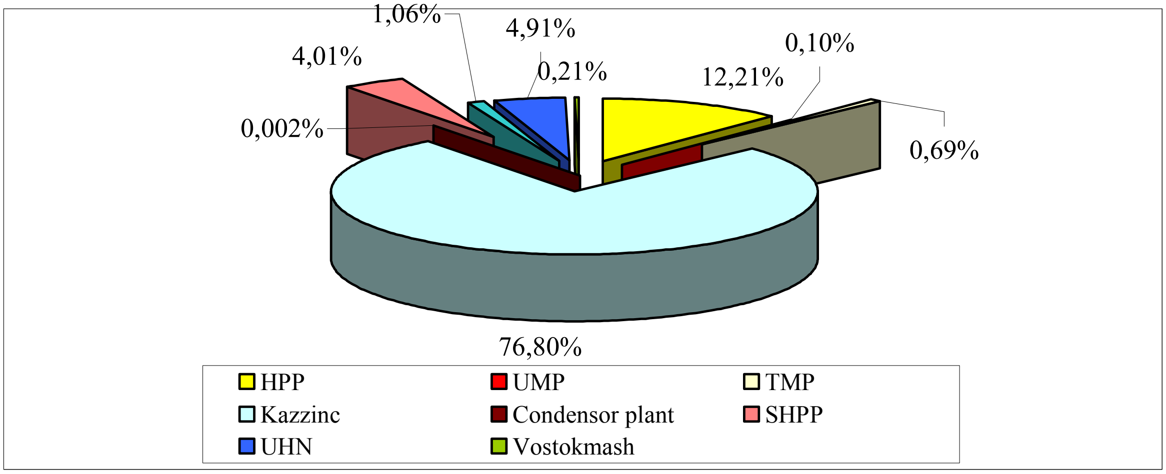


Figure 3.2. Contribution of enterprises into air pollution in Ust-Kamenogorsk

Up to 92 chemical components are emitted by the enterprises of Ust-Kamenogorsk city. In 2004 about 92,2 thousand tons of air polluting substances were emitted by the industrial enterprises, including 6,206 thousand tons of solid pollutants and 85,98 thousand tons of gaseous and liquid pollutants.

Figure 3.3 demonstrates the shares of major air pollutants emitted by the city enterprises. Sulfur dioxide comprises 72,38% of the overall pollutants.

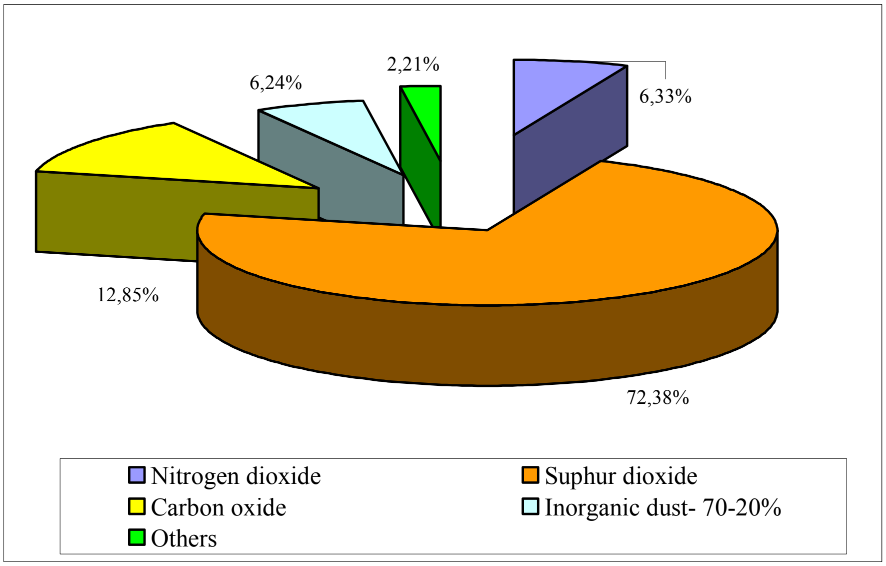


Figure 3.3. Shares of air pollutants emitted by Ust-Kamenogorsk city enterprises

In 2004 the average concentrations of air pollutants were as follows: sulfur dioxide – 1,7 $MPC_{average\ daily}$, dust – 1,5 $MPC_{average\ daily}$, nitrogen dioxide – 1,3 $MPC_{average\ daily}$, formaldehyde – 1,1 $MPC_{average\ daily}$, chlorine – 1, 0 $MPC_{average\ daily}$, lead - 1,0 $MPC_{average\ daily}$. Average concentration of carbon oxide, phenol and arsenic did not exceed 1,0 $MPC_{average\ daily}$. Maximum single concentrations of air pollutants were as follows: sulfur dioxide – 5,7 $MPC_{max\ single}$, phenol – 6,9 $MPC_{max\ single}$, nitrogen dioxide – 5 $MPC_{max\ single}$, dust – 5,0 $MPC_{max\ single}$, carbon oxide – 2,8 $MPC_{max\ single}$, chlorine – 2,4 $MPC_{max\ single}$. There were no any registered cases of pollutant concentrations in excess of 10 $MPC_{max\ single}$

The city area located close to the site of 6, Rabochaya Street is characterized as the most polluted with all controllable substances. In 2004 the air pollution index (API_5) was ranging within 4,5-9,5. Regions of Zaschita station and 30, Uritsky Street were slightly less polluted areas. Sites of Novaya Sogra, Silk Factory, Ablaketka village, Airport area were relatively clean parts of the city.

3.3. SURFACE WATER CONDITIONS

Major pollution sources of Ust-Kamenogorsk surface waters are discharges of industrial and household sewage into the rivers. Major volumes of sewage waters are discharged into Ulba river from such enterprises as Sogrinsky Heat Power Plant and Ust-Kamenogorsk Heat Power Plant. Less volumes of sewage waters are discharged into Ulba river from the state enterprise "Novaya Sogra", JSC UMP, JSC UK TMP, OJSC UK "Heating Network". According to the enterprises' records and reports, in 2004 the total of 48913 thousand m^3/year of industrial sewage were discharged into Irtysh river, and the total of 66930 thousand m^3/year of industrial sewage were discharged into Ulba river. Hence, the total discharge of pollutants into Ulba river was about 19896 tons, and the total discharge of pollutants into Irtysh river was 9439 tons. If to refer to the enterprises' records and reporting documentation, the aggregate total pollutants discharge from these enterprises did not exceed the discharge volumes which were specified as the limits of Maximum Permissible Discharge for the mentioned enterprises.

In addition to that, the smaller enterprises also discharge their industrial sewage into the rivers without having any preliminarily approved limits for volumes of such sewage discharge.

In certain seasons of the year ground waters also become the source of pollution supplied together with water drain into Ulba river.

Pursuant to results of the environmental surveys conducted in 2003-2004 by the order of Ust-Kamenogorsk city administration, conditions of the surface waters were assessed as follows.

Ulba river

Stone Pit - the mouth of Makhovka river

Within this river section surface waters are already polluted with sewage discharges from the big mining enterprises located upstream of the said area. Within the city boundaries of Ust-Kamenogorsk, polluted waters of Ulba river are intensively supplemented with waters drained from TMP waste storage dumps.

Average integrated index of water pollution was Zp = 2,2. Concentrations of Tl, Cd and oil products exceeded the limits of maximum permissible concentration (MPC).

The mouth of Makhovka river - the railway bridge

This river section is characterized by very high level of water pollution. During water sampling, concentration of thallium (Tl) was assessed as being 6 times higher than the limit of maximum permissible concentration for surface waters ($MPC_{surface\ water}$), concentration of cadmium (Cd) was assessed as being 1,7 times higher than maximum permissible concentration for waters of fishing industry ($MPC_{fishing\ industry}$), concentration of vanadium was 10 times higher than the relevant $MPC_{fishing\ industry}$. Mahovka river, Sogra village, etc. are the sources of pollution impact for this river section.

The railway bridge – Ulba river mouth

The biggest number of polluting sources are located within this sector of Ulba river channel including such polluting sources as the industrial sites of UK MP JSC KazZinc, JSC UMP, Heat Power Plant, storm water drain and others. Integrated index of surface waters pollution (Zp) was equal to 4,3. Concentration of thallium (Tl) was on average 3,2 times higher than the relevant limit of maximum permissible concentration for surface waters ($MPC_{surface\ water}$), concentration of cadmium (Cd) was 2,67 times higher than $MPC_{surface\ water}$, concentration of lead was 1,2 times higher than $MPC_{surface\ water}$, as well as concentration of oil products was 1,3 times higher than $MPC_{surface\ water}$.

Irtysh river

Strelka (the mouth of Ulba river) - the Pontoon bridge

Within the said river sector, a stream of Ulba river polluted waters inflows into Irtysh river, resulting in a considerable deterioration of Irtysh waters quality. Water quality is worsening from the level of “increased pollution” to the level of “high pollution”. Polluting substances are delivered into this sector of Irtysh river together with a stream of polluted ground waters from the city of Ust-Kamenogorsk and together with discharges of storm water drain system. Here, concentration of thallium was assessed as being 7,0 times higher than $MPC_{surface\ water}$, concentration of oil products was 1,46 times higher than $MPC_{surface\ water}$, concentration of cadmium was 1,06 higher than $MPC_{surface\ water}$.

The Pontoon bridge – Uvarovo passage

This river section is the last one located within the territory under study, and this river section is reflecting the overall impact caused to Irtysh river by the whole of Ust-Kamenogorsk city territory. The city’s Sewage Treatment Facilities (STF) discharge sewage into this part of Irtysh river. Since volumes of the current sewage are more than twice bigger than the STF nominal treatment capacity, these treatment facilities fail to ensure a proper treatment of all sewage volumes. Pollution of the river waters with groundwater drain was also identified. Within the given sector, the river channel is of rather twisted shape and covered with numerous islands associated with a considerable increase of the bottom sediments thickness. This insufficient treatment of supplied sewage is clearly observed 3-5 km downstream of the Sewage Treatment Facilities, where concentrations of thallium and oil products exceeded the established limits of $MPC_{surface\ water}$, and concentrations of ammonium ions and nitrites were higher than the limits of $MPC_{fishing\ industry}$. All these factors lead to classifying the pollution of this river section as of "high level".

Ust-Kamenogorsk Heat Power Plant - Strelka (mouth of Ulba river)

This Irtysh river section may be regarded as the river part where water pollutant concentrations are assessed as being within the background limits. At the same time, this river section is supplied with waters from Ust-Kamenogorsk water storage reservoir, which are still carrying pollutants from Zyryanovsky mining enterprise and Ognevsky mine (additionally contaminated with stable organic pollutants). Contamination with stable organic pollutants is resulted from the operations of Ust-Kamenogorsk Condenser Plant, where trichlorbynethyl (THB) (with up to 2,5% of high-chlorinated bynethyls (PHB) of chloren type (A-50 and A-60) is used as dipping electric insulating liquid.

Surface waters contamination is also caused by pollutants supplied from the adjacent territories. Sector of private housing is predominanting on the river's banks, and its population use the river banks as the place for disposal of household, construction and other wastes. Based on results of water sample tests, pollution of this Irtysh river sector is assessed as having the "increased pollution level".

Continuous monitoring of the surface waters pollution is carried out by East Kazakhstan Hydro-Meteorological Center (EK HMC). Water quality in the upper reach of the river within Ust-Kamenogorsk city area is assessed at the place called as "Stone Pit", located 3 km upstream of Sogrinsky industrial complex. Variation of macro-components composition in the river waters is predetermined by the seasonal changes. Minimal ion concentration is observed in April – May, i.e. during the spring high waters. The second minimum of the river water mineralization is detected in November–December. Throughout a year term ion concentrations in the waters are fluctuating from 50 up to 250 mg/dm^3. Hydro-physical characteristics of the river waters, such as transparency, chromaticity, temperature, pH, quantity of suspended matters are subjected to sharp changes. At the same time such river water parameters as content of oxygen, BOD_5 and carbon-dioxide gas were relatively unchangeable throughout a year term. Concentrations of all nitrogen-containing ions in the river waters were below the limits of the specified maximum permissible concentrations established for the fishing industry ($MPC_{fishing\ industry}$). As for micro-component concentrations in the river waters, in certain months of a year term concentrations of some heavy metals exceeded their relevant $MPC_{fishing\ industry}$ as follows: for copper such excess over the limit of $MPC_{fishing\ industry}$ was 2-6 times, for zinc - 3,8-16 times, for beryllium - 1-2 times, for manganese - 1-2,5 times. Just at the place of the river stream reaching the city area, in certain months oil products concentrations were 1-1.8 times higher than the limits of $MPC_{fishing\ industry}$.

Other hydro-monitoring station of East Kazakhstan Hydro-Meteorological Center (EK HMC) is located just in the city area, at the motor road bridge, 1,45 km upstream of the mouth of Ulba river. Changes of total ion concentrations are of the same character as in the previous river sections, because such changes are basically depending on the seasonal factors. Concentration of water-dissolved oxygen is remaining practically the same throughout a year term, however concentration of carbon dioxide gas is slightly growing. Chemical oxygen demand (COD) is insignificantly fluctuating within a year term, still being within the same limits, as detected at the previous monitoring station. Concentration of nitrogen ions does not exceed the limit of $MPC_{fishing\ industry}$. In certain months copper concentration in this river section is 1-7 times higher than the appropriate limit of $MPC_{fishing\ industry}$, zinc concentration is 1-24 times higher than the appropriate limit of $MPC_{fishing\ industry}$, concentration of beryllium is 1-3 times higher than the appropriate limit of $MPC_{fishing\ industry}$, concentration of manganese is 1-3,7 times higher than the appropriate limit of $MPC_{fishing\ industry.}$ In general, concentrations of practically all water pollutants and values of other water parameters, characterizing the worsening river water quality, are increasing from the upper to lower river sections.

River waters pollution with oil products is detected at the both monitoring stations. Just immediately in the upper reach of the river concentrations of some pollutant are higher than the established limits of $MPC_{fishing\ industry}$ caused as a result of sewage drain from Leninogorsk city and agricultural farms situated upstream in the upper reaches of Ulba river.

Results of water pollution sampling at three observations stations were taken into consideration at performing the water quality studies. These stations include the first one located 0,8 km downstream of the dam of UK Hydroelectric Power Plant, the second observation station was placed 0,5 km downstream of the Condenser Plant and the third hydro-post was located 0,35 km downstream of the pontoon bridge (i.e. 3,2 km downstream of Ulba and Irtysh rivers junction). Concentrations of macro-components in the river waters are remaining more or less stable in all seasons of the year. Increased copper concentration was detected in the river waters (source of such copper pollution is the ore mining zone of Zyryanovsky city). Concentrations of other analytes were below the specified limits of $MPC_{fishing\ industry}$.

In the middle of March 2005 LOTUS laboratory (Ust-Kamenogorsk) undertook water sampling in Irtysh and Ulba rivers pursuant to the work order of CC "NEDRA" LLP. List of analytes included such heavy metals as beryllium, iron, magnesium, manganese, copper, lead, chromium, and zinc.

Concentrations of manganese, copper and zinc in the river waters exceeded the specified MPC limits, established for fishing industry ($MPC_{fishing\ industry}$). Oil products concentration in the river waters also considerably exceeded the limits of $MPC_{fishing\ industry}$, moreover within the city area oil products concentration in the upstream river section was higher than the oil products concentration, detected in the area of the river mouth. Similar character of pollution distribution was also observed for zinc concentration in the river waters. Hence, at performing the river waters monitoring it was revealed that metal concentrations are higher in the upstream river section within the city area comparing to metal concentrations detected at Ulba river confluence into Irtysh river. The acquired results showed that the river waters coming into the city were already polluted and underwent certain purification within the city zone.

3.4. GROUND WATER CONDITIONS IN UST-KAMENOGORSK CITY AREA

Ust-Kamenogorsk region is characterized by the unique groundwater accumulations confined to Quaternary alluvial sedimentary strata, forming Ust-Kamenogorsk alluvial basin. The basin is composed of paleo-channel sediments of Irtyshs and Ulba rivers, retaining hydraulic connection with the waters within the recent river channel sediments of these rivers and with the surface watercourses. Water-bearing thickness reaches up to 20-120 m. Volume of groundwater static accumulations is about 5 billion m^3. General direction of groundwater drainage coincides with the direction of the surface water flows. There is a hydraulic contact between alluvial aquifer and Ulba and Irtysh rivers. When the rivers water level is low, ground waters are supplemented into the said rivers, however during the season of high waters in the rivers, the river waters are feeding groundwater bearing horizon. During the autumn season a hydraulic continuum is practically established between the groundwater table and the river waters. Major part of the natural groundwater resources is accumulated within the alluvial water bearing horizon due to surface waters absorption from the current river water flows (about 95%). Additional water supply to the aquifer is provided by water leaks from the city municipal water supply and sewage networks. Based on results of modeling, the size of such leaks was assessed of 17 l/sec per each км^2 area, which is equivalent to about 20-25% of the total volume of groundwater intake carried out by Vodocanal water supply facilities.

According to the information from "VostokKazNedra" Territorial Committee, the following groundwater reserves were explored, estimated and proven within the limits of Ust-Kamenogorsk alluvial basin: Korshunovsky, Severo-Atamanovsky, Nizhne-Sogrinsky, Atamanovsky, Pionersky, Elevatorny, Topolinny, Levoberezhny, Novo-Ust-Kamenogorsky groundwater deposits. Total useful groundwater resources, proven for $A+B+C_1$ categories and approved by the State Committees of Reserves of the USSR and the RoK, were equal to 1217,7 thousand m^3/day, including 774,9 thousand m^3/day of groundwater resources of industrial quality. Ground waters of the explored deposits are characterized by 0,1-0,6g/l mineralization containing calcium bicarbonate. At the time of groundwater resources exploration, water quality corresponded to the state GOST standard specified for “Drinking Waters”.

In 2004 five groundwater intake facilities have been operating in the sites with the explored and proven groundwater reserves, including Pioneer intake facility with 34,9 thousand m^3/day output capacity, Elevatorny (19,2 thousand m^3/day), Severo-Atamanovsky (55,6 thousand m^3/day), Novo-Sogrinsky (10,8 thousand m^3/day) and Atamanovsky (19,3 thousand m^3/day), shown in Fig. 3.1. Total output capacity of these water-intake facilities was equal to 139,8 thousand m^3/day (equivalent to 1618 dm^3/sec), inclusive of 19,3 thousand m^3/day (i.e 234 dm^3/sec) used for industrial/technical purposes. Novo-Ust-Kamenogorsky groundwater deposit is not being utilized.

In 2004 about 15 grouped groundwater intake facilities of various output capacity have been operated in the sites with non-proven water reserves. The biggest of them were Oktyabrsky (27,3 thousand m^3/day), Ablaketsky (2,3 thousand m^3/day), Lesozavodsky (7,5 thousand m^3/day), Microdistrict III (3,1 thousand m^3/day), JSC Adil (1,4 thousand m^3/day), Akhmirovsky (6,85 thousand m^3/day) and others (Fig.3.1). Total output capacity of these groundwater intake facilities was around 50 thousand m^3/day (579 dm^3/sec), including 47 thousand m^3/day (544 dm^3/sec) supplied for residential & sanitary use. Major part of these water intake facilities are not provided with any sanitary buffer zones, and their supplied water quality is low. For this reason in the 90-ties of the last century several groundwater intake facilities were abandoned, including those located in Stary Ploschadka district, in the city blocks 19 and 20, the area of Zaschita district. Waters of Octyabrsky water intake facilities are under the threat of being polluted beyond the maximum permissible limits.

There is a significant number of the groundwater pollution sources located within the territory of aquifer occurrence. Basically all the pollution sources are caused by the industrial enterprises. At present the industry-run environmental monitoring is carried out practically at all the industrial enterprises, and such monitoring includes investigations of groundwater conditions. Major groundwater pollution sources and groundwater monitoring results are summarized below.

Within UMP tailing dump area, aquifer is polluted with toxic components. Mineralization of groundwater in the area of *UMP tailing dump* is ranging from 10 up to 48 g/dm^3. The overall concentrations of polluting substances are equal to thousands of the maximum permissible limits. Concentrations of such polluting substances as dry residue, nitrates, sulfates, ammonium, lead, cadmium, fluorine and lithium exceeded the concentration limits established for the standards of drinking water quality. Concentration of beryllium assessed in the environmental monitoring wells in the territory of the tailing dump were 1,5 higher than the maximum permissible concentration limits (MPC). The integrated pollution indices were estimated as equal to 647 MPC limits for polluting substances of 1 & 2 hazard classes and equal up to 2624 MPC limits for polluting substances of 3 & 4 hazard classes, total level of alpha- and beta-radioactivity was up to 1650 and 130 $MPC_{surface\ water}$ limits accordingly.

Ecological parameters of ground waters occurring in the area of the UMP tailing dump were assessed as "dangerous" in terms of their overall pollution level which was considerably exceeding the specified $MPC_{surface\ water}$ limits.

Dry residue, sulfates, ammonium, manganese, beryllium, fluorine, total alpha- and beta-radioactivity pollution were measured in the environmental monitoring wells at the previously used *UMP tailing dump* and assessed as exceeding the specified MPC norms. The overall pollution level (measured in a number of the relevant MPC limits) was up to 76 MPC limits for polluting substances of 1 & 2 hazard classes, and up to 48 MPC limits for polluting substances of 3 & 4 hazard classes, total level of alpha-radioactivity was equal to 250 MPC limits.

Pollution from the waste dump site of JSC KazZinc. Major groundwater pollutants in this area are cadmium, thallium, zinc, manganese, beryllium, selenium, arsenic, mercury, lead, lithium, ammonium salt. The biggest polluting impact was caused by thallium (39-53%), cadmium (20%), ammonia (6-18 %), manganese (9-13 %).

Pollution from the operational premises of JSC KazZinc. Major groundwater pollutants in the area of the operational premises include cadmium, thallium, zinc, manganese, beryllium, selenium, arsenic, mercury, lead, lithium, ammonium salt.

Pollution from the ash disposal dumps of Heat Power Plants 1 and 2. Results of ground water surveys conducted in 2003-2004 in this site showed that the maximal pollutants concentrations in groundwater occurring in the area of the ash dumps (taking into account the background level as well) was 4,6 $MPC_{surface\ water}$ limits - for fluorine, 2,29 $MPC_{surface\ water}$ limits - for manganese, 2,5 $MPC_{surface\ water}$ limits - for nitrates, 3,7 $MPC_{surface\ water}$ limits - for boron. Concentrations of other polluting components spreading from the ash dump into ground waters were below the $MPC_{surface\ water}$ limits.

Pollution from the waste disposal sites of UK Condenser Plant. The largest toxic wastes disposal site used for disposing trichlorodiphenyl, i.e. the 1st hazard class pollutant is the waste storage pond at the Condenser Plant. This waste storage pond is a source of local pollution. Here the polluting elements are thallium (20 $MPC_{surface\ water}$ limits), lead (3,3 $MPC_{surface\ water}$ limits), iron (2 $MPC_{surface\ water}$ limits), mineral salts (2 $MPC_{surface\ water}$ limits), sulfates (1 $MPC_{surface\ water}$ limits). Trichlorodiphenyl, i.e. the major pollutant generated from the waste storage pond, was not subject to metering.

Pollution from the solid waste disposal sites of UK TMP and Slurry Pond No.3. UK TMK solid waste disposal facilities are located in two different places including one place used for solid waste disposal (sites No.1 and 2), and the second place used for the slurry pond (site No.3) and disposal facilities for solid chlorine-containing waste. Since there is no any reliable waterproofing of the previously used waste disposal facilities, chlorine-containing compounds are escaping from the waste disposal site together with atmospheric precipitation. The major polluting substances are chlorides. As for pollutants which concentrations were exceeding the established norms for drinking waters, lead concentrations in ground waters were ranging within 6-57 MPCsurface water limits, cadmium and lithium concentrations were up to 280 MPCsurface water limits, manganese concentration was up to 800-3510 MPCsurface water limits.

Pollution from the operational premises of JSC UK TMP. Ust-Kamenogorsk Titanium-Magnesium Plant is located in the northwest part of the city. Assuming the overall polluting impact of the operational premises, the waste disposal sites and slurry ponds, groundwater of the alluvial aquifer within about 3,5 $км^2$ area do not meet the requirements specified to drinking water norms. The drainage water-intake facilities used for supplying technical water from the currently operable water wells ensure quite efficient water supply in the controlled mode, thus contributing to limiting and localizing groundwater pollution. These drainage water-intake facilities enable to provide a successful pollution protection of Novaya Sogra drinking water intake facilities located in the immediate proximity (600 m to the south) as well as to ensure protection for the municipal water intake facilities of the city located downstream of the groundwater flow.

In addition to the pollution sources in the survey area as mentioned above, there is a number of smaller pollution sources caused by the ash disposal site No. 1 of Sogrinsky Heat Power Plant, waste disposal dumps of City Municipal Utility Enterprise “GorComChoz”, operational premises of OJSC “Adil”, the solid waste disposal site, the city water treatment installations, the previously used storage of mineral fertilizers and pesticides, storm drain storage pond of Silk Factory, Ust-Kamenogorsk Condenser Plant. Furthermore, there are areas in the city where ground waters are polluted from the outskirts housing blocks which are not outfitted with the sewage drain system and lead therefore to a significant pollution of ground waters with nitrogen-containing substances.

Fig.3.4 and 3.5 illustrate the areas of ground water pollution with 1^{st} hazard class substances (Tl, Be, Hg), 2^{nd} hazard class substances (Se, Cd, Sr, Co, B, Li), 3^{rd} hazard class substances (Mn, V, Ni, Cr^{+6}) and 4^{th} hazard class substances. As clearly seen in the said Fig. 3.4 and 3.5, ground waters occurring between Ulba and Irtysh rivers are characterized by significantly large areas of pollution. Ground waters of the right bank of Irtysh river occurring downstream of the junction of Irtysh and Ulba rivers are practically deprived of any volumes of good-quality groundwater, as pollution level of these ground waters is assessed as “high” (3-10 $MPC_{surface\ water}$ limits) and “extremely high” (10-100 $MPC_{surface\ water}$ limits) in terms of pollutants concentrations of the 1^{st} and 2^{nd} hazard classes.

Regular monitoring of the city ground waters radiation pollution was started after the introduction and implementation of the Sanitary Regulations and Norms SanR&N 3.01.067-97, specifying a maximum allowable limit for total α-radioactivity (0,1 Bq/l) and a maximum allowable limit for total β-radioactivity (1,0 Bq/l), deemed acceptable to ensure the radiation safety of drinking waters. According to the results of laboratory sample analyses accomplished in 2003-2004, pollution level of groundwater radiation in the central and western parts of Ust-Kamenogorsk city was characterized by the values which exceeded maximum permissible limits specified for α- and β-radioactivity (Fig.3.6) The adverse ground waters radiation pollution was identified within the zone of impact caused by the UMP (Ulba Metallurgical Plant) operational premises and the neighboring tailing dumps. According to the results of analyses accomplished in 2004, total α-radioactivity level of ground waters occurring in the close vicinity to the pollution sources, was 16 - 80 times higher than the norms specified for drinking waters, total β-radioactivity level was up to 6 times higher as against the norms specified for drinking waters. The water intake facilities belonging to the Airport, the Factory of construction materials, as well as “Altay geologist” water intake facilities, etc. and a big number of groundwater wells, aimed for personal use, are located in the area where ground waters are assessed as being adversely polluted with radioactive elements (downstream of the groundwater flow). As per the results of sampling undertaken in 2004, the total α-radioactivity level of ground waters was 2-4 times higher than the Maximum Permissible Concentration (MPC) limits specified for drinking waters, and total β-radioactivity level of the ground waters was within the limits of MPC norms specified for drinking waters. Taking into account the specific character of the production operations of JSC UMP, total α-radioactivity pollution of ground waters was probably caused by the occurrence of natural uranium, so that uranium concentrations in ground waters were lower than the permissible sanitary-toxicological limit of 1,8 mg / l.

The city's major water intake facilities used to ensure water supply for residential & sanitary purposes are included into the program of the state ground waters monitoring, being focused on the control upon the water pollutants concentrations. As per the monitoring results, several aspects were identified as follows.

As of the beginning of 2005, ground waters in such major water intake facilities of the city, as Nizhne-Sogrinsky, Octyabrsky, Novo-Sogrinsky, Severo-Atamanovsky, Pionersky, Lesozavodskoy, Elevatorny, Ablaketsky (Table 3.1) may be recognized as of satisfactory quality (i.e. concentrations of controllable pollutants did not exceed the limit of $MPC_{surface\ water}$, and the aggregate of pollutants concentrations measured in a number of the specified $MPC_{surface\ water}$ limits, did not exceed 3 $MPC_{surface\ water}$ limits, what corresponded to the permissible and moderate degree of pollution). However, constant use of waters with a moderate degree of pollution adversely affects the population health, resulting in the revealed intoxication symptoms. Concentrations of certain controllable pollutants in ground waters of the intake facilities subjected to polluting impact of the city's North Industrial Zone, periodically exceed the established $MPC_{surface\ water}$ limits, and the aggregate pollutants concentration is constantly exceeding the $MPC_{surface\ water}$ limit, being equal to 6 or more $MPC_{surface\ water}$ limits, which was assessed as moderate and high degree of water pollution (such as "Altay geologist" groundwater intake facilities located outside the western part of the surveyed area, and such as the intake facilities of the Airport and Microdistrict III). Ground waters of these water intake facilities are not fit for drinking purposes.

So far, radiation pollution of the water intake facilities used for the municipal residential & sanitary water supply is remaining satisfactory.

It is necessary to note that in 2004 about 185,0 thousand m^3/day of water were supplied to meet the residential & sanitary needs of over 305 thousand people. Water supply of 5,4 thousand m^3/day (2,9%) of unsatisfactory quality was provided to 23,770 people (7,8%), and such groundwater was taken from small intake facilities (Microdistrict III, the Airport facilities, "Altay geologist", Opytnoye field) as well as from the private water wells (in Menovoye and Stepnoye villages, close to Zaschita station).

Thus, so far some water intake facilities of the city provide clean water of drinking quality, however there is a certain probability of their quality deterioration in the near future because of the fact that these water wells are located on the way of the pollution migration along the aquifer.

In spite of the fact that quantities of natural groundwater resources are significant in

Ust-Kamenogorsk area, such ground waters are becoming less fit for satisfying drinking water needs of certain parts of the city because of their high pollution.

There is an urgent need of undertaking cardinal remediation measures with the purpose to prevent pollution spread throughout the aquifer.

Fig. 3.4

Fig. 3.5

Fig 3.6

Table 3.1

Quality characteristic of ground waters in major water-intake facilities of Ust-Kamenogorsk

Water-intake (ref. No. on the map)	Symbol in Fig. 3.1	Summary pollution factor, calculated in numbers of MPC limits; Major pollutants, (pollution degree)	
		Pollutants of 1 & 2 class hazard	Pollutants of 3 & 4 class hazard
		2002-2004	2002-2004
Altaisky geologist, №1	*	2,4-12,9; Cd, Tl, B, Pb (2-4)	3,3-4,7; NO_3, SO_4 (2-3)
Airport , №2	*	1,7-5,9; Cd, Pb, Ba (2,3)	2,4-2,6; NO_3, SO_4 (2)
III Microrayon, KSM, №3	d	3,2-5,4; Tl, Cd, Pb, Ba (3)	2,7-3,7; NO_3, SO_4 (2)
Octyabrsky, №19	g	1,3-2,6; Cd, Pb (2)	0,4-0,9; NO_3 (1)
Nizhne-Sogrinsky, №27	a	0,5-1; Cd (1)	0,3-0,4; NO_3 (1)
Novo-Sogrinsky, №31	k	0,9-1,3; Cd (1-2)	0,4-0,9; NO_3, Fe (1)
Severo-Atamanovsky, №32	b	0,25-1; Cd (1)	0,3-0,5; NO_3, SO_4 (1)
Pionersky, №39	c	0,3-1,2; Cd (1-2)	0,3-1,34; Mn, NO_3 (1-2)
Lesozavod, №54	f	0,4-1,1; Cd (1-2)	0,4-1,57; Mn, NO_3 (1-2)
Elevatorny, №55	c	0,5-1,5; Cd (1-2)	0,5-1,2; NO_3, SO_4, Mn (1-2)
Ablaketsky, №57	h	0,2-1; Cd, Pb (1)	0,2-0,5; NO_3, Fe (1)

** - water intake facilities located outside the western boundary of the city*

3.5. CONDITIONS OF THE CITY SOILS

The industrial giants of non-ferrous and ferrous metallurgy, nuclear industry, heat & power engineering are located just within the residential areas of Ust-Kamenogorsk and cause strong adverse impact on the city soils. Such soils impact is resulted from ambient air pollution with heavy metals which subsequently fall-out on the city soils, that are the major depository element of the environment. Soils pollution with heavy metals of certain intensity was detected in all parts of the city - on the area of more than 200 sq. km. Now soils are regarded as the areal source of secondary contamination with heavy metals that might cause an adverse impact to the contacting elements of the environment.

Summary of the soils environmental surveys earlier accomplished in Ust-Kamenogorsk city is provided hereunder. In the beginning of 90-ties of the last century sampling was carried out in the area of Altay Hydro-Geological Expedition, and in 2000 JSC Institute of Geologic Sciences performed the laboratory sample analyses and accomplished the report preparation.

The areal distribution of soils pollution with heavy metals is characterized by a well-defined zoning, expressed in reducing range of toxicants and decrease of toxicant concentrations versus the increasing distance from the major pollution sources. Soils pollution within the city territory is configured into concentric-zonal shape.

The zone with Z_C> 128 is characteristic for the industrial sites of OJSC “KazZinc”, JSC UMP and UK Heat Power Plant as well as for the adjacent territories. In these areas the average value of integrated contamination index Z_C is 1534 times bigger than the background concentration value. Range of heavy metals is wide enough and includes the following elements ranged based on their relevant K_c values:

Sb^{624}, Pb^{406}, Ag^{189}, As^{100}, Cd^{62}, Zn^{49}, Cu^{42}, Sn^{38}, Bi^{21}, Hg^{8}, Mo^{3}, Ba^{3}.

(K_C - is the ratio of actual and background concentrations of each polluting element; Z_C - is the integrated index showing the total sum of abnormally sincreased concentrations of polluting elements versus the background concentrations)

As per snow sampling results, beryllium was additionally detected amongst the area pollutants. Total area of this zone is 7.38 sq. km. Soil contamination intensity eas defined as extremely hazardous.

The zone with Z_C = 32 – 128. The area characterized by the specified level of soils contamination is of complicated shape being close to an oval stretched in the north-west direction of the prevailing winds. The area includes housing blocks, which surround the industrial sites of OJSC "KazZinc" and UK Machinery Plant lovated at 2.5-5 km distance (housing blocks are located in Lenin Avenue, Bazhova Street, at Zachita station, Melzavod, Shmelev Log, and include a part of Krasina village, blocks of many-storied buildings near the ash disposal sites of UK Heat Power Plant, etc.)

Practically the full range of major polluting elements, typical for this zone, was identified in soils of this zone and assessed in anomalously high concentrations (ZC > 128). However, their average concentrations were the order-lower: for lead - 25 times lower, for antimony - more than 200 times lower, for silver - 23 times lower, etc. The integrated sum of toxicants concentrations ZC was 28 times lower that the anomalously high integrated concentrations. Associative range of heavy metals distribution is as follows:

Pb^{16}, Hg^{15}, Cd^{11}, Zn^{8}, Ag^{8}, Cu^{3}, Sb^{3}, Sn^{2}

Same as in the zone with (ZC > 128) predominant pollutants include the toxicants of the 1st hazard class, such as lead, mercury, cadmium and zinc, appropriately placed in the left part of the associative range of heavy metals group.

Arsenic, bismuth, beryllium and zirconium were additionally identified in solid snow residue.

Total area of this zone is 22.92 sq. km. Soils contamination with heavy metals was assessed as corresponding to a high level of hazard.

Zone with (Z_C = 16 – 32). This zone is shaped in a form of the swath being from 1 to 4 km wide. It is surrounding the territory of the zone with (ZC = 32 – 128) and includes narrow plums mapped in the north-east of the survey area (i.e. Sogrinsly plum detected in Ulba river valley) and the plums in the north-west part close to the Airport area. Most of housing blocks in the regional center of Ust-Kamenogorsk are contaminated with pollutants which concentrations are ranging within the above specified limits: many-storied buildings adjacent to the Ust-Kamenogorsk railway station; Palace of Sports, Ushanova square; Prombaza as well as including the private housing sector in Stary Podhoz village; and partially – in Staraya Sogra, Krasina settlement, Staraya Zachita, KSM, Airport, etc.

Composition range of heavy metals detected in soils of this zone (ZC = 16 – 32) is somewhat narrower comparing to the zones described above, however heavy metals of the 1st class of hazard remain to be predominant pollutants in this area:

Hg^{8}, Pb^{7}, Zn^{5}, Ag^{4}, Cu^{2}, Sn^{2} Z_C average = 23 (in the city)

Polluting components detected in Sogrinsky pollution plum are remaining within the same composition, retaining the same prevailing character and concentrations, thus testifying to their emission from the same pollution source:

Hg^{8}, Pb^{7}, Zn^{3}, Ag^{3}, Cu^{2}, Sn^{2} Z_C average = 20

The results of snow cover sampling within the described zone are very much indicative. Antimony, cadmium, bismuth, arsenic were additionally identified in atmospheric precipitation together with a wide range of the toxicants typical for rare-metals industrial production (Ulbinsky Metallurgical Plant), including such elements as zirconium, niobium and beryllium, which concentrations were assessed at the level of 2–4 higher than the relevant soils background concentration limits. Titanium and vanadium were identified within Sogrinskiy pollution plum near the Titanium-Magnesium Plant.

Soils contamination within the described zone corresponds to a moderate level of hazard [20]. Area of contamination is 47.91 sq. km.

Zone with (Z_C = 4 – 16). The specified pollutant concentrations are most typical for the zones of remote suburbs, surrounding the city from the north, east and north-west. Most part of this area is devoid of inhabitants. Among the housing blocks of the regional center, such contamination of a relatively low level is typical to the most comfortable part of the city (“Strelka”, the embankment of Irtysh river). Similar situation was detected in Ablaketka area and in the housing block adjacent to Ust-Kamenogorsk Hydroelectric Power Station

Associative range of heavy metals distribution was as follows:

Pb^4, Zn^3, Ag^2, Cu^2, Hg^2.

The average value is $Z_C = 9$, i.e. the integrated pollutant concentration is 9 times higher than the value of the relevant background pollution concentration limit.

Based on snow sampling results, transgression impact from such elements as Cd, Sb, Sn, Bi, As, Nb, Zr was additionally revealed.

Soils contamination with pollutants, which concentrations are 16 times higher than the background value of such pollutants concentrations, is regarded as admissible [Methodological Guidelines on soils chemical pollution assessment, Moscow, 1987]. Assuming the specific features of the regional center area, where the toxicants of the 1st class of hazard are prevailing (lead, zinc, mercury), as well as the transgress impact from arsenic and cadmium, a “permissible” contamination is divided into two ranges, including the range for average pollution level (Z_C = 4 – 16) and the range for moderate pollution level (Z_C = 2 – 3).

So, the area of 166.47 sq. km in Ust-Kamenogorsk city is characterized by medium soils contamination (4–16 times higher than the background concentration level).

Zone with (Z_C = 2 – 3) is outlined in a form of separate spots located in the northern part of the survey area, covering mainly the left bank of Irtysh river. These areas coincide with the crop-lands and probably this fact led to decreased pollution concentrations in the top soil (0 – 5) layer, which was sampled at performing the environmental and geochemical surveys. In this zone only lead was identified in the increased concentration equal to 2 regional Clarks.

As per snow sampling results, such pollutants as Ag, Cd, Zn, Cu, Hg, Bi, Sn, Nb, Zr. Z_P were detected in the atmospheric precipitation in addition to the detected lead. The area, characterized by the specified level of soils contamination, is equal to 19.32 sq. km.

Hence, pursuant to the results of the environmental-geochemical surveys accomplished in the beginning of the 90-ties of the last century within Ust-Kamenogorsk city and its outskirts, there were no any detected areas with the background level of pollutant concentrations. As a result of over fifty-year operations of two large industrial enterprises, a technogenic areal anomaly was formed in Ust-Kamenogorsk city, being characterized by high heavy metal concentrations in soils. Soils pollution, caused by small spotted pollution sources including the heat power installations and motor transport facilities, is shaded by the strong impact made by the above specified industrial facilities. So small spotted pollution sources were therefore inaccessible for their pollution interpretation.

In 2004 Altay Branch of the Institute of Geological Sciences named after K.I. Satpaev performed the controlling soils sampling in the regional center of Ust-Kamenogorsk city, such sampling program comprised of 802 soil samples in total. These investigations were accomplished within the program "Environmental surveys of soils contamination in Ust-Kamenogorsk area" focused on analyzing the distribution regularity of integrated heavy metals concentrations and their vertical migration in various surface terrain conditions.

Comparative analysis showed that by the year of 2004 the previously revealed technogenic anomaly retained its general morphologic, structural and genetic properties. Same as in the beginning of the 90-ties of the last century, the soils contamination within the city territory was shaped in concentric oval zones, affected by the inversion air flows along the valley of Irtysh and Ulba rivers. Heavy metal concentrations and number of polluting metals were detected to be gradually reducing versus the growing distance from the major pollution source. Irtysh river retained its function of a thermal-hydrodynamic barrier, hindering from pollution spread from the North Industrial Zone to the left side of the river valley. Residential areas close to the sites of Silk Factory (SF), Strelka, Irtysh Quay and Novaya Sogra remained to be relatively environmentally sound.

As for polluting elements detected in the zones of adverse environmental impact, the list of pollutants as well as the range of prevailing major pollutants (Pb, Sb, Cd, Ag) remained practically unchanged, and it remained the same as before for the left part of the associative range of toxicants distribution.

There were several new polluting elements newly detected in certain zones, such as Bi, P - detected in the zone of high hazard, Cd – detected in the zone of moderate hazard, etc.

When assessing quantitative parameters of the area of technogenic impact, there was revealed a tendency of the pollution level increase, leading to worsening of soils pollution category, the increase of Zc values and growth of heavy metals concentrations. Areas characterized by hazardous and extremely hazardous contamination became more than twice larger, and average Pb concentrations increased by 10 – 34% in the said zones, leading to 1034 ton increase in Pb quantity occurring in the soils layer of 0-5 cm thickness.

Hence, all major environmental elements of the city area were seriously changed owing to long-lasting adverse impact upon the elements of the city environment caused by the city enterprises. All components of the environment within the surveyed area (over 260 km2), including the residential & the industrial zones, the nearest outskirts and the city suburbs, were found to be polluted with heavy metals.

4. BASIC TECHNICAL SOLUTIONS OF FEASIBILTIY STUDY

As stated above, ground waters of the main aquifer in Ust-Kamenogorsk city are greatly contaminated. Especially strong contamination of groundwater was observed in the western part of the city. Some water intake facilities designed for drinking purposes have been abandoned at the mentioned place. Water intake facility located in III Microrayon is at the stage of being closed. Drinking water from Oktyabrskiy water intake facility, situated westward of Ulba and Irtysh rivers, is under the threat of becoming non-conformable to the standards of drinking water quality. Contamination of ground water gained a regional character. Currently, only ground waters of the river bank territories remain clean (i.e. meet the standards of drinking water quality). Certain industry-controlled water intake facilities of industrial plants, maintained with the purpose to intercept polluted waters, formed within the Central Industrial Complex, are not capable of providing a fully resisting barrier to contaminated ground waters progressing to south and south-west. It is required to take more thoroughgoing measures for the ground waters remediation.

This Feasibility Study proposes to conduct remediation measures on ground waters treatment in a form of two groups. The purpose of the first group of measures is to prevent further infiltration of contamination from the slurry ponds into the subsurface horizons, and the second group of measures is aimed at intercepting the contaminated ground waters by using a hydraulic barrier, then to perform ground waters treatment and injection into the aquifer at the location upstream of the Central Industrial Complex. In this case it will be required to liquidate any leakages from the industrial facilities, which is to be undertaken by the enterprises themselves.

The required measures on improving the situation with ground waters in the city of Ust-Kamenogorsk are grouped into 3 classes:

- measures at the industrial sites of high priority;
- measures at the industrial sites of minor priority;
- measures in the areas of the municipal facilities.

This classification does not imply that the environmental hazards of the “minor priority” objects are negligible and could be postponed for too long. But is does mean that, given the limited funding available, these funds should be used for performing the high-priority activities first where the most pressing problems must be solved.

This Feasibility Study concentrates on the first group of measures, i.e. at the sites of high priority. The strongest contamination of ground waters is localized in the area of KazZinc Industrial Complex – UMP - UHPP. Flow of contaminated ground waters spreads towards the major water-supply sources of Ust-Kamenogorsk city. It is required to prevent spread of ground waters contamination downstream of the water intake facilities through the liquidation of the following main sources of ground waters contamination:

- uranium slurry pond of UMP-6;
- “new slurry” terricone No. 6 KazZinc (State-owned facilities);
- slurry reservoir of the Condenser Plant;
- removal of leakages, if any, within the territory of KazZinc, UMP, UKHPP premises.

List of the main (alternative) cardinal measures on the leaks removal or the impact mitigation is as follows:

- relocation of contamination sources to better suited sites;
- covering of dumps to minimize leakage through the sedimentary thickness;
- wastes immobilization aiming to minimize leaching of hazardous substances from wastes;
- removal of contaminated soil and formations of aquifer;
- repair of processing equipment with leakages;
- minimization of wastes toxicity prior to storing.

More realistic way to reduce infiltration of contamination into the aquifer under prevailing conditions (according to FS developers) might be a creation of covering systems (Store and Release Cover), which may serve as a barrier preventing filtered atmospheric precipitation from further penetration. SRC–systems are based on the principle of “storage and evaporation”, i.e. exclusion of infiltration into the aquifer by making a storage layer of certain thickness. The said layer can restrain penetrated atmospheric precipitations of wet season until a dry season, when the accumulated moisture from SRC system is evaporated. Moreover, evaporation process, root system of vegetation, which are slated to be planted along the surface of the covering, will fortify the consumption of moisture accumulated in SRC system. According to FS developers’ experience, brown loam is suitable for overlapping, and the mentioned loam is abundant in the region of Ust-Kamenogorsk. Usable water capacity of this loam is estimated at about 10%. At such water capacity, loam thickness of about 250 cm seems appropriate.

Final landscape design will consist of grass sowing on the entire area of settling vessel as well as in planting of about 10 softwoods aiming to fortify process of water evaporation, which accumulates in the center of the reservoir, and to minimize volume of water, which needs to be collected and processed.

Guarantee period of such covering is almost 200 years.

As stated above, second group of remediation measures is intended to intercept contamination through making a hydraulic barrier, to purify and inject treated waters into the aquifer upstream of the Central Industrial Complex.

Hydraulic practice has several approaches on ground waters interception. Characteristic of the said approaches is detailed in Table 4.1. Removal of contaminated soil might be included into this category of the aquifer treatment.

Two last options deemed to be as the most suitable from this list of ground waters treatment measures.

The idea of ground waters pump-out and treatment leads to the arrangement that the contaminated ground waters are to be withdrawn from the aquifer and subjected to treatment. Next, purified water is either discharged into the river or pumped into the aquifer upstream of the Central Industrial Complex, aiming to fortify the dilution process. The repeated infiltration can significantly reduce time and costs required for ground waters remediation.

The specified capacity of ground water intake consumption at the peripheral parts of the Industrial Complex totals 830-1000 m^3/hour. Each well is able to yield 10 l/sec, it should be noted that the water level lowering in the water intake facility will comprise less than 1 m. Therefore, the well field will consist of 23 wells, and a distance between water wells will be 150 m, wells’ depth will equal to 20-50 m. (depending on the bedrock occurrence), length of mesh filters will be 10-40 m.

Table 4.1

Characteristic of the available methods of contaminated ground waters interception

Method	Characteristic	Disadvantages	Method acceptability
1. Removal of contaminated soil from the aquifer	Volume of possible excavated soil in the area of central industrial complex totals almost 30 million meters ^{3}.	High cost (almost USD 300 mil.)	Not acceptable
2.Permeable reactive barriers (PRB)	Contamination is adsorbed in special adsorbent pellets with great specific surface.	Present contamination area is great enough: width 3,5 km, aquifer's capacity is almost 50 m. There is no total guarantee regarding wall impermeability High cost. Almost USD 20 mil.	Not acceptable
3. Impermeable barriers	Curtain grouting, ground flow doesn't run through such curtain. Therefore, area of contamination is localized. Raise of ground water level in front of the wall is regulated by evaporation	Tentative length of wall is 3,5-4,0 km, great capacity of aquifer. Realization of such huge engineering structure is complicated and expensive task. Underflooding of the territory, reduction of natural ground resources downstream are likely to be occurred. Approximate cost is USD 30 mil.	Not acceptable
4.Introduction of stabilizing substances into the aquifer	Substances enabling to transfer polluting agents into insoluble forms and to settle them in the aquifer	Demand in great number of reagents. Very great volume of ground waters is contaminated and one hardly can rely on ground water remediation by suing this way. High cost (almost USD 300 mil.)	Not acceptable
5.Treatment of ground waters immediately prior to supplying to water consumer		Localized preparation of drinking water for supplying it to consumers will entail rise in cost of water supply, and this in its turn can lead to unauthorized water consumption from private water wells. Condition of ground waters, upon which water supply is based, will aggravate. Continuing inflow of contamination will be observed in Irtysh river.	Deserves due attention for near-term prospect
6.Hydraulic barrier (pumping out – treatment – injection)	Interception of contaminated waters inflow facilitates a considerable reduction of polluting agents migration downstream. Fortification (speeding-up) of ground water treatment process can be achieved through upstream injection of purified ground waters, by doing this one reaches more rapid effect of horizons flushing.	Investment and operating expenses will total almost USD 6,3 mil.	Most optimal way of ground water remediation.
7.Relocation of water intake facilities to the habitat of clean ground waters		Continuation of contaminants' spread along the aquifer.	Presents interest in combination with previous way.

Total operational capacity of infiltration water intake facilities is 830 m^3/h. Production capacity of one well is 5-6 l/sec, number of wells - 46, distance between the wells– 100 m, wells' depth is 20-50m. Increase of injected wells number comparing with a number of wells within the water intake facilities is conditioned by the fact that, under such conditions it will be minimal raise of ground waters level at water injection point.

Removal of contaminants from drinking water before supplying to central water supply network is a technically resolvable task. In connection with the fact that ground waters contain great number of various components, including toxic ones, which significantly threaten the water quality, it is required to apply multistage treatment. Treatment process is based on a combination of physical-chemical and biological stages. Biological treatment is required for neutralizing nitrates in water. The proposed stations of ground waters treatment are constructed in the form of two linear systems 500 m^3/hour each.

Until water supply system in the city of Ust-Kamenogorsk is repaired, all purified water from the water treatment unit will be either discharged into Irtysh or Ulba river (since filtration volume from water-distribution system is enough for diluting contaminated flow of ground waters) or used by any consumers (if the consumer for this water volume will be announced). Purified waters will be discharged upon agreement with the environmental authorities, on the basis of discharge standardization. In other words, withdrawn waters should be treated to the limits specified in the applicable standards.

Developers of the Feasibility Study reviewed various ways of groundwater treatment, however preference was given to sedimentation. Ferric chloride (100 g/m^3) and lime milk (pH increases up to 10,5) is used in the water treatment unit as the sedimentation agent. Formed sediments in the volume of 7,5 t/year are anticipated to be transported to one of UMP slurry reservoirs.

The effectiveness of the implemented remediation measures will be traced by way of monitoring ground waters in the area of Industrial Zone, towards Oktyabrskiy and III Microrayon water intake facilities, as well as towards Irtysh river. Wells' position should correspond to the expected migration of ground waters pollution plum.

Monitoring system should be arranged so that all the companies involved into such monitoring should have an access to the monitoring data, and observations should be undertaken according to the joint program using certain technical means.

Based on combination of the above listed remediation measures, (Table 4.2) Developers of the Feasibility Study proposed 11 options for ground waters remediation. According to these options future ground waters conditions were forecasted on the basis of the mathematical simulation.

Based on results of Table 4.2 only options 4, 7, 9 deserve due attention:

- Option 4 – exclusion of contamination sources, elimination of leakages from water supply network, remediation of water intake facilities as well as the water intake facilities for purified ground waters injection;
- Option 7 – removal of contamination sources, remediation wells, elimination of leakages from water supply network. However, treatment processes run slower than in option 4.
- Option 9 – relocation of Oktyabrskiy water intake facilities to the left bank of Irtysh river, removal of contamination sources.

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Table 4.2

Remediation measures stipulated in FS and acceptability of alternative forecasts

Option	**Remediation measures**							**Note**
	Liquidation of priority –oriented contamination sources (Central Industrial Zone)	**Remediation wells**	**Leaks**	**Infiltration wells**	**Relocation of Oktyabrskiy water intake facility to the left bank**	**Liquidation of contamination source**		
						TMC	**SHPP**	
Option 1	_	_	+	_	_	-	-	Option is not acceptable
Option 2+option 10	+	_	+	_	_	+	+	***Can be considered as temporal option, until leakages in water network are liquidated***.
Option 3	_	+	+	_	_	+	+	Option is not acceptable
Option 4	+	+	_	+	_	+	+	***Option is of interest.***
Option 5	+	+	+	_	_	+	+	***Option is acceptable only at early stage of remediation, when water network is repaired this option won't be accepted***
Option 6	+	+ (upstream of Oktyabrskiy and III Microrayon water intake facilities)	+	_	_			Option is not accepted, since interceptive water intake facilities reduce operating capacity of water intake facilities designed for drinking needs
Option 7	+	+	_	_	_	+	+	***Option deserves due attention.***
Option 8	_	_	+	_	+			Option is of no interest.
Option 9	+	_	+	_	+			***Option presents interest if contamination sources of central Industrial Complex are liquidated***
Option 11 (option 2 + exclusion of TMC water intake facility)	+	_	+	_	_	+	+	Option is of no interest.

Obligatory condition for ground waters remediation as per all three options (4, 7, 9), being of interest, appears to be the removal of contamination sources. Remediation wells are typical for options 4 and 7. The advantage of such options is the restriction of contamination spread along the aquifer. Infiltration wells are envisaged only in Option 4. This option cardinally changes hydrochemical situation for much shorter time, if compared to Option 7, i.e. Option 4 seems to be the most optimal.

5. ENVIRONMENTAL IMPACT ASSESSMENT DURING THE PROJECT IMPLEMENTATION

Great positive effect associated with ground waters remediation is anticipated while implementing technical solutions stipulated in the Feasibility Study. However, achievement of this effect is linked with some slight negative impacts upon environmental components, for example, during objects construction.

Option enabling to optimally solve problem on ground water remediation will require construction of remediation and infiltration water intake facilities (Table 4.2), plant for extracted ground water purification, the said option will as well stipulate overlapping of tailings storages, ash-disposal areas. Therefore, construction stage will be formed as follows:

- Overlapping of tailings storages and ash-disposal areas,
- Wells drilling
- Pipelining, construction of purification plant for ground waters.
- Construction of purification plant for ground water.

Maintenance stage includes:

- Ground water withdrawal /injection,
- Ground water purification,
- Discharge of purified waters into the river (provisional arrangements),
- Storage of wastes of purification.

At the stage of the Feasibility Study development, the FS section of Pre-EIA summarized the impact factors upon the environmental components, and provides only with qualitative characteristics of impact level. At the subsequent design stage it is planned to provide with detailed qualitative assessment of impact upon environmental components, which might be caused as a result of construction operations while building remediation facilities for ground waters.

5.1. IMPACT UPON THE ENVIRONMENTAL COMPONENTS DURING THE FACILITIES' CONSTRUCTION

Impact on ambient air

Emissions caused by internal combustion engines of the equipment, which serve the well at construction stage, and by dusting of well site surface will be discharged into atmosphere in the course of wells construction. It must be noted that emissions into atmosphere will be minimal. Owing to the fact that wells will be drilled in the city, drilling equipment will operate on electric power, in other words, no emissions into atmosphere will be made.

The same will be true during construction of water-pipe trenches (construction of the conduit) – pollutants' emissions will be minimal.

Period of purification plant construction includes those works, during which contaminants' emission into atmosphere is anticipated. Main impact factors upon ambient air will be: leveling of the site, access road construction; excavation for foundation; soil loading into dump-trucks and transportation; operation of internal combustion engines of the main equipment and mechanisms; transportation, unloading and storage of inert materials and cement; transportation and supply of inert materials and cement into drilling rig bowl; welding operations; cutting of reinforcement; production of casing; standby diesel-generator.

Level of impact upon ambient air of the adjacent urban areas during overlapping of slurry reservoirs and ash-disposal areas arouses special interest, since excavation works (contouring, leveling, final covering, building and development of hydrotechnics) are accompanied with dusting of movable ***stored wastes*** and emission of exhaust gas released by the internal combustion engine. Overlapping is planned to be undertaken at the following objects:

- cone-shaped dump No.6 of KazZinc;
- dump 6 of UMP;
- slurry reservoir of Condenser Plant
- ash disposal site 1 of UHPP;
- ash disposal sites 2a and 2b of UHPP;
- TMP dump;
- dump of the experimental Lead-Zinc Plant;
- dump of Sogrinski Heat & Power Plant;

Process of covering these waste storage reservoirs slightly differs, however common features of such covering are as follows: relocation of the material, contouring, extraction and filling of the material, delivery and unload of the loam, compressing of under layers, construction of drainage channels. It is expected to employ special equipment at dumps and slurry reservoirs, such as: bulldozers, excavators, ditch diggers, truck cranes, self-dumping vehicles.

During restoration of all dumps and slurry reservoir, gross pollutant emissions into atmosphere will total 296,6385 t of contaminants, including 119,2178 t of harmful agents, 177,32068 t of gaseous polluting components.

Contribution share of each contaminating agent into total volume of gross emissions during dumps' restoration is provided in Figure 5.1.

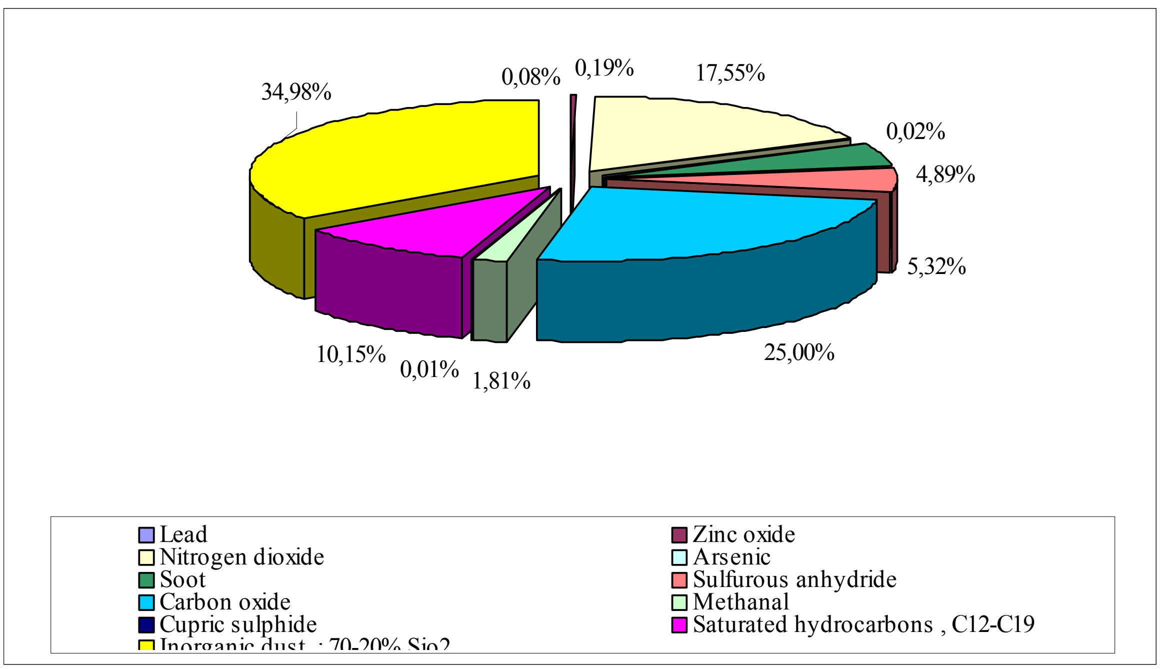


Figure 5.1 Pollutant emissions (%) into atmosphere during restoration at dumps and slurry storage reservoirs of Ust-Kamenogorsk city

Forecasting of atmospheric contamination (calculation of pollutant ground level concentration) is carried out according to software system “Era”, version 1.6, which was developed by “Logos-Plus” firm, Novosibirsk, and approved with the Main State Hydrometeorological Observatory named after A.I. Voyekov No.998/25 dated 30.04.99 of the RoK Ministry of Natural Resources and Environment Protection. “Procedure on calculation of contaminants’ concentration (in ambient air), which are contained in the emissions caused by plants” had been implemented in calculations WRD 211.2.01.01-97 (IRD-86).

According to calculations, the expected maximum ground level concentrations of all analyzing ingredients at the border of residential area won’t exceed quality criterion for ambient air, specified for populated area, air condition in the area of projected site location will be changed within specified limits.

Impact on surface and ground waters

No impact will be caused upon surface waters, since there are no any surface waters within the area of objects construction.

Main impact factor upon ground waters while constructing the aforesaid objects might be penetration of contaminants (chemical reagents) into the aquifer, which are contained in drilling fluid. However, geologic profile and wells’ depths indicate that in the course of drilling fluids preparation, no any chemical agents will be used. Therefore, one shouldn’t expect any impact upon ground waters.

Construction works on overlapping of slurry reservoirs, ash-disposal areas won’t cause any impact on ground waters in place of their location, impact factors are not observed.

Land withdrawal, soil impact

Construction of wells (wells drilling), pipelines, plant for ground water treatment will be associated with withdrawal of urban lands inclusive of the permanent land allocation for placing the wells and treatment plants and land location for the temporary use will be done during the water pipeline construction. Land withdrawal procedure within the limits of the city is stipulated in the relevant legislative documents.

Line of remediation and infiltration wells will be located along the periphery of the industrial complex; where land territories are available, i.e. not occupied by private housing sector and industrial buildings.

As a part of temporary soils withdrawal, certain adverse impact will be caused to soils integrity. It is planned to reclaim soil in compliance with the relevant regulatory documents.

Land will also be withdrawn for the construction of ground water treatment facilities, which will be located west of the industrial complex. Here land areas are available for the construction of the mentioned facilities. When construction works are completed, the territory of the treatment facilities construction should be cleaned of the construction waste and reclaimed.

No any additional land withdrawal is envisaged during operations of covering the slurry storage reservoirs and ash disposal sites. Works on covering these objects will be aimed at improvement of the soil-vegetation layer of slurry storage reservoirs’ surface.

Flora impact

There is a park zone located west of Central Industrial Complex, where construction of the ground water treatment facilities is planned. Land allotment for construction of the building should be made outside of this park zone. At the subsequent facilities’ design stages it is required to identify character of vegetation within the construction area.

Wastes formation

Drill wastes will be formed in the course of wells construction. Mainly, drilling wastes would be represented by slurry of drill cuttings, small amount of waste drilling mud, drilling wastewater. Drilling wastes might be temporarily stored and then transported to the pre-specified place, according to the agreement concluded with organization, which is capable of storing these wastes.

During construction of the ground water treatment facility, it is anticipated that construction wastes will be generated, and removal of such wastes will be agreed upon with the relevant organizations.

5.2. IMPACT ON THE ENVIRONMENTAL COMPONENTS AT THE STAGE OF THE FACILITIES EXPLOITATION

Pursuant to the FS, the following facilities, associated with ground water remediation, will be put in operation: remediation and infiltration water intake facilities, pipeline networks, ground water treatment plant, number of covered slurry storage reservoirs and ash-disposal sites.

Impact on ambient air

No any emissions into atmosphere are envisaged during the facilities exploitation stage.

Covering of dumps, slurry reservoirs, ash-disposal areas will cause a positive impact on ambient air conditions.

Impact on surface waters

As for the impact upon surface waters, to be caused by the planned measures associated with ground waters remediation, the following may be stated. Alluvial aquifer is closely linked with surface water of Ulba and Irtysh rivers. Withdrawal of ground waters by remediation water inlet will change volume of contaminants supplied by ground waters to Irtysh river. Maximum annual discharge (e.g. zinc, as the element dominating over metals in aquifer) into Irtysh river, estimated according to the simulation results is provided in Table 5.1.

Table 5.1

Maximum annual zinc discharge into Irtysh river according to the simulation results (without considering a slowdown)

Forecast	Characteristic of the forecast option	Maximum annual zinc discharge into the basin of Irtysh river, t/year	Year of maximum discharge
1	2	3	4
1 option	Inaction, leakages in water mains are not liquidated	320	-
2 option	Contamination sources are liquidated, leakages in water mains are not liquidated	284	In 33 years
3 option	Contamination sources are not liquidated, water supply intake in commissioned, leakages in water mains are not liquidated.	192	In 50 years
4 option	Contamination sources are liquidated, leakages in water mains are liquidated, remediation and infiltration wells are commissioned	204	In 43 years
5 option	Contamination sources are liquidated, remediation wells are commissioned, , leakages in water mains are not liquidated, infiltration wells are not commissioned	84	In 38 years

Continuation of table 5.1

1	2	3	4
7 option	Contamination sources are liquidated, leakages in water mains are liquidated, remediation wells are commissioned, infiltration wells are not commissioned	220	In 44 years
8 option	Contamination sources are not liquidated, leakages are not liquidated, remediation and infiltration wells are not commissioned. Oktybarskiy water intake facility is relocated to the left bank of Irtysh river	300	In 50 years
9 option	Contamination sources are liquidated, leakages are liquidated, Oktyabrskiy water intake facility is relocated to the left bank, remediation and infiltration wells don't operate	72	In 36 years

As shown in this Table, in terms of impact upon surface waters (in the context of inflow of minimum volumes of contaminants into the surface waters), the most effective option is deemed to be Options 5 and 9. The FS proposes Option 4 as the most optimal one, i.e. it is the option, when the following technical solutions will be implemented: contamination sources will be liquidated, leakages from water supply and sewage systems will be excluded, remediation and infiltration wells will be put into operation. However, this option is not optimal in terms of impact upon the surface waters, since infiltration leakages from the municipal water supply and sewage systems is excluded in comparison with other options. In terms of impact on the surface waters, the most optimal is deemed to be Option 9.

Impact on ground waters

Change of ground water level

Operation of remediation and infiltration line of wells will result in deformation of ground water level. Rise of water level will occur in the north industrial zone, while recession will be observed in central part of the city due to different directions of operation by number of wells (Figure 5.2). Watershed of balanced surface will be observed in the north of industrial zone.

Maximum level recession, which is equal to 1-2 m will be in the area of western periphery of remediation line of wells. Maximum growth of level will be in the center of infiltration water intake facility, it will total a bit over 1 m.

With level rise, area will be greatly smaller than the area of level recession. Rise of ground water level will be observed in the north of industrial complex. Remediation water intake facility consists of 23 wells, number of injected wells is twice as large. This construction is justified, since as far as number of injected wells increases, value of level rise is reduced. In this part of industrial zone groundwater's occurrence depth is 7-20 m. Thus, level rise by 1 m won't entail underflooding of the territory.

Recession of ground water level will be observed in the great territory of the city. However, value of such recession averagely totals 0,2-0,8 m, and thus, according to data of ground water dynamics, this value doesn't exceed the value of natural fluctuation.

Water intake facilities of "meat refrigerator facilities", "the city blocks 19-20", "Construction site" fall within the zone to be affected by the remediation water intake facility. (The last two water intake facilities have been already closed for the reason of significant pollution of ground waters). Within the area of water intake facility "meat refrigerator facilities" recession of level is forecasted to be approximately by 1,0 m. At this stage of investigations one can state that such level recession is insignificant and won't have impact on water collection of this water intake facility. Meanwhile, one will have to undertake deepening of filter installation interval not only at this water intake facility, but also at Oktyabrskiy water intake facility, which is localized southward.

Fig 5.2

Change of ground water quality

Principal intention of this FS is to work out the program on ground water remediation, i.e. to work out the proposals oriented to improvement of ground water quality. FS analyzes various options of ground water remediation. These options are characterized by different combination of remediation actions (Table 4.2). All the options had been implemented on hydrogeological model, including option “inaction”, which is based on the fact that contamination sources are not liquidated. The only positive moment, for ground waters, found in this option is presence of leakages from water supply and sewage systems, which are currently observed. These leakages act as dilutant. Meanwhile, pollution keeps on easily spreading along the aquifer. At present, ground waters in the majority of the river-bank water intake facilities still remain suitable for drinking purposes (contamination is lower Maximum Permissible Concentrations for drinking waters), however, some day, according to forecast, there won’t be any water intake facilities on the left bank which would withdraw water of good quality. Acting water intake facility Oktyabrskiy, at this option, worsens the rate of contamination spread along the aquifer. Closure of Oktyabrskiy water intake facility will enable to reduce hydraulic gradient, and contamination spreading speed in south direction.

Water intake facility of III Microrayon, located in the west part of the city, is currently on the verge of its hydrochemical capacities. Naturally, according to the forecast, it is abandoned once and for ever.

“Inaction” option is not acceptable, since all water intake facilities along Ulba river and in the area of its confluence with Irtysh river should be closed for a long period. Closure of Oktyabrskiy water intake facility will entail reduction of pollutant transport from Central industrial complex towards the said water intake facility, however, it will cause stronger progression of contaminants from Central industrial complex in west direction towards gravel pits on the right coast of Irtysh river.

Based on the analysis of forecasting alternatives, it was made a conclusion stating that the most optimal solution of problem associated with ground water quality improvement is:

- unquestionable liquidation of ground water’s contamination sources,
- implementation of ground water treatment system (remediation and infiltration water intake facilities),
- liquidation of leakages in water supply and drainage systems.

This option of forecast showed as follows.

According to simulation results, for some time, when the above listed technical solutions are implemented, strengthening of contaminations will be observed in Oktyabrskiy water intake facility, and only after 10-15 years water quality in this water intake facility will be drastically improved. On the whole, it will take almost 30 years for ground water treatment, as opposed to the option, when infiltration line of wells is not envisaged– treatment process in this option is extended for 50 years.

Implementation of this option will have positive impact on ground water condition in west part of the territory. However, even in this case it won’t be possible to improve water quality of III Microrayon water intake facility.

Negative moment of the option of non-infiltration line of wells is regional recession of ground water level, which might lead to the necessity to deepen filters of exploitation wells of the municipal single water intake facilities, including Oktyabrskiy. Necessity to discharge withdrawn water into Irtysh river is also deemed as negative.

It must be noted, that during simulation, migration of ideal indicators was imitated. Therefore, sorption processes by clayey materials, chemical, biological, radioactive disintegration hadn’t been taken into account. Whereas the processes of diffusion, hydrodynamic dispersion, dilution had been taken into account. Therefore, it should be stated that heavy metals move in nature much slower comparing to those calculated in model. In this connection, forecasting concentrations according to model, are higher than those in nature. However, while modeling, FS developers made attempts to take into account moderation factor using two methods – first method stipulates usage of moderating coefficient according to literature data and the second one stipulates solution of reverse stationary problem using monitoring investigations data in order to obtain migrational characteristics of the aquifer. Both methods of problem solution appeared to be unsuccessful– the obtained model result is far from real results. Therefore, pursuant to FS, it was made the decision on the necessity to conduct (during a year) monitoring investigations on aquifer's migration characteristics identification. Only when these characteristics are received it will be possible to make the adjustment of these model solutions.

In spite of the fact that the obtained forecasting results (exclusively of moderation factor) are more "offensive", these forecasts enable to evaluate tendencies of change of ground water quality condition in prospect, based on these model solutions one can make univocal conclusions regarding solution of the problem associated with supplying the water of good quality.

Impact on soil and flora

Overlapping of environmental contamination sources will definitely play positive role in remediation of the environment, including soil.

Membrane will allow reducing filtration of atmospheric precipitations into ground waters, it will protect atmosphere against dusting, increased radiation, keep from contact with harmful agents, while the landscape arrangements (planting of vegetation) will add not only aesthetic appearance to the territory, but it will as well play positive role in purifying air of the adjacent territory. Emissions into atmosphere will be considerably reduced, and this, in its turn, will greatly slow down further soil pollution through ambient air.

Change of balanced surface of ground waters might influence on root system of vegetation. However, natural level of ground waters in the area of maximum recession of level during water withdrawal by remediation water intake facility comprises almost 7-10 m. Recession of ground water level in the volume of 1-2 m no more of the amplitude of ground water level seasonal fluctuations. In other words, root system is adapted to such level fluctuations of ground water, and such changes will unlikely have great impact upon vegetation.

Impact on geotechnical soil properties (assessment of possible change of territory shakability and stability of buildings and structures).

Such changes of level will hardly influence on territory shakability. Increase of shakability approximately by +1 might be resulted in such case when it would be thinning of ground waters if these waters will significantly rise. Meanwhile, in this particular case, thinning of ground waters is not the subject of discussion. Ground water level will stay, as before, at considerable depths.

As for the changes of soil bearing capacity, if its water saturation is changed, main jeopardy will be represented by soil, loams and sandy soil. Rubbly-pebbles and half-rocks don't change bearing capacity in case of soaking.

Situation with level change, to this or other way, in both cases won't entail worsening of buildings' stability. Value of ground water level change as a result of maintenance of both lines of wells will be no more of the value of natural level fluctuation. It should be noted that natural level of ground water occurs at the depths, which exceeds the capacity of sealing cover, i.e. it is set at occurrence depth of loam bottom, and, as a rule, it is set in gravel – pebbles. In this connection, level recession as a result of pumping out, won't influence on bearing capacity of the said soil.

Wastes

Special attention deserves formation of great wastes' volumes resulted in water treatment, the mentioned wastes should be either sent to one of slurry reservoirs of UMP, or subject to further processing for extraction of metals, production of construction materials, etc.

Thus, analyzing the impact upon environmental components it might be stated that both at construction stage, and at the stage of objects (designed for ground water remediation) maintenance all forecasted negative impact will be of low intensity (Table 5.2). No any great negative consequences are envisaged for the environment. However, at the same time it is planned to solve acute problems associated with ground water quality condition. Positive effect as a result of project implementation is obvious. All these positive moments of FS implementation will positively influence on population health.

The necessity of FS solutions realization is dictated by the following circumstances.

- In the nearest future the issue regarding supply with qualitative drinking water to Ust-Kamenogorsk city will escalate.
- Ground waters on the right bank in the nearest 5-15 years will be, as before, polluted even in case of treatment of the aquifer through pumping-injection of ground waters.
- Contamination of Oktyabrskiy water intake facility in the nearest future is inevitable. The effect of treatment will appear only after 20-25 years.
- In the nearest time one shouldn't expect qualitative ground waters in the right bank of Ulba and Irtysh rivers.
- Real solution of the problem regarding qualitative water supply for the forthcoming time appears to be maintenance of ground water intake facilities located on the left bank of Irtysh and Ulba rivers.
- Relocation of drinking water intake facilities to the left bank doesn't rule out the necessity in remediation water intake facility.

Therefore, water supply problem might be solved provided that:

- Contamination sources are liquidated
- Ground waters are purified (pumping out or pumping out/injection)
- Drinking water intake facilities located in central and western part of the city are relocated to the left bank of Irtysh river
- Water intake facilities located in south-east and eastern part of the city are involved into water supply process

Exclusion of the measures on pumping out and treatment of ground waters will entail rapid spread of contaminants towards Irtysh river to the zone of acting Oktyabrskiy water intake facility.

Regardless of the fact that the process of aquifer remediation will encompass several decades, it is required to start implementation now so that not to dramatize today's situation.

Table 5.2

Integrated impact assessment of major technological operations on elements of the environment

Impacted elements / Impact source	Ambient air	Surface waters	Ground waters	Soils	Flora	Fauna	Subsidence, seismicity change	Health
Construction stage								
Wells' drilling	Low negative	–	–	Low negative	Low negative	Low negative		–
Pipeline laying-out	Low negative	–	–	Low negative	Low negative	Low negative		–
Construction of water treatment plant	Low negative	–	–	Low negative	Low negative	Low negative		–
Sludge ponds' covering	Low negative	Low negative –	–	Low negative	Low negative	Low negative		–
Operational stage								
Pump-out/injection	–	–						
• Hydrodynamic changes			Low negative	–	Low negative	–	Low negative	
• Hydrochemical changes			High positive					High positive
Water treatment	–	–	–	–	–	–	–	
Treated waters discharge into the river	–	Low negative	–	–	–	–	–	
Sludge disposal	Low negative	–	–	–	–	–	–	

Impact level:
- – - No impact
- (grey bar) - Low negative
- (green bar) - High positive

6. ENVIRONMENTAL MANAGEMENT PLAN

This FS is the environment targeted project, that proposes ways of ground waters remediation in the form of the environmental measures. As mentioned above, FS proposed two main measures aimed at ground waters quality improvement:

- Covering of slurry reservoirs for liquidation of atmospheric precipitation infiltration through the body of slurry reservoir and contaminants penetration into ground waters (liquidation of leakages, elimination of contaminants infiltration within the area of ground waters pollution sources deemed as obligatory activity, however, this activity is not a part of the measures stipulated in this project),
- Interception of ground waters using the remediation water intake facility, purification and injection of waters upstream of ground water flow.

According to investigations, while implementing FS solutions, resultant impact upon ground waters is expected to be significantly positive, it should be noted that the impact will be observed on the other environmental components, however, such impact will be slight. Meanwhile, it is anticipated to undertake complex of activities directed to reduce impact at the stage of the facilities' construction and maintenance.

6.1. CONSTRUCTION STAGE

As it was previously noted, during the stage of construction of ground waters remediation facilities (construction of water supply wells and infiltration wells, water pipeline, plant for ground water treatment, covering of slurry reservoirs and ash-disposal areas), certain adverse impact upon the environmental components may be detected within the operational area. Notably, it will be impact on ambient air, caused by dusting of stored wastes, excavation, loading, unloading operations. In this connection it is planned to undertake monitoring of ambient air.

6.1.1. Monitoring of ambient air

The purpose of this monitoring is to monitor ambient air conditions while performing reclamation works at dumps and slurry reservoirs and after implementation of the activities stipulated by the project.

Main objectives:

Quality control of ambient air at the border of buffer zones of Cone-shaped dump No.6 of KazZinc, dump 6 of UMP, slurry reservoir of Condenser Plant, ash disposal site No. 1 of UK HPP, ash-disposal sites 2a, 2b of UK HPP, TMP dump, dump of Experimental Lead-Zinc Plant, dump of SHPP and in the residential areas closely located to these dumps.

Monitoring should be carried out in compliance with the "Instruction on atmospheric contamination control" WD 52.04.186-89 and "Standard rules for arrangement and conduction of the industrial environmental monitoring", approved by the Ministry of Natural Resources and Environment Protection No.215-П dated 16.08.1999,

According to RoK Law "On Environment Protection" as of 15.07.1997 and clauses 21,22,23 of RoK Law " On Ambient Air Protection" as of 23.03.2002, all enterprises, which operate in the city of Ust-Kamenogorsk and have sources of contaminants' emissions, should carry out industrial monitoring of ambient air.

Monitoring of ambient air includes as follows: monitoring of ambient air quality at the border of buffer zones of plants and control of contaminants' emissions in accordance with the approved projects of standards for maximum permissible emissions.

As a part of this work, due to the fact that in the course of dumps and slurry reservoirs reclamation all sources of contaminants' emission are fugitive, it is slated to undertake monitoring only at the adjacent territories: at the border of buffer zones and in the nearest residential zones.

While undertaking monitoring of ambient air during reclamation works it is expected to obtain information on near-surface air layer concentrations of contaminants in ambient air. Ambient air quality will be monitored for ingredients, acting as the main contaminants during works performance. The following substances relate to main contaminants: inorganic dust with silicon content 20 to 70%, carbonic oxide, nitrogen dioxide, sulphur dioxide, lead and its inorganic compounds.

Industrial monitoring of ambient air is required to be carried out on a contractual basis with the certified laboratories of plants (lead-zinc plant, UHPP and others).

Values of measurement results obtained in-situ are compared with maximum single permissible concentrations (MPCm.s.) or with tentative safe exposure level (TSEL) for populated areas, as per the lists of RoK 3.02.036.99 and RoK 3.02.037.99 and additionally with the values of near-surface air layer concentrations, which are obtained by using an approach of the mathematical simulation, provided in section 5.4.

As required, near-surface air layer concentrations will be monitored in working area, and criterion for ambient air assessment will be maximum permissible concentrations for working area, adopted according to GOST (state standard) 12.1.005-88 "General sanitary–hygienic requirements to air of working area". Should the concentrations of this or another components be increased it is expected to use personal protective equipment (e.g., respirators with relevant filter for protection against dust, gloves).

Peculiar feature, while measuring atmospheric contamination at the border of the buffer zone, is a continuous or periodic variation of wind direction, almost 40-50o, in this connection, in order to get reliable data on air pollution, sampling should be undertaken according to the fan system – simultaneously in 3 points from leeward side and in 1 point from windward side.

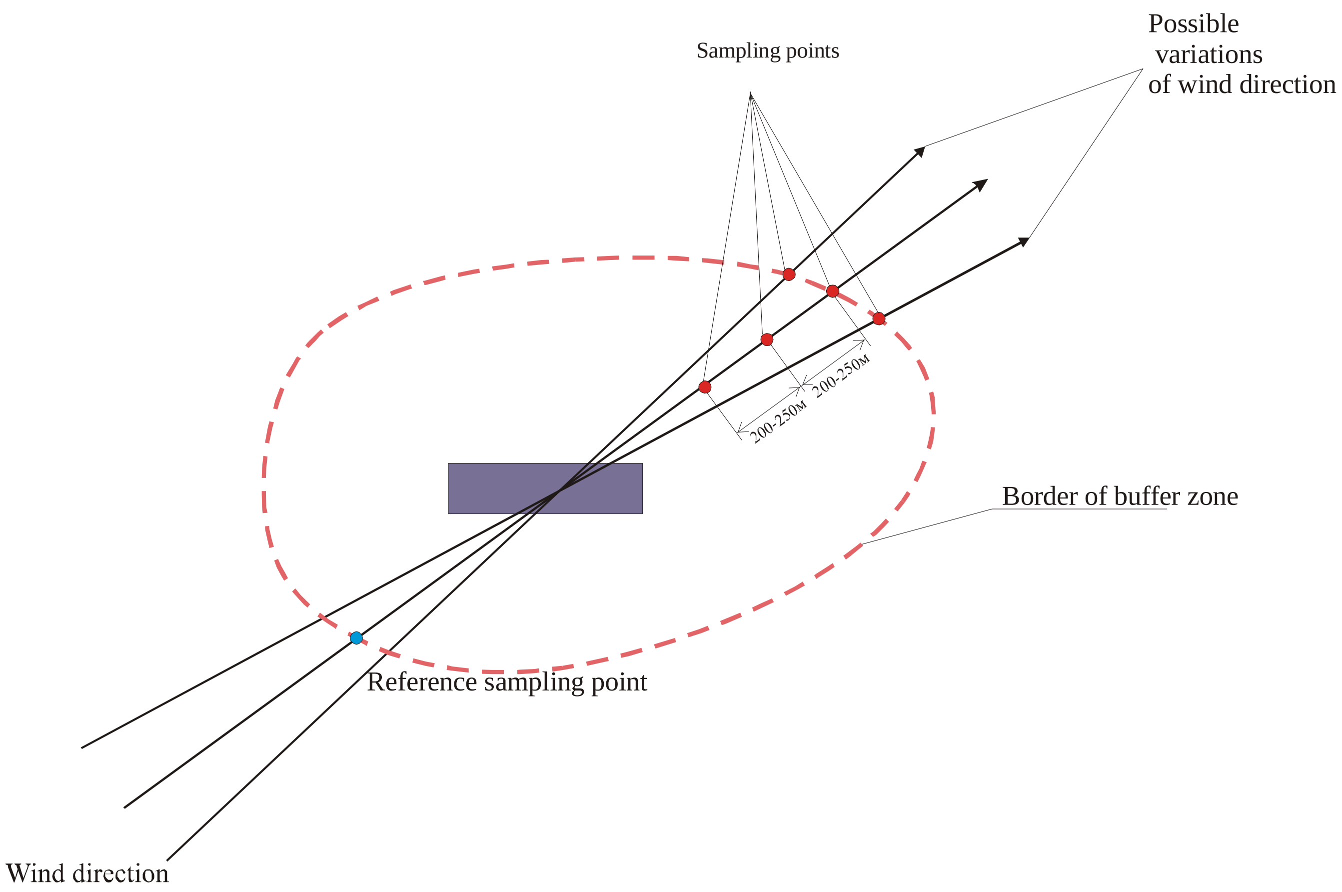
In residential zone measurements will be undertaken in one – two points taking into account wind direction and impact of the main contamination sources.

Duration of air sampling, which is intended to define single concentrations of contaminants, will total 20-30 minutes. Some 3 samples will be collected during one sampling cycle in each point. Sampling will be performed at height of 1,8-2,0 m above the ground surface. Monitoring frequency of near-surface air layer concentrations will be once per 10 days.

Quality control of ambient air is anticipated to be undertaken at the border of buffer zone of Cone-shaped dump No.6 of KazZinc, dump 6 of UMP, slurry reservoir of condensator factory, ash-disposal area 1 of UHPP, ash-disposal areas 2a, 2b of UHPP, TMC dump, dump of experimental lead –zinc plant, SHPP dump and in residential zones closely located to these dumps. Size of buffer zones is specified for each plant in the projects of standards for maximum permissible emissions.

Location of sampling points during instrumental measurements is given in Figure 6.1.

Scheme
of air sampling



Tables 6.1 and 6.2 illustrate the controllable air parameters and instruments for their measurements. The controllable air components are as follows: nitrogen dioxide, carbonic oxide, inorganic dust, lead and its compounds, since the mentioned components dominate in ambient air at the sites targeted for reclamation.

Upon completion of each stage of measurements, such measurements should be registered in special logs, and it is required to prepare interim quarterly reports. Following the completion of quarterly monitoring works it is required to produce the final report representing the analysis and summary of the acquired measurement results. The report should be agreed upon with the relevant environmental authorities.

Table 6.1

Instruments for measuring meteorological characteristics

Parameters	Device	Measuring range	Accuracy	Quantity and duration of observations *
Ambient air barometric pressure	Aneroid-barometer BAMM	80 * 103 to 106 * 103	±5%	once during 10 min
Ambient air temperature, ^{o}C	Mercury thermometer	-30 to +50	±0.5	2 readings
Velocity of air flow, m/s	Digital anemometers AP1	0 to 5, 1 to 20	0,2 м/м 0,5 м/с	3 times
Wind direction	Pennon, Compass	0 to 360	$\pm 5^{o}$	3 times
Air humidity, %	Aspirated hydrometer MV-4M	10 to 100	±1.0%	2 times 4 min each
Weather condition	Visual	-	-	-
Ground surface conditions within 100 m radius	Visual	-	-	-

* - quantity and duration of air parameters measurement during one cycle of sampling

Table 6.2

Methods and instruments for measuring pollutants' concentrations in ambient air

No.	Air component	Measuring methods		
		Main		
		Method	Instrument	Accuracy
1	Nitrogen dioxide	Photometrical with sampling on membranous sorbent	Photoelectric colorimeter KFK-3	± 18
2	Carbonic oxide	Electrochemical	Palladium-3 Palladium-2M Control by Ecoline Plus	± 20 ± 5
3	Inorganic dust	Weight	Electro-aspirator EA-3	±20
4	Lead and its compounds	Atomic –absorption method	Spectrophotometer	±15

Cost of ambient air monitoring will be specified based on the cost of one analysis and quantity of samples collected. As known, covering of slurry storage reservoirs and ahs-disposal sites will be performed within 2 years: four slurry reservoirs of high priority will be covered during 5 months, and the facilities of lower priority will be covered during 3 months (it is planned to perform simultaneous covering of several facilities). It is expected to undertake 3 measurements per month at each site under monitoring. And 4 samples will be collected at each measurement in accordance with Figure 6.1. Price for one sample analysis will total around 15,000 KZT. Hence, cost of sampling at the objects of high priority will amount to 3,600 KZT, while the cost of sampling at the objects of lower priority will be 1,800 KZT.

6.1.2. Environmental protection measures during the drilling operations and soils extraction for temporary use

At performing the construction operations, there will be no impact on the surface and ground waters, therefore any environmental protection measures are not planned.

Certain volume of soils will be wthdrawn from the use during the construction of the water pipeline system. After completion of the water pipeline construction the soils must be reclaimed. Soils reclamation area will comprise of 170 thousand m^2. Reclaiming will be carried out within the framework of a separate project and will consist of the return of the removed soil layer to its initial location. At the places where the soil layer was absent, grass sowing must be done so as to mitigate water and wind erosion processes. Cost of the soils reclamation on the land strip of the water pipeline will be approximately 500 thousand KZT.

During the wells drilling, all generated drill cuttings should be removed to an appropriate place (under the contract with the enterprise capable of accepting these wastes for storage). Volume of drill cuttings to be disposed will total 207 m^3 (393 t). Cost of such waste disposal will be about 43 thousand KZT.

6.2. PERIOD OF EXPLOITATION

Ground waters monitoring will be the main activities enabling to ensure the control upon ground waters conditions during the conduct of technical operations.

Ground waters monitoring

To monitor the environmental processes and to control the efficiency of the pollution sources liquidation as well as to ensure the possibility of undertaking a timely response, the Feasibility study recommended to construct a number of monitoring wells in the area of Central Industrial Complex and on the way of the pollution plum spread towards the water intake facilities (Octyabrsky, North-Atamanovsy, III Microrayon) and Irtysh river bank. Total of 25 wells will be drilled for this purpose, their location layout is shown in Fig. 6.2. The remediation wells at the water intake facilities will also be used for monitoring purposes (i.e. the additional 23 wells). Monitoring wells will be placed on the expected way of the pollution plum spread, enabling to identify the pollution sources and assess the impact from various enterprises. Depth of the monitoring wells should be equal to at least 2/3 of the aquifer thickness, while some f the wells should be as deep as till the base of alluvial sediments. To perform interval sampling, wells should be grouped into clusters.

Monitoring wells located downstream of the remediation water intake facilities in the direction towards Octyabrsky and III Microrayon water intake facilities, Irtysh river and Central Industrial Complex should be used for the controlling of the following water parameters:

pH, dry residue, water hardness.

Macrocomponents: NO_2, NO_3, CO_3, HCO_3, Cl, SO_4;Ca, Mg, Na, K, NH_4.

Microcomponents:

- As, F, Mo, Cu, Pb, Zn, Se, Cd, Tl, Be, V, Ni, Sr, B, Cr+6, Co, Li, Al, Hg, Ti, Ba, Ta, Ag.

Organic matters:

- Phenol, total hydrocarbons, benzene, toluene, ethylbenzene, xylene, volatile organic compounds, polyaromatic hydrocarbons

Radioactivity:

- Total α – radioactivity, total β – radioactivity.

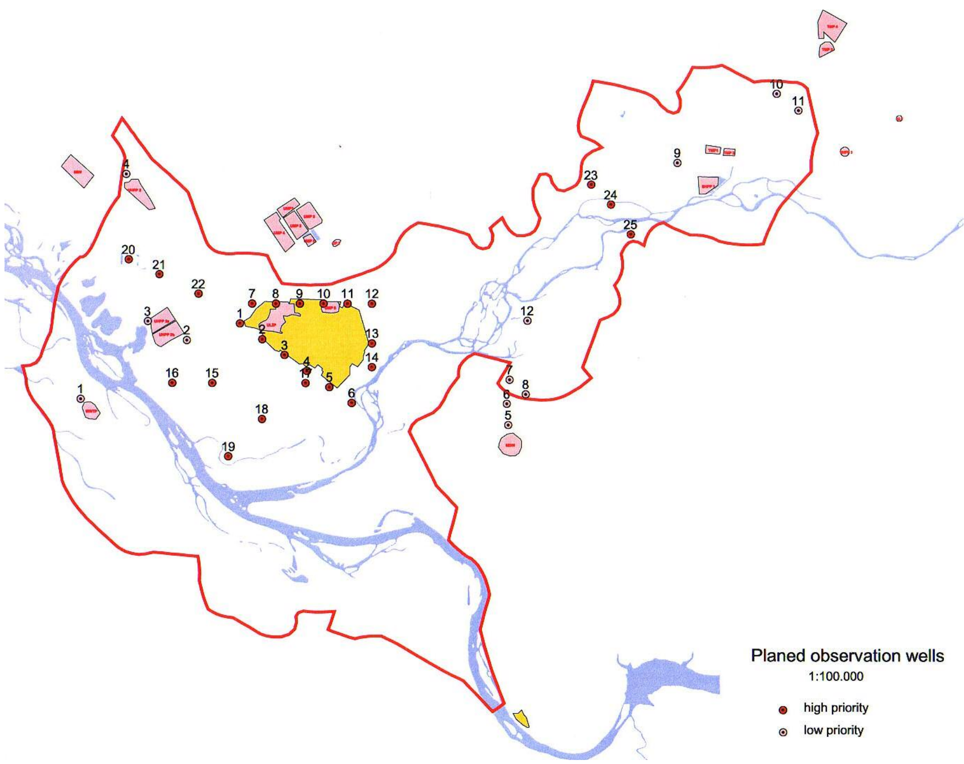


Fig. 6.2. Layout scheme of observation wells

As stated above, 25 monitoring wells in the central part of city (plus additional 23 wells of the remediation water intake facilities) will be purposed not only for monitoring of the results of the project performance. Results of the first year of observations should enable to make a reliable calibration of the hydrochemical model. Therefore sampling frequency during the first year of monitoring should be at least once a month. Further on the sampling frequency may be reduced down to 1-2 times per a quarter.

The covered areal pollution sources belonging to the group of so called “lower priority” (TMP1, UK HPP 1, 2 a,b, Sogrinskaya HPP) should also be outfitted with the monitoring facilities so as to control the quality and efficiency of the covering. Other 12 observation wells should be constructed on the sites of the said enterprises. Frequency of the observations should be twice a year (deemed as sufficient).

Controllable groundwater parameters on the site of ***TMP 1*** **-** pH, water mineralization, water hardness, Ca, Mg, Cl, SO_4, PO_4, NO_3, NH_4, Fe, Ti, V, Mn, Pb, Cd, Tl, Li, B.

Controllable groundwater parameters on the site of ***ash disposal dumps***: Ca, Mg, Na+K, Cl, SO_4, HCO_3, pH, NO_3, NH_4, Fe, F, As, V, Mn, Cu, Pb, Zn, Se, Cd, Tl, Hg, Be, oil products, total α – and β – radioactivity.

Some groundwater pollution sources such as, for example, ***domestic waste dump***, do not contribute to pollution of the aquifer, which is used for the water supply to the city. Certain presence of mercury and lead was detected in the wells located downstream of the groundwater flow, ad it is the unacceptable fact. It is necessary to clarify the reasons groundwater pollution with these components, which is possible to do by virtue of drilling the observation wells of about 15m deep. Drilling of 4 wells will be sufficient at the first stage of monitoring, ad such monitoring program may subsequently be expanded.

Controllable groundwater parameters will include: pH, dry residue, Ca, Mg, Na+K, Cl, SO_4, HCO_3, pH, NH_4, NO_3, Fe, Cu, Pb, Cd, As, oil products.

Frequency of observations is planned to be once per a quarter.

Water sampling in wells should be taken only after a sufficient water volume is flushed with a use of the electric pump. Immediately after flushing such water parameters as temperature, pH, redox potential should be measured. Water samples should be taken with a use of the sampling instrument.

Accuracy of the analytes detection method should be at least 0,5 $MPC_{surface\ water}$.

Tables of chemical composition will be compiled and hydro-chemical maps will be generated on the basis of results of groundwater chemical analyses. Changes in the qualitative composition of groundwater and the reasons thereof will be revealed by virtue of comparing the acquired results with results of the earlier accomplished analyses.

As mentioned above, water sampling in monitoring wells should be at least once a month during the first year of the monitoring program. This means that (25 wells x 12 samples) = 300 samples will be taken during the first year of the monitoring program. Cost of 1 sample analysis for all controllable groundwater parameters will be about 13000 thousand KZT per year (for the central line of observation wells).

In the future, monitoring will be carried out by involving 37 wells located in the central part of the survey area and 12 wells located on the operational sites of the enterprises belonging to the group of lower priority. Analysis cost for samples taken in the in the central part of the survey area will be (37 x 45000 x 4) = 6660 thousand KZT per year.

Assuming that the analysis cost for samples from wells of the lower priority enterprises is 22000 KZT, total cost of analyses will equal to (22000 x 12 x 4) = 1056 thousand KZT per year. So, the total cost of the sample analyses will be 20716 thousand KZT per year (151 thousand USD). Cost of the analyses to be performed within 25 year term will amount to 517900 thousand KZT (3780 thousand USD)

Analytical works under the monitoring program

Analytical works should be carried out at the certified and approved laboratories. Currently in Ust-Kamenogorsk groundwater sample analyses are performed at the following certified laboratories:

- Laboratories of JSC UMP, JSC TMP, UK JSC KazZinc, Oskemen-Vodocanal;
- Laboratory of TOPAZ LLP (previously owned by the former geologic exploration committee "VostokKazNedra");
- Laboratories of Sanitary-Epidemiological Station (SES) and EKO Territorial Committee of Environmental Protection (i.e. the noncommercial organizations)

Data acquisition, processing and management

Typically, each company, which causes the environmental pollution in Ust-Kamenogorsk city, is conducting the environmental monitoring within its premises inclusive of ground waters monitoring as well. Results of the environmental monitoring are compiled into summary tables and reports, which are submitted to EKO Territorial Committee of Environmental Protection and Territorial Committee "VostokKazNedra". As monitoring under the proposed project may be classified as of local level (intended for the study of the subsurface technogenic changes in the socially-economically important areas), so the most rational approach in this case will be to entrust Territorial Committee "VostokKazNedra" to perform such monitoring, because this organization has the sufficient experience in performing the interpretation of hydrogeological monitoring data, is manned with the qualified experts and equipped with the relevant methods for data interpretation. At the same time local, industry-controlled and the state-run monitoring programs should be united by virtue of using the up-to-date technical instrumentation and facilities. All companies, carrying out the monitoring operations, should have an access to all monitoring results. The patented software ALWIS, developed by WISMUT GmdH is recommended for the implementation of such large-scale environmental projects.

Alternatively, it is possible to employ the groundwater pollution database created on the basis of the GIS system.

Continuously operable hydrogeological model, made for the river right-bank area, may serve as the basis for prediction and prevention of hydrodynamic and hydrochemical processes.

Systems of reaction measures and engineering protection

Results of the local monitoring data interpretation will enable to evaluate the efficiency of the pollution sources isolation, to identify new pollution sources, to trace results of groundwater remediation (efficiency of groundwater treatment). At revealing a stable growth of pollutants concentrations in ground waters, it will be necessary to identify a source of such growing pollution and notify the company being the pollution source, to be followed by applying the sanctions.

Schedules of the remediation measures and monitoring observations is provided in Table 6.3.

Table 6.3

Measures on the environmental impact remediation, schedule of the remediation measures and their cost

Source of the impact	Measures on the impact remediation	Duration of the impact (months after the project commencement)		Cost of remediation measures (USD)
		start	finish	
Construction stage				
Drilling	Storage of non-toxic drill cuttings 207 m^3, (343 t)	12	24	Cost of drill cuttings storage – 43,230 KZT (315.5 USD)
Pipeline construction	soils reclamation	70	88	500 thousand KZT (3650 USD)
Construction of water treatment facilities	no	-	-	-
Covering of the slurry storage ponds	Ambient air monitoring Personal protective equipment	18	42	5400 thousand KZT (39.4 thousand USD)
Stage of the facilities exploitation				
Pump out/ injection of ground waters	Groundwater monitoring	24		13000 thousand KZT in the 1st year (94.9 thousand USD) 7716 thousand KZT for each next year (56.3 thousand USD)
Ground waters treatment	Storage of 7,350 t/year wastes of 3rd toxicity class	40	52	3234 thousand KZT (23.6 thousand USD)

6.3. INSTITUTIONAL ALLOCATIONS OF RESPONSIBILITIES

The project is planed to be realized under the supervision of the Committee of water resources under the RoK Ministry of agriculture. The Committee of water resources will entrust Project Management Committee with the powers to organize construction of the planned facilities. Such construction of ground water rehabilitation facilities will be carried out by contracted companies, which will perform the following:

- Wells drilling,
- Construction of the pipeline,
- Construction of the ground water treatment facilities

All the contracted organizations have special environmental protection divisions in their organizational structure, including as follows.

- Department (agency) for the environmental protection during projects implementation,
- Department (agency) for work safety, fire safety and industrial sanitation (responsible for supervising the compliance with work and fire safety rules, stipulated in the relevant normative documents),
- Department for emergency situations management (responsible for the use of money contingencies and implementation of emergency measures, actions coordination (as required) under the threat of emergency or in case of any emergency occurrence).

At the stage of the project designing, all the contracted organizations should work out EIA projects, providing for maximum permissible air emissions (MPE), maximum permissible discharges to water bodies (MPD) and the Program of the environmental monitoring during the construction operations. In addition to that, the Plan should be developed for reclamation of soils to be exposed to the mechanical impact.

The above mentioned EIA projects, MPE and MPD projects, the Program of the environmental monitoring and Plan of soils reclamation should be prepared by the specialized organizations. These documents should be agreed upon with the state environmental protection authorities (Fig. 1.1.). Cost of such projects will be 15-100 thousand USD approximately.

At the sage of exploitation of the ground water rehabilitation facilities, the institutional base will be as follows. All the rehabilitation facilities will be under the management of the independent operating body to be initiated and formed by the Committee of water resources. This Operating Body will implement management and control of the enterprise of ground water treatment, the enterprise of ground water pump out and injection. The ecologist of higher authorities may be entrusted to supervise the implementation of environmental protection measures during the project fulfillment. The key aspect of the facilities exploitation stage is the ground waters monitoring. Such monitoring may be carried out by the territorial committee “VostokKazNedra” or the Oblast Committee of environmental protection. Alternatively, an independent committee may be formed for the ground waters monitoring within the framework of the planned project.

7. RESULTS OF THE PUBLIC OPINION ANALYSIS WITH REGARD TO THE FS SOLUTIONS IMPLEMENTATION

On May 11, 2005 the hall of Municipal Akimat (administration) hosted the meeting of Working Group (in the presence of Ust-Kamenogorsk Deputy Akim – Kudinov A.U), that is responsible to supervise this project. The initiator of this meeting was CC “NEDRA” LLP. Discussion of the FS final version and EIA project were the main issues in the meeting’s agenda.

Specialists of the industrial plants, including the representatives from Territorial Administration “VostokKazNedra”, WBRD representatives, representatives from “Sange” Research Center (Astana) were among the attendees of the mentioned meeting. Specialists from the Regional Committee of the Environmental Protection were invited to attend this meeting, but unfortunately they were absent. The attendees positively accepted the FS and EIA solutions.

The FS and EIA were put for the public discussion; and such public discussions were conducted on May 12 in the Technology park premises within the East Kazakhstan Territorial Geological Committee in Ust-Kamenogorsk. Information on the public hearings was advertised in the Republican newspaper “Kazakhstanskaya Pravda” and in the electronic newspaper “EcoPravda of Kazakhstan”. Moreover, a week before the public hearings, the facsimile messages had been sent to the Regional Committee of Environmental Protection and major industrial plants of Ust-Kamenogorsk city, indicating the place and time of the public hearings.

Representatives of the International Bank of Reconstruction & Development, as well as the representatives of supervisory authorities, industrial enterprises, research organizations operating in the city of Ust-Kamenogorsk were among the participants of the mentioned hearings.

Total number of attendees comprised of 98 persons.

The Consulting Center “NEDRA” LLP was responsible for the public hearings arrangement:

The following reports were made at the meeting:

1. Results of the geological simulation for options of ground waters remediation. Methods of dumps and slurry reservoirs remediation. Report was presented by Dr. Ralf Goerner, director of JV Geooilservice Kazakhstan LLP, Ph.D of Mineralogy Science.

2. Preliminary Environmental Impact Assessment for FS technical solutions. Report was presented by Kalmykova N.V., the deputy director of Ecological Research Department of the Consulting Center “NEDRA” LLP (Almaty), Ph.D of Mineralogy Science.

3. Results of Social assessment of Ust-Kamenogorsk Environment Remediation Project. Report was presented by: Dzhandosova Janar, Director of “Sange” Research Center, Baitugenova Nataliya, Project Manager.

Main questions addressed to the reporters were as follows:

1. What kind of polluting substances will be subject to removal from ground waters?
2. What kind of methods for ground waters purification from trichlorodiphenyl polluting substances of Condenser Plant will be applied?
3. Is it expected any slurry formation while purifying polluted waters in the treatment facilities? What will be a volume of such slurry and where will it be stored?
4. What kind of remedial actions are proposed for Zachita station area?

5. What kind of remediation measures will be undertaken for remediation of 3 Mikrorayon and Zachita water intake facilities, located in the west part of the city?
6. Will Oktyabrszkiy water intake facility be relocated? Did you consider the option of its relocation to the north?
7. Is it planned to conduct any treatment to remove radionuclides?
8. What is the expected capacity of the ground water treatment facilities?

The meeting of the public hearings approved the Feasibility Study solutions and emphasized the urgent necessity of their implementation.